

Diet and dietary patterns during pregnancy in nulliparous women in Ireland: a longitudinal cohort study

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Declaration

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Summary

Background: The impact of maternal diet in pregnancy, for both the mother and baby, has been widely documented. Much of the research on diet in pregnancy has focused on the relationship between single nutrients and maternal and neonatal outcomes. However, more recent studies have demonstrated the need to study diet as a whole.

Aim: To identify the diet, dietary patterns, and physical activity levels of nulliparous women during pregnancy, analyse associations with pre-pregnancy and pregnancy factors, and explore associations with pregnancy, birth, neonatal and postpartum outcomes.

Design: Longitudinal quantitative study.

Setting: One large maternity hospital site in Ireland.

Methods: Site hospital and university ethical approval were granted. Eligible women were nulliparous, aged 18 or over, and able to read and understand English sufficiently to complete the Maternal health And Maternal Morbidity in Ireland surveys, in early pregnancy and at 3 months postpartum. A 'Diet and Physical Activity survey' was developed, validated and tested for reliability, and administered in the third trimester of pregnancy. Dietary adequacy, balance, quality assessed according to four dietary methods: the Alternate Healthy Eating Index for pregnancy in Ireland (AHEI-P (Ireland)), k-means cluster analysis, adequacy of all macronutrients and Protein:Non-protein (P:NP) ratio.

Sample: A total of 872 nulliparous women were recruited during early pregnancy, 557 of whom completed all three surveys and had a dietary intake classified as 'plausible'.

Results: Pre-pregnancy predictors of dietary pattern/quality in need of improvement during pregnancy were: being aged ≤ 29 years (AOR 3.3, 95% CI 1.9-5.9, $p=0.000$) (cluster analysis), being educated to Leaving Certificate/vocational level (AOR 2.5, 95% CI 1.5-4.2, $p=0.001$) (cluster analysis), not exercising (AOR 2.5, 95% CI 1.4-4.5, $p=0.003$) (cluster analysis), never being satisfied with body image (AOR 2.0, 95% CI 1.2-3.3, $p=0.005$) (cluster analysis), being overweight (AOR 2.1, 95% CI 1.3-3.3, $p=0.001$) (AHEI-P (Ireland)), reading food labels sometimes (AOR 2.0, 95% CI 1.3-3.1, $p=0.002$) (AHEI-P (Ireland)) and (AOR 2.4, 95% CI 1.3-4.4, $p=0.003$) (cluster analysis) or never (AOR 2.3, 95% CI 1.2-4.3, $p=0.013$) (AHEI-P (Ireland)) and (AOR 4.9, 95% CI 2.3-10.5, $p=0.000$) (cluster analysis) and not taking supplements (AOR 1.9, 95% CI 1.3-2.8, $p=0.001$) (AHEI-P (Ireland)). Pregnancy predictors of dietary pattern/quality during pregnancy were: being overweight pre-pregnancy (AOR 2.3, 95% CI 1.5-3.5, $p=0.000$) and having food cravings during pregnancy (AOR 0.6, 95% CI 0.4-0.8, $p=0.003$). According to cluster analysis, predictors of dietary pattern/quality during pregnancy, for amount of time spent walking per week were: being aged ≤ 29 years (AOR 3.3, 95% CI 1.9-5.9, $p=0.000$), having Leaving Certificate/vocational level education (AOR 2.6, 95% CI 1.5-4.5, $p=0.001$), smoking (AOR 5.1, 95% CI 1.5-17.2, $p=0.008$), having stopped drinking alcohol during pregnancy (AOR 1.9, 95% CI 1.1-3.4, $p=0.024$), walking for less <150 minutes (AOR 1.6, 95% CI 1.1-2.7, $p=0.043$) or not walking (AOR 4.2, 95% CI 2.1-8.6, $p=0.000$) and vomiting during pregnancy (AOR 2.5, 95% CI 1.6-3.8, $p=0.000$). When exercise was assessed using the variable for

moderate physical activity time per week, the predictors of dietary pattern/quality during pregnancy were: doing moderate exercise for <150 minutes (AOR 2.8, 95% CI 1.1-7.1, $p=0.033$) and doing no moderate physical activity (AOR 6.9, 95% CI 2.8-17.3, $p=0.000$) and vomiting during pregnancy (AOR 2.3, 95% CI 1.5-3.6, $p=0.000$).

Women more likely to initiate breastfeeding had MSc or PhD level education (AOR 2.7, 95% CI 1.3-5.4, $p=0.006$) (AHEI-P (Ireland)) and (AOR 2.8, 95% CI 1.4-5.7, $p=0.004$) (cluster analysis) and were non-Irish (AOR 2.7, 95% CI 1.2-4.7, $p=0.004$) (AHEI-P (Ireland)) and (AOR 2.4, 95% CI 1.2-4.7, $p=0.010$) (cluster analysis). Women less likely to initiate breastfeeding were aged ≤ 29 years old (AOR 0.4, 95% CI 0.2-0.8, $p=0.003$) (AHEI-P (Ireland)), educated to Junior Certificate level or less (AOR 0.2, 95% CI 0.1-0.8, $p=0.021$) (AHEI-P (Ireland)) and (AOR 0.2, 95% CI 0.1-0.9, $p=0.041$) (cluster analysis), Leaving Certificate/vocational level (AOR 0.3, 95% CI 0.2-0.5, $p=0.000$) (AHEI-P (Ireland)) and (AOR 0.3, 95% CI 0.2-0.6, $p=0.000$) (cluster analysis) and were in the diet that needed improvement group (AOR 0.5, 95% CI 0.3-0.8, $p=0.004$) (AHEI-P (Ireland)) and (AOR 0.3, 95% CI 0.2-0.5, $p=0.000$) (cluster analysis). Women more likely to be breastfeeding at 3 months postpartum were sometimes satisfied with their body image (AOR 5.2, 95% CI 1.9-14.5, $p=0.002$) (AHEI-P (Ireland)) and (AOR 5.0, 95% CI 1.8-14.0, $p=0.002$) (cluster analysis). Women less likely to be breastfeeding at 3 months postpartum were aged ≥ 35 years (AOR 0.5, 95% CI 0.2-0.9, $p=0.015$) (AHEI-P (Ireland)) and (AOR 0.5, 95% CI 0.3-0.9, $p=0.043$) (cluster analysis), educated to leaving certificate/vocational level (AOR 0.4, 95% CI 0.2-0.8, $p=0.004$) (AHEI-P (Ireland)) and (AOR 0.5, 95% CI 0.3-0.9, $p=0.019$) (cluster analysis), or had a diet during pregnancy that needed improvement (AOR 0.6, 95% CI 0.4-0.9, $p=0.039$) (AHEI-P (Ireland)) and (AOR 0.4, 95% CI 0.3-0.7, $p=0.000$) (cluster analysis). There was no statistically significant association found between any of the four dietary methods used to assess diet during pregnancy and outcomes: gestational length, infant weight at birth, postpartum depression and postpartum anxiety. Participants whose P:NP ratio were below the median were statistically less likely to birth spontaneously in comparison to women who were in the above the median for P:NP ratio group in the univariate logistic regression analysis (OR 0.7, CI 95% 0.4-0.9, $p=0.037$) however P:NP ratio lost its statistical significance when brought to a multinomial multivariable model.

Conclusion: Even highly educated, older pregnant women also need some improvements in their diet and lifestyle during pregnancy. Further studies are needed to better understand the diet-disease relationship as diet during pregnancy might be one of the most powerful tools to start ending cycles of disparities and diseases.

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List of abbreviations

Acrylamide (AA)

Adequate Intake (AI)

Adjusted odds ratio (AOR)

Alternate Healthy Eating Index (AHEI)

Alternate Healthy Eating Index for Pregnancy (AHEI-P)

American Academy of Pediatrics (AAP)

American College of Obstetricians and Gynecologists (ACOG)

American Diabetes Association (ADA)

American Institute of Medicine (AIM)

Artificially-sweetened (AS)

Average Requirement (AR)

Basal metabolic rate (BMR)

Blood Pressure (BP)

Body Mass Index (BMI)

Born in Guangzhou Cohort Study (BIGCS)

Caesarean section (CS)

Carbohydrates (CHOs)

Cardiovascular disease (CVD)

Centre for Disease Control and Prevention (CDC)

Content validity indices (CVIs)

Coombe Women and Infants University Hospital (CWIUH)

Danish National Birth Cohort (DNBC)

Developmental Origins of Health and Diseases (DOHaD)

Diabetes and Pregnancy Study (IADPSG)

Diagnostic and Statistical Manual of Mental Disorders (DSM)

Diet history questionnaire (DHQ)

Diet Quality Index (DQI)

Diet Quality Index International (DQI-I)

Diet Quality Index Revised (DQI-R)

Diet Quality Score (DQS)

Dietary Approach to Stop Hypertension (DASH)

Dietary References Intakes (DRIs)

Digestible Indispensable Amino Acid Score (DIAAS)

Eating Choice Index (ECI)

Edinburgh Postnatal Depression Scale (EPDS)

Energy contribution to the total energy intake (%TE)

Energy Intake (EI)

Essential amino acids (EAA)

Estimates Average Requirement (EAR)

European Commission for Public Health (ECPH)

European Food and Safety Authority (EFSA)

European Lactation Consultants Alliance (Elacta)

European Prospective Investigation of Cancer (EPIC)

Fetal alcohol spectrum disorder (FASD)

Fetal Origins of Adult Disease (FOAD)

Food and Agricultural Organization (FAO)

Food Diary (FD)

Food frequency questionnaire (FFQ)

General Data Protection Regulation (GDPR 2018)

Gestational diabetes mellitus (GDM)

Gestational weight gain (GWG)

Glycemic index (GI)

Glycemic load (GL)

Haemolysis, elevated liver enzymes and low platelets (HELLP)

Healthy Eating Index (HEI)

Human chorionic gonadatropin factor (hCG)

Hyperemesis gravidarum (HG)

Impaired Glucose Tolerance (IGT)

Institute of Medicine (IOM)

Insulin resistance (IR)

International Association of the Low and Middle income countries (LMIC)

International Physical Activity Questionnaire (IPAQ)

Intraclass correlation coefficient (ICC)

Intrauterine Growth Restriction (IUGR)

Irish Survey of Lifestyle, Attitudes, and Nutrition (SLÁN)

Large for gestational age (LGA)

Last menstrual period (LMP)

Low birth weight (LBW)

Maternal health And Maternal Morbidity in Ireland (MAMMI)

Maternity and Infant Care (MWIC)

Mean adequacy ratio' (MAR)

Mediterranean Diet Quality Index (MDQI)

Mediterranean Diet Scale (MDS)

Mediterranean-type diet (MD)

Modified Mediterranean Diet Scale (MMDS)

Monounsaturated fatty acids (MUFA)

Multiple source method (MSM)

Nausea and vomiting in pregnancy (NVP)

Newcastle-Ottawa scale (NOS)

Non-communicable diseases (NCDs)

Non-randomised studies (NRS)

Norwegian Mother and Child Cohort (MoBa) study

Nutrient adequacy ratio (NAR)

Odds ratio (OR)

Oral glucose tolerance test (OGTT)

Osaka Maternal and Child Health (OMCH) study

Participant information leaflet (PIL)

Physical activity (PA)

Physical Activity Level (PAL)

Polyunsaturated fatty acids (PUFA)

Population Reference Intake (PRI)

Postnatal Depression (PND)

Postpartum weight retention (PPWR)

Pregnancy, Infection and Nutrition (PIN) study

Principal component analysis (PCA)

Protein Digestibility Corrected Amino Acid Score (PDCAAS)

Protein: Carbohydrate ratio (P:C ratio)

Protein: Non-protein ratio (P:NP ratio)

Quality assessment (QA)

Randomised Controlled Trial (RCT)

Recommended Dietary Allowance (RDA)

Recommended Nutrient Intake (RNI)

Reference Intake ranges for macronutrients (RI)

Reported Energy Intake (rEI)

Royal College of Obstetricians and Gynaecologists (RCOG)

Saturated fatty acids (SFA)

Semi-quantitative food frequency questionnaire (SQFFQ)

Short form (SF)

Small for gestational age (SGA)

Statistical Package for Social Sciences (SPSS)

Systematic review (SR)

Sugar-sweetened (SS)

Tolerable Upper Intake Level (UL)

United States of America (USA)

Women and Their Children's Health (WaTCH) study

World Health Organization (WHO)

24-hour dietary recalls (24hRs)

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Chapter One: Introduction

1.1 Introduction to the topic

The focus of recent studies on nutritional epidemiology has increasingly shifted from a single nutrient/specific foods approach to dietary pattern analysis, as nutrients are not consumed in isolation (Hu 2002, Hoffmann *et al.* 2013, Cespedes & Hu 2015, Chen *et al.* 2016). Moreover, it has been recognised that investigating dietary patterns of a population, instead of individual nutrients or foods, also benefits the formulation of public health dietary recommendations on healthful dietary patterns (Cespedes & Hu 2015).

Nutrition has been defined as the “science of food, the nutrients and other substances therein, their action, interaction and balance in relation to health and disease, and the processes by which the organism ingests, absorbs, transports, utilises and excretes food substances” (Arthur *et al.* 2015, p. 1).

Having a poor quality diet is one of the top five predictors of mortality in women (Van Horn 2006). Food and nutrition are basic requirements for the promotion and maintenance of health, and what a pregnant woman eats, before and during pregnancy impacts not only on her health and pregnancy outcomes but also on her baby's health for the rest of its life (Malek *et al.* 2015). There is a growing body of evidence demonstrating how early-life nutrition and other conditions may have an impact on the offspring's health throughout the lifecycle (Currie & Rossin-Slater 2015, Langley-Evans 2015, Godfrey *et al.* 2017).

Women who are pregnant, or planning a pregnancy, are more aware of what they should eat and are willing to modify their diet (Szwajcer *et al.* 2007, Crozier *et al.* 2009a, Atkinson *et al.* 2016, Forbes *et al.* 2018). However, a lack of reliable and accessible information on diet during pregnancy can negatively impact on a woman's ability to make effective/informed dietary changes. In addition, pregnant women often report that they do not receive appropriate or individualised dietary advice and that they find the available information on diet during pregnancy confusing (Ferrari *et al.* 2013, Atkinson *et al.* 2016).

1.2 Statement of the problem and study rationale

A measure of a country's progress, widely and historically used, is the rate of maternal mortality (or deaths) (Bouvier-Colle *et al.* 2012, Firoz *et al.* 2013). Even in high-income countries where maternal mortality is relatively rare, it should still be taken as a key indicator of the quality of a health system, as it raises arguments about the effectiveness and quality of care (Bouvier-Colle *et al.* 2012). The burden of maternal morbidity (health problems that women experience during pregnancy and postpartum) also needs close attention and further investigation, as morbidity itself can be the cause of maternal mortality, as well as a possible origin of a lifetime disability for mother and baby (Manning *et al.* 2017, Firoz *et al.* 2013).

In order for pregnant women to engage or to continue with healthy behaviours during pregnancy, it is crucial that they have opportunities to discuss diet and lifestyle with maternity care professionals during their antenatal care (Flannery *et al.* 2019).

In order to reinforce a positive pregnancy, the WHO developed a list of recommendations on antenatal care with 49 recommendations related to five different types of interventions, and nutritional intervention was one of them (WHO 2016). Those diet interventions involve dietary advice and education, as well as dietary supplement use (WHO 2016), and also highlight the importance of achieving diet adequacy not only in relation to macronutrients but also micronutrients.

Becoming a mother is considered to be a positive time in women's lives yet it is also a time when unfavourable health problems can emerge (Meaney *et al.* 2016). Moreover, it has also been suggested that pregnant women (and women who are planning a pregnancy) are more open to changes that might benefit their baby and improve pregnancy outcomes (Malta *et al.* 2016). Therefore, pregnancy (and the preconception period) has been suggested as an ideal time to offer women interventions, including diet, to improve their health (Royal College of Physicians of Ireland & Health Service Executive 2011, Olander *et al.* 2016, Olander *et al.* 2018).

The Nutrition and Physical Activity strand was established, as part of the **Maternal health And Maternal Morbidity in Ireland (MAMMI)** study, so that predictors of dietary patterns during pregnancy could be identified. This study was also designed to identify what women ate during their pregnancy, the adequacy, balance, quality and pattern of their diet, their socio-behaviours during pregnancy as well as pregnancy, birth,

neonatal and postpartum outcomes that might be related to their diet. Therefore, this PhD study on 'Diet and dietary patterns during pregnancy in nulliparous women in Ireland' originated from the Nutrition and Physical Activity strand so that women's diet as a whole could be explored, to overcome limitations of studying single nutrients or specific dietary food groups.

1.3 Maternal Health and Maternal Morbidity Ireland (MAMMI study)

The Nutrition and Physical Activity strand was developed as part of my PhD work, and embedded in the last wave of the MAMMI study, at the Coombe Women and Infants Hospital (CWIUH). The MAMMI study is an ongoing multi-centre, multi-strand study exploring the health and health problems experienced by first-time mothers before and during pregnancy and up to 12 months after the baby's birth.

Originally, participants completed five surveys: in early pregnancy (survey 1) and at 3 (survey 2), 6 (survey 3), 9 (survey 4) and 12 (survey 5) months postpartum. A total of 3,047 women have been recruited to the MAMMI study and the study is complete in all three sites.

The objectives of the MAMMI study (<https://www.tcd.ie/mammi/>) are:

- (i) to describe the existence, extent and prevalence of morbidity during pregnancy and the first year postpartum in primiparous women
- (ii) to gain an in-depth understanding of the impact of childbirth, motherhood and any related morbidity on women's health and health needs
- (iii) to identify the health-service(s) and self-help seeking behaviour of women
- (iv) to determine the associated risk factors that may be amenable to intervention.

1.4 Nutrition and Physical Activity strand, MAMMI study - Coombe Women and Infants University Hospital (CWIUH)

The antenatal 'Diet and Physical Activity survey' (survey 1A), from the Nutrition and Physical Activity strand, was a new antenatal survey developed as part of my PhD work, 'Diet and dietary patterns during pregnancy in nulliparous women in Ireland', and introduced to the last wave of the MAMMI study, at the Coombe Women and Infants University Hospital (CWIUH). It was the second antenatal survey administered in the late second/early third trimester of pregnancy when the study participants were around seven months pregnant, approximately two months after they had completed the first antenatal survey.

Information on maternal diet during pregnancy (in the third trimester around 28-32 weeks of pregnancy) was collected from a sample of nulliparous women using a validated and comprehensive dietary specific tool to collect dietary data. The main focus of the analysis was to measure participants' diet from a whole-diet approach. Therefore, diet was assessed adopting four different approaches/methods. The practice of physical activity both before and during pregnancy was investigated (as well as changes in social behaviours, such as drinking alcohol and smoking cigarettes). Finally, pre-pregnancy and pregnancy predictors of dietary patterns/diet quality, as well as number of pregnancies, birth, neonatal and postnatal outcomes for the mother and baby were measured and their association with maternal diet during pregnancy was investigated, analysed and discussed in depth.

1.5 Overview of the thesis and chapter contents

This thesis is structured in seven different chapters. Because of the volume and variation in studies on diet during pregnancy, the literature review is divided into two chapters. Chapter two reviews the literature on women's pre-pregnancy diet, maternal diet during pregnancy, nutritional guidelines and the dietary recommendations for pregnancy, and maternal health and social behaviour changes. It sets the scene for the reader and provides an overview of the many aspects that should be taken into consideration when undertaking a study around diet during pregnancy.

Chapter three comprises a systematic review on diet during pregnancy. The rationale for performing a systematic review of the literature was to identify, evaluate, and summarise the findings of all the relevant literature on outcomes of maternal diet during pregnancy. The findings served as a basis to guide the conduct of this study's methodology (e.g., choosing the most appropriate diet assessment tool and the conduct of diet adequacy and quality assessment) and its key contributions are outlined in chapter three.

Chapter four consists of a detailed description of the methodology used for the study and demonstrates how the Nutrition and Physical Activity strand relates to, and is embedded in, the MAMMI study. Chapter five reports the results from the final sample of 557 participants, and chapter six presents a general discussion of the results in the context of current literature. Chapter seven concludes the thesis, giving the strengths and limitations of this research, the implications and recommendations for clinicians, policy-makers and future research in relation to maternal diet during pregnancy, in particular, a larger sample of pregnant women is suggested for future researchers aiming to explore further the relationship between diet during pregnancy and mode of birth.

1.6 Conclusion

This chapter showed not only the importance of diet and a healthy diet during pregnancy but how diet is related to socio-demographic/economic status. Additionally, this chapter outlined the increasing importance of dietary advice during pregnancy due to the short and long-term impact on maternal, fetal and neonatal health. The next chapter explores further the existing literature around diet and lifestyle before-during pregnancy.

Chapter Two: Literature Review

2.1 Introduction

This chapter explores the literature surrounding maternal diet during pregnancy and dietary guidelines: what women should be eating during pregnancy (and even before pregnancy), whether the nutritional requirements are really increased and how women's diet during pregnancy could be related to health outcomes for themselves and for their babies. It also discusses diet assessment and the complexity of the most recent approaches used to measure diet as a whole. Moreover, this chapter also discusses the literature on dietary supplement intake, physical activity during pregnancy and breastfeeding.

The chapter gives a global overview of diet before and during pregnancy and the multiple factors that need to be considered when undertaking a study in this area. The literature search and review was conducted to inform the research proposal and was updated and refined through the years of this PhD so that it contextualises the study and the issues that ought to be addressed. From this reading, a need was recognised for a systematic review of all the relevant literature on outcomes of maternal diet during pregnancy, which led to the conduct of the review in chapter three.

2.2 Maternal diet and Body Mass Index before pregnancy

The health, diet and lifestyle of women preconception is directly linked to pregnancy health and outcomes for the mother and child (Gardiner *et al.* 2008, Barker *et al.* 2018, Koletzko *et al.* 2018, Stephenson *et al.* 2018). Women of reproductive age are encouraged to eat a balanced diet, adopt a healthy lifestyle and achieve an appropriate weight for height ratio (John *et al.* 2014).

The 'Body Mass Index' (BMI) is a numerical value of a person's weight in relation to their height and is commonly used to indicate nutritional status and categorise adults into anthropometric groups (Nuttall 2015). Though it has limitations, it remains one of the most commonly used indices for indirectly measuring adult body fat, and is used to

categorise people as being underweight, a healthy weight, overweight or obese (Appendix 2-1) (Duren *et al.* 2008, Adab *et al.* 2018). It estimates the body's weight rather than fat, despite being described as an indicator of body fatness. BMI is one of several methods used to assess body composition (such as bioimpedance, quantitative magnetic resonance, air displacement plethysmography, dual-energy X-ray absorptiometry, MRI and NMR spectroscopy) (Lemos & Gallagher 2017).

Pre-pregnancy BMI is considered to be an important predictor of pregnancy health and outcomes (Forsum *et al.* 2013, Pan *et al.* 2016). Potential negative outcomes linked to a high pre-pregnancy BMI include: gestational hypertension and pre-eclampsia (Schummers *et al.* 2015, Pan *et al.* 2016, Savitri *et al.* 2016); gestational diabetes (Torloni *et al.* 2009, Schummers *et al.* 2015, Pan *et al.* 2016, Dong *et al.* 2017); preterm birth (Schummers *et al.* 2015, Pan *et al.* 2016); fetal macrosomia (Schummers *et al.* 2015, Pan *et al.* 2016, Vinturache *et al.* 2017); shoulder dystocia (Schummers *et al.* 2015, Pan *et al.* 2016) and caesarean section (Schummers *et al.* 2015). A low pre-pregnancy BMI has been associated with low infant birth weight (Yu *et al.* 2013, Pan *et al.* 2016), and preterm birth and intrauterine growth restriction (Salihi *et al.* 2009, Pan *et al.* 2016).

2.3 Maternal diet during pregnancy

Maternal diet as a basic requirement for the promotion and maintenance of health has an important role during pregnancy, as what a pregnant woman eats, before and during pregnancy, impacts not only on her health and pregnancy outcomes, but also can shape her baby's health for the rest of her/his life (Calkins & Devaskar 2011, Black R.E. *et al.* 2013, Darnton-Hill & Mkparu 2015, Emmett *et al.* 2015, Malek *et al.* 2015, Chen *et al.* 2016, Diemert *et al.* 2016).

The impact of maternal diet in pregnancy, for both the mother and baby, has been widely documented, and pregnancy is recognised as an ideal time to promote positive changes (Royal College of Physicians of Ireland & Health Service Executive 2011, Olander *et al.* 2016, Olander *et al.* 2018). Becoming and being pregnant can enhance a woman's understanding of the importance of a healthy diet and exercise (Phelan 2010, O'Brien *et al.* 2017), and can encourage women to make positive dietary and physical activity changes (Phelan 2010). Women who are pregnant, or are planning a

pregnancy, become more aware of what they should eat and are willing to modify their diet (Szwajcer *et al.* 2007, Crozier *et al.* 2009a, O'Brien *et al.* 2017).

2.4 Early life, diet and disease

The fetus was once considered to be preserved from all the unfavourable environmental toxins by the placenta, and the placenta was considered a “perfect filter” (Almond & Currie 2011, p. 1) where the mother would “pay the nutritional price of pregnancy” (Meltzer *et al.* 2011, p. 1).

However, in 1990, David Barker, based on epidemiological findings, stated that “the womb may be more important than the home” (Barker 1990, p. 1), and promoted the need for research focused on the intrauterine period rather than later on in childhood (Barker 1990). This is known as the “fetal origins of adult disease” (FOAD) and is a topic that has gained increasing attention over the past two decades (Calkins & Devaskar 2011, p. 1, Emmett *et al.* 2015, p. 1, Jahan-Mihan *et al.* 2015, p. 3), (Wadhwa *et al.* 2009). The International Society for Developmental Origins of Health and Disease (DOHaD) was created to continue research in this field (Wadhwa *et al.* 2009).

The Lancet series on Maternal and Child undernutrition, in 2008, highlighted the great positive impact that proper nutrition, and healthy growth from conception to the child's second year of life (“the first 1000 days” of life), has on the prevention of potential future disease (Horton 2013). “The first 1000 days” concept is grounded in the life course epidemiological model (that incorporates epigenetics) and inspired a global campaign and project to invest in this unique and powerful window of opportunity (Black *et al.* 2013).

Despite this increasing body of literature demonstrating a strong correlation between maternal diet and pregnancy outcomes (Lucas *et al.* 2014), coupled with the fact that pregnant women are more receptive to dietary advice (Arrish *et al.* 2017), there is limited published research about dietary advice during pregnancy (de Jersey *et al.* 2013, Lucas *et al.* 2014, Bookari *et al.* 2017). The available literature shows that pregnant women lack information about what to eat (Ferrari *et al.* 2013, Lucas *et al.* 2014, Ockenden *et al.* 2016, Bookari *et al.* 2017) and the lack of knowledge affects their dietary behaviours and dietary choices (Arrish *et al.* 2017, Bookari *et al.* 2017).

This lack of awareness can be an obstacle to women in achieving a healthy diet and adequate supplement use during pregnancy (Bookari *et al.* 2017).

There are specific WHO guidelines for healthcare professionals on nutritional education for pregnant women (Lucas *et al.* 2014), and many countries have their own antenatal guidelines on nutritional advice in relation to healthy eating, use of vitamins and supplements, etc. (Lucas *et al.* 2014). However, most healthcare professionals do not receive detailed education on pregnancy nutrition issues and therefore offer women limited information (Flannery *et al.* 2019, de Jersey *et al.* 2013, Lucas *et al.* 2014, Snyder 2017).

2.5 Pregnant women and the dietary guidelines for pregnancy

Two systematic reviews have shown that pregnant women do not follow the national dietary recommendations for energy intake and macronutrients (Blumfield *et al.* 2012a) or micronutrients (Blumfield *et al.* 2013), and suggested that those women are at risk of deficient consumption of micronutrients (Blumfield *et al.* 2013). In Ireland, the situation is also of concern; a recent study that measured the dietary intake of 402 pregnant women attending antenatal care in one national maternity hospital found that this sample of women were not adhering to the recommendations for diet during pregnancy (Mullaney *et al.* 2017). Since nutritional deficiencies during pregnancy have such a negative impact on the mother, child and future generations, adequate nutrition is essential (Darnton-Hill & Mkpuru 2015).

2.5.1 Macronutrients

Macronutrients are nutrients provided by food as an important source of energy. Macronutrients play an important role in nutrition research as over-nutrition has overtaken under-nutrition problems, even in low-income countries, creating a “double burden” of disease (Crino *et al.* 2015, p.2). Maternal macronutrient consumption can also impact fetal development in various periods of pregnancy (Blumfield *et al.* 2012a, Sharma *et al.* 2018, Mousa *et al.* 2019).

2.5.2 Energy requirements of pregnancy: what is the energy cost of pregnancy?

Dietary requirements during pregnancy are slightly increased due to the extra energy costs of maternal adipose tissue storage, preservation of maternal tissues associated with pregnancy and the needs of the developing fetus (Kind *et al.* 2006, Darnton-Hill & Mkiparu 2015). While the total energy cost of pregnancy can be calculated, it is not equally distributed throughout the trimesters of pregnancy (Guilloty *et al.* 2015) and there are varying estimations of the additional energy required (Appendix 2-2).

2.5.3 Carbohydrates (CHOs)

In the last decade, carbohydrates (CHOs) have acquired a negative reputation, as a result of its link with the risk of cardiovascular disease (CVD), with suggestions that it may be a greater contributor to CVD than saturated fats (Augustin *et al.* 2015), and as a result of the high protein diet trend for weight reduction. However, CHOs represent a key nutrient and the main source of energy for our body, brain (Blaak 2016, Lowensohn *et al.* 2016), and growing fetus (Moses *et al.* 2006, Lowensohn *et al.* 2016), as well as being a good source of micronutrients (Goletzke *et al.* 2015).

Nutritionally, CHOs are grouped into two categories: those that can be digested and absorbed, the 'glycaemic carbohydrates', and those that pass directly to the colon: 'non-digestible carbohydrates', also known as 'dietary fibres' (EFSA 2017, p.13). According to the European Food and Safety Authority (EFSA) Panel on Dietetic Products, Nutrition, and Allergies (NDA), CHOs should provide between 45-60% of adults' and children's energy intake (EFSA 2017), or 45-64% of energy intake (Kominiarek & Rajan 2016), and an intake of 25g of fibre per day (EFSA 2017). However, literature has reported a positive association between a diet containing more than 25g of dietary fibre per day and health benefits, such as reduced risk of coronary heart disease, type 2 diabetes and maintaining appropriate weight (EFSA 2017), and an intake of 14g per 1000 calories during pregnancy is recommended (Trumbo *et al.* 2002).

The recommended values are 175 grams (g) of carbohydrates per day, as they are increased during pregnancy (Lowensohn *et al.* 2016), and it is important that pregnant women choose CHOs with high nutritional quality (Lowensohn *et al.* 2016), usually reflected by whole grain (dietary fibre) content and glycemic index (GI) and load (GL)

(Goletzke *et al.* 2015, Lowensohn *et al.* 2016). GI and GL are concepts explored later in this thesis (chapter 4).

2.5.4 Proteins

Protein is another of the three macronutrients and should be ingested as part of a balanced diet. It performs structural and functional tasks (Elango & Ball 2016) and should provide around 10-35% of daily energy intake (Manore 2005, Rodriguez & Miller 2015). Evidence shows that the average intake of protein ranges from 67-114g/day for men and 59-102g/day for women in European countries, around 12-20% of the total energy intake (EFSA 2017).

During pregnancy, the metabolism of protein is altered in order to support the healthy growth and development of the fetus, preserve maternal homeostasis and support lactation. An appropriate intake of protein is key to positive outcomes of pregnancy, including preventing intrauterine growth restriction (IUGR) and low infant birth weight (LBW) (Stephens *et al.* 2015, Elango & Ball 2016). Protein requirements increase progressively during pregnancy, especially in the third trimester, to support fetal growth and preserve maternal tissues (Marangoni *et al.* 2016). It goes mainly to the fetus (42%), uterus (17%), blood (14%), placenta (10%) and breasts (8%) (Butte & King 2005) and, while international guidelines recommend that maternal intake should be increased during pregnancy (Marangoni *et al.* 2016), recommendations vary (Appendix 2-3).

2.5.5 Fats

Dietary fats (or lipids) also provide a major amount of energy (calories) (EFSA 2017) and are necessary for the absorption of fat-soluble vitamins (A, D, E and K) and essential nutrients (German & Dillard 2004). Fatty acids are the important elements of a fat molecule (structural elements) and they perform many tasks in the body (German & Dillard 2004, EFSA 2017).

Fatty acids are divided according to their number of double bonds: those with no double bond (saturated fatty acids), those with one double bond (monounsaturated fatty acids), and those with two or more double bonds (polyunsaturated fatty acids) (EFSA 2017). Some countries have specific dietary recommendations for the intake of total fat and different fatty acids (EFSA 2017). Cholesterol, also considered to be a fat,

does not provide energy (calories) but has an important function in multiple metabolic processes (EFSA 2017).

Long-chain polyunsaturated fatty acids omega-3 (ω 3 or n-3) and omega-6 (ω 6 or n-6) (LC-PUFAs) are fatty acids made of 18-20 carbons or more, and are divided into two groups based on the position of the first double bond from the methyl end fatty acid group: the eicosapentaenoic acid omega-3 (EPA), docosahexaenoic acid omega-3 (DHA) and the arachidonic acid omega-6 (ARA) (Abedi & Sahari 2014, Zárata *et al.* 2017). Omega-3 fatty acids, such as EPA and DHA, have been suggested as very important during pregnancy and their supplementation is linked to multiple health benefits to the baby (Swanson *et al.* 2012), such as growth and development of the brain (Conway *et al.* 2018). Their requirements are highest in the last trimester of pregnancy (Conway *et al.* 2018).

Also during pregnancy, the quality of fat consumed seems to have a greater impact on health outcomes than the total intake of fat (Marangoni *et al.* 2016). For instance, a systematic review and meta-analysis (nine studies) that investigated the effect of omega-3 fatty acid (a polyunsaturated fatty acid) on early preterm birth (before 34 weeks gestation), any preterm birth or other maternal and neonatal outcomes, concluded that the intake of omega-3 fatty acids has a positive association in preventing early and any type of preterm birth (Kar *et al.* 2016).

During pregnancy, the recommended intake of total fat is unchanged compared to non-pregnant women (Kominiarek & Rajan 2016, Marangoni *et al.* 2016) and should provide around 20-35% of the daily energy intake (Kominiarek & Rajan 2016).

2.5.6 Micronutrients and supplementation

Micronutrients, vitamins and minerals, are needed in smaller amounts than macronutrients, nevertheless they are fundamental for a healthy pregnancy and take part in every maternal, placental and fetal activity (Gernand *et al.* 2016). During pregnancy, the intake of some micronutrients should be increased more than the intake of macronutrients (Marangoni *et al.* 2016). The literature suggests that fetal metabolism, organ growth, development and function might be affected by the maternal micronutrient profile during pregnancy and might be linked to chronic diseases in the children in the long term (Blumfield *et al.* 2013).

Research on the relationship between micronutrient status, deficiency and supplementation has, mainly, focused on pregnant women from low-income nations, nevertheless women from high-income countries are also at risk of deficiencies (Blumfield *et al.* 2013), partly due to eating unhealthier diets with poor nutritional value (Wolf *et al.* 2017). At the same time, women in high-income countries may be at risk of an excessive intake of micronutrients, due to both food and dietary supplement intake (Blumfield *et al.* 2013).

Maternal dietary supplement use is an easier and more common approach to increase the intake of multiple micronutrients during pregnancy; however, its efficacy needs further investigation (Allen 2005). During pregnancy, some of the micronutrients commonly provided as dietary supplements, and that have received more attention, include fat soluble Vitamins A, D and E, Folate, Iron, Zinc, Iodine, Copper, Selenium and B6 and B12 (Gernand *et al.* 2016).

Hence, it is necessary to understand if food is providing enough nutrients or if any kind of dietary intervention, such as supplementation or food fortification, is needed to improve diet quality and achieve an optimal maternal intake (Blumfield *et al.* 2013). Some of the recommendations for vitamins and minerals during pregnancy are illustrated in Table 2-1. Some common micronutrient supplements are summarised in Appendix 2-5.

Table 2-1: Recommendations for selected micronutrients (vitamins and minerals) intake during pregnancy

Nutrient	Recommendation Adult women	Recommendation Pregnant women
Vitamin A ($\mu\text{g RE}$)	490 μg /d (≥ 18 y/o)* (AR) 600 μg /d (≥ 18 y/o)**	490 μg /d* (AR) +100 μg /d
Vitamin D (μg)	15 μg /d (≥ 18 y/o)* (AI) 10 μg /d (≥ 18 y/o)**	No changes* No changes**
Vitamin E (α-Tocopherol) (mg)	11 mg/d (≥ 18 y/o)* (AI)	No changes*
Vitamin K (μg)	70 μg /d (≥ 18 y/o)* (AI)	No changes*
Vitamin C (mg)	80 mg/d (≥ 18 y/o)* (AR) 95 mg/d (≥ 18 y/o)* (PRI) 40 mg/d (≥ 18 y/o)**	105 mg/d* (PRI) +10 mg/d**
Vitamin B1 (Thiamin) (mg/MJ)	0.072 mg/MJ (≥ 18 y/o)* (AR) 0.1 mg/MJ (≥ 18 y/o)* (PRI) 0.8 mg/d (≥ 18 y/o)**	No changes (AR)* No changes (PRI)* +0.1 mg/d (last trimester only)**
Vitamin B2 (Riboflavin) (mg)	1.3 mg/d (≥ 18 y/o)* (AR) 1.6 mg/d (≥ 18 y/o)* (PRI) 1.1 mg/d (≥ 18 y/o)**	1.5 mg/d* (AR) 1.9 mg/d* (PRI) 1.3 mg/d**
Vitamin B3 (Niacin) (mg)	1.3 mg/d NE/MJ (≥ 18 y/o)* (AR) 1.6 mg/d NE/MJ (≥ 18 y/o)* (AR) 14 mg/d (18 y/o)**	No changes* No changes**

	13 mg/d (≥19-50 y/o)**	
Vitamin B5 (Pantothenic acid) (mg)	5 mg/d (≥ 18 y/o)* (AI)	No changes*
	1.3 mg/d (≥ 18 y/o)* (AR)	1.5 mg/d* (AR)
Vitamin B6 (Pyridoxine) (mg)	1.6 mg/d (≥ 18 y/o)* (PRI)	1.8 mg/d* (PRI)
	1.2 mg/d (≥18 y/o)**	No changes**
Vitamin B7 (Biotin) (μg)	40 μg/d (≥ 18 y/o)* (AI)	No changes*
	250 μg/d DFE/day (≥ 18 y/o)* (AR)	No changes (AR)*
Vitamin B9 (Folate) (μg)	330 μg/d DFE/day (≥ 18 y/o)* (PRI)	600 μg/d* (AI)
	200 μg/d (≥ 18 y/o)**	+200 μg/d**
Vitamin B12 (Cobalamin) (μg)	4 mg/d (≥ 18 y/o)* (AI)	4.5 mg/d* (AI)
	860 mg/d (18-24 y/o)* (AR)	No changes*
	750 mg/d (≥ 25 y/o)* (AR)	
Calcium (mg)	1000 mg/d (18-24 y/o)* (PRI)	No changes**
	950 mg/d (≥ 25 y/o)* (PRI)	
	800 mg/d (18 y/o)**	
	700 mg/d (≥19-50 y/o)**	
	1.3 mg/d (≥ 18 y/o)* (AI)	1.5 mg/d*
Copper (mg)	1.0 mg/d (18 y/o)**	No changes**
	1.3 mg/d (≥ 19 y/o)**	
Fluoride (mg)	2.9 mg/d (≥ 18 y/o)* (AI)	No changes*

	150 µg/d (≥ 18 y/o)* (AI)	200 µg/d (≥ 18 y/o)*
Iodine (µg)	140 µg/d (≥ 18 y/o)**	No changes**
	7 mg/d (≥ 18 y/o premenopausal)* (AR)	No changes*
	6 mg/d (postmenopausal)* (AR)	No changes**
Iron (mg)	16 mg/d (≥ 18 y/o premenopausal)* (PRI)	
	11 mg/d (postmenopausal)* (PRI)	
	14.8 mg/d (15-50 y/o)**	
	300 mg/d (≥ 18 y/o)* (AI)	No changes*
Magnesium (mg)	300 mg/d (18 y/o)**	No changes**
	270 mg/d (≥18 y/o)**	
Sodium (mg)	1600 mg/d (≥18 y/o)**	No changes**
	550 mg/d (≥ 18 y/o)* (AI)	No changes*
Phosphorus (mg)	625 mg/d (18 y/o)**	No changes**
	550 mg/d (≥ 18 y/o)**	
	3500 mg/d (≥18 y/o)* (AI)	No changes*
Potassium (mg)	3500 mg/d (≥18 y/o)**	No changes**
	70 µg/d (≥ 18 y/o)* (AI)	No changes*
Selenium (µg)	60 µg/d (≥ 18 y/o)**	No changes**

Zinc (mg)	300 mg/d (LPI) – 6.2 mg/d* (AR)	+1.3 mg/d (≥18 y/o)
	600 mg/d (LPI) – 7.6 mg/d* (AR)	
	900 mg/d (LPI) – 8.9 mg/d* (AR)	
	1200 mg/d (LPI) – 10.2mg/d* (AR)	
	7.0 mg/d (≥ 19 y/o)**	No changes**
*(EFSA 2017) ** (Great Britain Department of Health and Social Security1991) *** years old (y/o) **** Adequate Intake (AI) ***** Average Requirement (AR) ***** Population Reference Intake (PRI)		

2.6 Common diet-related health disorders during pregnancy

While undernourishment and starvation are major problems in many countries, in others maternal obesity, another form of malnutrition, has become the leading cause of concern (Flannery *et al.* 2019, Yang *et al.* 2019, Khor 2008, Mathers *et al.* 2008, Restrepo Mesa & Parra Sossa 2009, Araujo 2012, Popkin *et al.* 2012, Hou 2013, Conde & Monteiro 2014, Sarmiento *et al.* 2014, Severi & Moratorio 2014). While inappropriate dietary patterns contribute to premature deaths of mothers and babies and impairs physical and brain development, being overweight or obese also impacts on maternal, fetal and neonatal health and wellbeing (Marchi *et al.* 2015, Mariona 2016).

The increase in the number of women who are in the overweight and obese BMI range prior to pregnancy (Shieh *et al.* 2018, Chen *et al.* 2018, Craemer *et al.* 2019), and who also experience excessive weight gain during pregnancy (Shieh *et al.* 2018, Craemer *et al.* 2019, Kunath *et al.* 2019), creates new public health challenges as they are at an increased risk of developing adverse maternal and neonatal health outcomes. For that reason, it is crucial to identify these adverse outcomes, both short and long-term, how they are related to diet before and during pregnancy (and other life-style factors such as physical activity).

2.6.1 Obesity, gestational weight gain (GWG) and postpartum weight retention (PPWR)

It is estimated that up to two-thirds of women of reproductive age in the US and Europe are overweight or obese, with differences shown across and within countries, depending on state/region, race/ethnicity, and socio-economic status (Conway 2011).

A systematic review of systematic reviews on outcomes of obesity in pregnancy found that obesity is associated with numerous adverse outcomes for mothers (increased rates of caesarean section (CS) and instrumental vaginal birth, depression/mental health problems, long-term obesity, gestational diabetes mellitus, pre-eclampsia and hypertension, surgical site infection, lower breastfeeding initiation and duration rates) and babies (preterm birth, increased infant birth weight, malformation and congenital anomalies, fetal death, miscarriage and stillbirth) (Marchi *et al.* 2015).

2.6.2 Weight gain during pregnancy

In an attempt to minimise the adverse consequences of inadequate or excessive weight gain for the mother and fetus, and also to guide a healthy Gestational Weight Gain (GWG), the American IOM revised the gestational weight gain guidelines (Appendix 2-4) and introduced a weight recommendation guideline specifically for women with obesity (Rasmussen *et al.* 2009).

Inadequate GWG is related to preterm birth (Wen & Lv 2015, Borenstein *et al.* 2017, Chavan *et al.* 2018), LBW (Wen & Lv 2015, Borenstein *et al.* 2017, Kominiarek & Peaceman 2017), IUGR (Borenstein *et al.* 2017), prematurity (Borenstein *et al.* 2017), and even failure to initiate breastfeeding (Kominiarek & Peaceman 2017). Excessive GWG is related to negative outcomes such as pre-eclampsia (Borenstein *et al.* 2017, Hillesund *et al.* 2018, Wulandari *et al.* 2018), large-for-gestational-age (LGA) (Borenstein *et al.* 2017, Kominiarek & Peaceman 2017), gestational diabetes (Borenstein *et al.* 2017), caesarean section (Borenstein *et al.* 2017, Kominiarek & Peaceman 2017), and also increases postpartum weight retention (PPWR) (Borenstein *et al.* 2017, Kominiarek & Peaceman 2017). Additionally, GWG may be a sensitive matter for women because body image satisfaction is negatively linked to BMI (Heery *et al.* 2013).

Despite the adverse outcomes of inappropriate GWG during pregnancy, research shows that the proportion of women who gain more weight than the IOM recommendations remains very high (Heery *et al.* 2013, Heery *et al.* 2015); 60% of pregnant women exceeded the recommendations for GWG (Ockenden *et al.* 2016).

2.6.3 Nausea and vomiting during pregnancy

Nausea and vomiting in pregnancy (NVP), often experienced by women in the early weeks of pregnancy, is commonly known as “morning sickness” (Flaxman & Sherman 2000, p. 114, Einarson *et al.* 2013). While the precise aetiology of NVP remains unknown, it is thought to be a consequence of several metabolic and endocrine factors of placental origin, especially the human chorionic gonadotropin factor (hCG) (Austin *et al.* 2019, Mitsuda *et al.* 2018, Bustos *et al.* 2017, Lee & Saha 2011) and the symptoms range from nausea (frequently associated with food-specific aversions) to persistent vomiting and hyperemesis gravidarum (Barjaktarovic *et al.* 2019, Fejzo *et al.* 2019, Bustos *et al.* 2017, Lee & Saha 2011, Pepper & Craig Roberts 2006).

Approximately 5% of women will experience NVP during the whole pregnancy (King & Murphy 2009). While NVP prevalence varies around the world, a meta-analysis of 59 studies reported prevalence of 35-91% (median 69%, and meta-analytic average of 69.4%) (Einarson *et al.* 2013). Simple changes in the diet and lifestyle are frequently recommended to women with NVP (Bustos *et al.* 2017, Lee & Saha 2011, King & Murphy 2009). Some previous studies have reported a positive association between the existence of NVP and pregnancy health outcomes (Flaxman & Sherman 2000, King & Murphy 2009, Lee & Saha 2011), such as preterm delivery (Lee & Saha 2011), but recent literature linked NVP with LBW (Petry *et al.* 2018) and to a higher total body fat mass and abdominal fat mass levels in childhood (Poeran-Bahadoer *et al.* 2019).

A more serious expression of NVP is hyperemesis gravidarum (HG) which is associated with adverse health outcomes for both mother and fetus/child (King & Murphy 2009, London *et al.* 2017, Tian *et al.* 2017), such as weight loss and dehydration to the mother (Tian *et al.* 2017) and increased risk of preterm birth, as well as increased risk of neurodevelopmental delay in children (Tian *et al.* 2017).

2.6.4 Mental Health disorders

Mental illnesses have a remarkable impact on the global burden of disease (Steel *et al.* 2018), and clinical depression has become the leading cause of disability in the world (Friedrich 2017). Pregnancy has been reported as a time of psychological, as well as physical and physiological, changes (McPhie *et al.* 2015, Biaggi *et al.* 2016) and apart from all the positive expectations, some women may experience stress and difficulties and become more susceptible to mental disorders, such as depression and anxiety (Biaggi *et al.* 2016).

It is estimated that 15-25% of women will experience a mental health condition in the course of pregnancy or during the first year after giving birth; 15% will develop depression during pregnancy and 15-20% will be affected by some sort of depression sometime during the first year after giving birth (Higgins *et al.* 2016).

The relationship between diet and depressive disorders has been studied extensively over the past decade and findings suggest an association between better mental health outcomes and better diet quality (O'Neil *et al.* 2014, Jacka *et al.* 2017). Molyneaux *et al.* (2014) found that women with obesity had higher odds of reporting both depressive

and anxiety symptoms during pregnancy, and higher odds of reporting depressive symptoms postpartum. A meta-analysis found that women with obesity had 67% higher odds of developing depression postpartum than normal-weight women (Molyneaux *et al.* 2014). However, it is unclear whether the women who reported postpartum depression had also experienced depression before pregnancy (Molyneaux *et al.* 2014).

Mental health disorders and maternal depression and anxiety are other health outcomes found to be associated with food behaviours during pregnancy in the systematic review, and are discussed further in the next chapter.

2.7 Food intake and diet in pregnancy

In spite of the fact that there are numerous definitions and guidelines on what a diet should contain, the Academy of Nutrition and Dietetics states that all foods can be consumed in moderate amounts as part of a healthy and balanced diet (Freeland-Graves & Nitzke 2013). Traditionally, research on nutrition had focused on the relationship between single nutrients and diseases or outcomes of pregnancy (McGowan & McAuliffe 2013). However, more recent studies have demonstrated the need to investigate diet as a whole since individuals do not usually consume a single food, but eat a variety of foods simultaneously, and it is the combination and interaction of several nutrients that permits a better analysis of the positive or negative impact of food on our bodies (Raghavan *et al.* 2019, Freitas-Vilela *et al.* 2017, Lu *et al.* 2018, Nicklas 2004, McGowan & McAuliffe 2013, Collins *et al.* 2015).

For instance, evidence shows that modifying dietary patterns seems to have a higher impact on lowering blood pressure than supplementing diet with a single nutrient (Hu 2002). The Dietary Approach to Stop Hypertension (DASH) is a good example of a popular dietary pattern plan used to reduce blood pressure (Bazzano *et al.* 2013).

The analysis of dietary patterns has been used in several studies in the last decade (Oude Griep *et al.* 2013, Englund-Ögge *et al.* 2014, Cespedes & Hu 2015, Chen *et al.* 2016, Thorpe *et al.* 2016). The use of dietary patterns together with indices of diet quality can help to group people according to their eating habits and compare these to current nutritional guidelines and nutritional adequacy (Collins *et al.* 2015). Dietary patterns and analytical methods are discussed in detail in chapter 4 and chapter 6.

2.8 Physical Activity (PA), exercise and pregnancy

Physical activity (PA) has been defined as “any bodily movement produced by skeletal muscles that result in energy expenditure” (Caspersen *et al.* 1985, p. 126, Kader & Naim-Shuchana 2014, p. 2, Daly *et al.* 2016, p. 358) and exercise as “a subset of physical activity that is planned, structured, repetitive, and purposeful in the sense that improvement or maintenance of physical fitness is the objective” (Caspersen *et al.* 1985, p. 126, Kader & Naim-Shuchana 2014, p. 2, Daly *et al.* 2016, p. 358).

Although healthy pregnant women used to be advised not to exercise during pregnancy, due to potential risks of preterm birth and loss (Di Mascio *et al.* 2016), literature has shown that exercise is safe and beneficial for mother and fetus in the short and long term (Nascimento *et al.* 2015, Moyer *et al.* 2016). Currently, most international guidelines are consistent in recommending that pregnant women, without contraindications, should engage in some type of PA (Downs *et al.* 2012, Evenson *et al.* 2014, Mottola *et al.* 2018).

Some of the positive outcomes that can be related to PA during pregnancy for maternal and child health include: reduced risk of pre-eclampsia (Aune *et al.* 2014b, Spracklen *et al.* 2016, Thompson *et al.* 2017); lower risk of developing gestational diabetes (Russo *et al.* 2015, Thompson *et al.* 2017); better control of gestational weight gain (da Silva *et al.* 2017, Thompson *et al.* 2017); achieving a vaginal birth (Di Mascio *et al.* 2016); improved self-esteem (Thompson *et al.* 2017), as well as long-term health of the offspring (Moyer *et al.* 2016).

Despite evidence of the many benefits, often women stop doing PA when they become pregnant due to the physiological and psychological changes (Melzer *et al.* 2010, Kader & Naim-Shuchana 2014, Watson *et al.* 2016). The promotion of PA should be a priority in public health (Nascimento *et al.* 2015), and there is a need for studies exploring diet and PA behaviours during pregnancy.

Studies on diet and nutrition during pregnancy still do not include PA as an important variable in their analysis (Baranowski 2004). However, just like diet during pregnancy, PA during pregnancy is becoming increasingly recognised as an important determinant of pregnancy outcomes (Di Mascio *et al.* 2016, Chan *et al.* 2019, DiPietro *et al.* 2019) and should not be overlooked.

2.9 Lifestyle changes and pregnancy

Although many women do alter their diet during pregnancy, the changes made vary depending on women's social and education status and are, generally, not enough to achieve optimal dietary intake recommendations (Crozier *et al.* 2009a, Crozier *et al.* 2009b). A longitudinal study in the UK found that pregnant women were much more likely to change behaviours such as smoking and alcohol intake than change their consumption of fruits, and women with lower levels of education were less likely to follow the recommendations than women with higher levels of education (Crozier *et al.* 2009a). An individual's decision to make dietary changes is influenced by a set of complex physiological, psychological, social and economic factors (Sobal & Bisogni 2009), and pregnant women may be confused by all the conflicting messages in the media about healthy eating and lifestyle (Ferrari *et al.* 2013, Freeland-Graves & Nitzke 2013, Johnson *et al.* 2013, Reyes *et al.* 2013).

2.10 Mode of birth

How a woman gives birth impacts on all aspects of her postpartum health in the short and long-term (Fenaroli *et al.* 2019, El Sayed & Emarah 2019, Sinnott *et al.* 2016). CS can be life-saving for both mother and fetus in some special circumstances (Sinnott *et al.* 2016); however, the rising rates of CS worldwide (El Sayed & Emarah 2019, Vinturache *et al.* 2014, Denham *et al.* 2019, Sinnott *et al.* 2016) raises concerns when performed with no medical indication (El Sayed & Emarah 2019, Denham *et al.* 2019, Sinnott *et al.* 2016, Xiong *et al.* 2016). CS has been linked to a number of risks to women's health (Esteves-Pereira *et al.* 2016, Sinnott *et al.* 2016) and not to mention the fact that higher rates of CS are more likely to cause an increased burden in the healthcare system (Xiong *et al.* 2016).

The impact of maternal diet and maternal dietary patterns during pregnancy, as a possible predictor of mode of birth, has not been explored previously. However, some studies have identified modifiable nutritional-related factors, such as a higher pre-pregnancy BMI, that are associated with an increased risk of CS (McDowell *et al.* 2019, Vinturache *et al.* 2014, Kirchengast & Hartmann 2017) and GWG (McDowell *et al.* 2019, Seligman *et al.* 2006, Fixler and DeFranco 2019).

For instance, while being overweight/obese pre-pregnancy has been consistently linked with a higher risk of having a CS, some studies have explored weight loss

interventions for women of reproductive age (Xiong *et al.* 2016) and others have focused on determining if the risk of CS can be reduced by controlling GWG (Xiong *et al.* 2016). Pre-pregnancy BMI is both a predictor of GWG and the basis for IOM GWG guidelines (Chen *et al.* 2017). Therefore, it is important to try to explore associations with diet and dietary patterns and mode of birth.

2.11 Breastfeeding

Breastfeeding is universally acknowledged as the best option for infant feeding and the World Health Organization (WHO) and many other international guidelines, such as the American Academy of Pediatrics (AAP) and the European Commission for Public Health (ECPH), strongly recommend that infants are exclusively breastfed for the first six months of life. There is strong and still growing evidence of the wide range of positive short and long-term health benefits of breastfeeding for the mother and child (Horta *et al.* 2015, Sankar *et al.* 2015, Binns *et al.* 2016, Rollins *et al.* 2016, Victora *et al.* 2016, Mosca & Gianni 2017) (Appendix 2-6). The consequences of not breastfeeding are substantial and include adverse health outcomes (for the mother, family and offspring), and economic consequences for governments (Walters *et al.* 2016).

Breastfeeding intention and breastfeeding have multifactorial determinants and are linked to many factors explored in this thesis (other than diet) and which have been reported previously in other studies. These include socioeconomic status (Heck *et al.* 2006, Flacking *et al.* 2007, Amir & Donath 2008), maternal BMI (Donath & Amir 2000, Oddy *et al.* 2006, Donath & Amir 2008, Wojcicki 2011, Mullaney *et al.* 2014, Turcksin *et al.* 2014), drinking and/or smoking (Donath & Amir 2004, Giglia *et al.* 2006, Mullaney *et al.* 2014), and maternal age (Mullaney *et al.* 2014).

A broader understanding of this relationship could be of great importance, particularly in Ireland which has one of the lowest breastfeeding rates in the European region (Tarrant *et al.* 2011, Gallagher *et al.* 2016, Department of Health 2016, Sutton *et al.* 2016). In 2015, just 58% of mothers initiated breastfeeding (Healthcare Pricing Office 2017), and Irish women were less likely to breastfeed than non-Irish women living in Ireland (Mullaney *et al.* 2014, Gallagher *et al.* 2016). According to another study, Irish women were also more likely to discontinue breastfeeding earlier (Tarrant *et al.* 2011).

While some predictors of breastfeeding have been studied previously (Anzman *et al.* 2010, Shrivastava *et al.* 2013, Scaglioni *et al.* 2018), maternal diet during pregnancy has never been assessed as a potential predictor of breastfeeding practice.

2.12 Conclusion

Adequate and high-quality dietary intake is vital, both preconception and during pregnancy, given the great impact on the mother's and baby's health, in the long and short-term. Thus, the existing nutrition guidelines are key to assisting health care professionals to advise women to follow a balanced diet, based on the current knowledge.

Caution is needed, though, as part of what was assumed to be accurate in traditional human nutrition research has been revised over time. While there is a growing body of literature around diet, research needs to continue as there is much more to be learned, better understood and improved. A good example of this is the transition being observed in the analysis of diet: from a nutrient approach/single food focus towards identifying dietary patterns/diet as a whole. More importantly, the knowledge generated from research needs to reach women, as many report being unsure of what to eat.

Chapter Three: A systematic review of diet during pregnancy

3.1 Introduction

Diet and nutrition are essential to achieving optimum health for all, and what a pregnant woman eats before and during pregnancy impacts not only on her health and pregnancy outcomes, but also on her baby's health for the rest of its life (Vickers 2014, Malek *et al.* 2015, Smith & Ryckman 2015, Morrison & Regnault 2016). In spite of the extensive and growing literature around maternal diet during pregnancy and outcomes, there are still controversies; thus it is crucial to understand, in-depth, the role of diet as a whole during pregnancy and measurement tools used, as they are constantly evolving (Satija *et al.* 2015, Kirkpatrick *et al.* 2017).

Therefore, the rationale for performing a systematic review (SR) was to identify, evaluate, and summarise the findings of all the relevant literature on outcomes of maternal diet during pregnancy. This review brings together a body of knowledge from all the high-quality studies that not only guides the conduct of this study's methodology but also underpins this thesis and contributes to the discussion of my findings in relation to evidence from reliable research (Gopalakrishnan & Ganeshkumar 2013).

Finally, it is important to note that the use of dietary supplements was taken into consideration in the systematic review search (in the search string). There were two reasons for that: first, the SR would be a more comprehensive search and review, and second, the contribution of dietary supplements to women's diet during pregnancy could be evaluated. Along the PhD journey it became clear that assessing the contribution of dietary supplements to women's diet would be considerable additional work and that the search could be divided into two different systematic reviews (diet only during pregnancy and diet and supplement use during pregnancy). The findings presented in this SR chapter are in relation to the studies around diet during pregnancy only.

3.2 Aim

To determine the associations between diet during pregnancy, without the intake of dietary supplements, and maternal, fetal and infant outcomes up to 12 months postpartum.

This was achieved by assessing primary observational studies that:

1. reported on maternal diet (or food groups) during pregnancy;
2. reported on maternal diet with or without dietary supplement use during pregnancy;
3. used a validated dietary tool to assess maternal diet during pregnancy;
4. explored maternal diet and reported on at least one health outcome: maternal, fetal and/or infant up to the first 12 months postpartum.

3.3 Methods

Selection of studies

A protocol was developed *a priori* and recorded in Trinity College Dublin as part of the doctoral confirmation. Eligibility criteria were developed (Table 3-1) and used to select appropriate studies that could potentially answer the research question.

Table 3-1: Systematic review eligibility criteria

	Include	Exclude
Population	Pregnant women	Studies on infants/children/animals/non-pregnant women/men, etc.; studies in non-comparable societies such as those conducted solely in rural/semi-rural areas or with pregnant teenagers, minority and vulnerable groups, low income groups, fishing communities/villages (with a small unrepresentative sample).
Exposure	Diet/dietary pattern/nutrition during pregnancy without dietary supplement use	Diet/dietary pattern/nutrition during pregnancy with dietary supplement use
Outcomes	Maternal, fetal or infant outcomes up to the first 12 months postpartum.	Diet measured before and during pregnancy where it was not possible to extract diet related to the pregnancy period. Irrelevant outcomes. Diet measured before and during pregnancy where it was not possible to extract data relating to diet without dietary supplements
Study design	Observational studies	Books, book chapters, editorials, opinion pieces, indices, conference reports and unpublished theses. Randomised controlled trials (RCTs) on preconception dietary/vitamin/mineral supplements, experimental studies, dietary interventions or RCTs of vitamin/mineral supplements in pregnancy), qualitative studies, pilot and validation studies, reviews, systematic reviews and case-control studies.

The following electronic databases were searched: PubMed, CINAHL, SCOPUS and Maternity and Infant Care (MIC), with no date restrictions applied. Full text retrieval was limited to English language publications, due to the unavailability of translation services, but no restrictions were applied to the searches. Identifying potentially eligible non-English language studies is important because it allows the researcher to consider the potential for publication bias (Higgins & Green 2011, McDonagh *et al.* 2013).

A search string was designed by using the PEOs framework (Population, Exposure, Outcomes) (below). The final search string can be found in Appendix 3-1.

Search string: Pregnancy OR pregnant OR antenatal OR prenatal OR gestation OR gestational OR gravida AND Diet OR nutrition OR food OR “health food” OR “health eating” OR “Polyunsaturated fatty acids” OR “Long-chain polyunsaturated fatty acids” OR “Docosahexaenoic acid” OR “Eicosapentaenoic acid” OR supplement OR “food supplements” OR “dietary supplements” OR “diet supplements” AND “food frequency” OR “food frequency questionnaire” OR “food survey” OR “food questionnaire” OR “food diary” OR “food behavior” OR “food behaviour” OR “food preferences” OR “food habits” OR “food record” OR “food intake” OR “diet survey” OR “diet record” OR “dietary pattern” OR “dietary factors” OR “dietary intake” OR “dietary changes” OR “dietary quality” OR “diet quality” OR “dietary assessment” OR “diet assessment” OR “diet assessment tool” OR “24-hour recall” OR “24-hour dietary recall” OR “nutrition survey” OR “nutrition assessment” OR “maternal nutrition” OR “maternal diet” OR “eating behaviour” OR eating OR “eating behavior” OR “eating pattern” OR “eating habits” OR “health behavior” OR “health behaviour” OR “energy intake” AND “pregnancy outcomes” OR “pregnancy complications” OR “maternal health” OR “fetal health” OR “foetal health” OR “Body Mass Index” OR “nutritional status” OR “body composition” OR anthropometry OR “body weight” OR morbidity OR morbidities OR “risk factors” OR “adverse effects” OR comorbidity OR malformation OR “congenital abnormality” OR “birth defects”

The search was performed on the 22nd of September 2018. Reference lists of included studies were also checked for relevant studies.

3.4 Data collection

All retrieved studies (after duplicates were removed) were independently screened by two authors (DD and JM) first by title and then by abstract. If there was any disagreement, a third review author was consulted. Thereafter the remaining studies were screened by full text, with involvement from the whole team, divided into three pairs (CB and JM; DD and JM; JK and JM), with any disagreement resolved by a third

review author. Reference management software was used to import and collate studies from the different databases.

3.5 Assessing methodological quality of the studies

Assessment of the methodological quality of the studies is an important step of a systematic review (Higgins & Green 2011, Moja *et al.* 2005, Lo *et al.* 2014), especially when observational studies are involved (Manchikanti *et al.* 2009) as they vary more in their design (Reeves *et al.* 2013), are more exposed to risks of bias (Reeves *et al.* 2013) and are more likely to be used by policy-makers (Bilotta *et al.* 2014). The selection of the right quality assessment (QA) tool enables studies to be rated according to specific criteria (Higgins & Green 2011, Bilotta *et al.* 2014), and guides the selection and use of data from studies that meet the pre-defined methodological standard.

There are over 300 QA tools (Petticrew & Roberts 2008, Bilotta *et al.* 2014), with 157 of these tools assessing quality in non-randomised studies (NRS) (Moja *et al.* 2005). While some tools are appropriate for randomised control studies and others for observational studies, the use of different tools on the same studies can result in different levels of quality being reported (Bilotta *et al.* 2014). Therefore, choosing the most appropriate tool to assess the quality of studies is essential.

The Newcastle Ottawa Scale (NOS) for cohort studies, the second most frequently used tool on systematic reviews (SRs) of non-randomised studies (NRS) (Petticrew & Roberts 2008), and recommended by the Cochrane Collaboration (Langley-Evans 2015) and Cochrane handbook (Higgins & Green 2011) was chosen. As shown in Table 3-2, the standard NOS for cohort studies was modified to assess the methodological quality of the studies in this SR.

Following completion of full text screening, included studies were divided among the same pairs to undergo quality assessment (QA). QA was done independently by each author and compared between the pairs.

The following criteria were assessed (Table 3-2):

- 1) Selection: representativeness of the cohort, how well the dietary assessment tool was described, whether they used validated tools of measurements and how data were collected; and
- 2) Outcomes: assessment method, duration of follow-up and attrition.

The NOS tool uses a “star system” awarded across the different categories (and its specific items), where each item is awarded a star if the specific criterion is met or if it is not applicable, and no star if the criterion is not met or is unclear. In this modified NOS QA tool, a score of 1 was given for each star awarded, and the final score was calculated by summing up those six individual scores. To be included for data extraction, a study had to be awarded six stars, in other words, a study had to meet all QA criteria. Appendix 3-2 presents QA of all papers on diet only.

Table 3-2: Modified Newcastle-Ottawa Scale (NOS) for cohort studies

Newcastle Ottawa Scale (adapted) – Diet during pregnancy that contribute to risk factors to the mother, fetus and infants – a systematic review																	
SELECTION								OUTCOMES									
1) Representative of the exposed cohort (Representativeness of diet in pregnant women)				2) Describes adequately how diet is assessed? (Type of tool used, timing of use, way diet was assessed, validated tool) (Yes/No)	3) Ascertainment of exposure (How were the data collected)			1) Assessment of outcome				2) Was follow up long enough for outcome to occur (Yes/No)	3) Adequacy of follow-up of cohorts				
A	B	C	D	A or B	A	B	C	A	B	C	D	A or B	A	B	C	D	E
truly representative of the population (pregnant women)	somewhat representative	selected group	no description	A) Yes B) No	FFQ; Food Diary; 24-hour food recall	Another diet assessment method	no description	Independent blind assessment	record linkage	self-report	no description	A) Yes B) No select and adequate follow up period for outcome of interest	complete follow-up - all subjects accounted for	subjects lost to follow-up (<20%) unlikely to introduce bias.	Follow up rate >80% and no description of those lost	no state-ment	not applicable
Select one of the alternatives: A or B score 1 C or D score 0				Select one of the alternatives: A scores 1 B scores 0	Select one of the alternatives: A scores 1 B or C score 0			Select one of the alternatives: A or B score 1 C or D score 0				Select one of the alternatives: the alternatives: A scores 1 B scores 0	Select one of the alternatives: A or B or E score 1 C or D score 0				

3.6 Data extraction and data management

In consideration of the large amount of data that are presented during the systematic review process, and in order to employ good data management practices, a data extraction table was purposively devised (Table 3-3). Key findings from the final included studies were extracted by one reviewer and checked by a second, in the pairs described above. If disagreement arose, a third reviewer was involved.

Table 3-3: Data extraction table

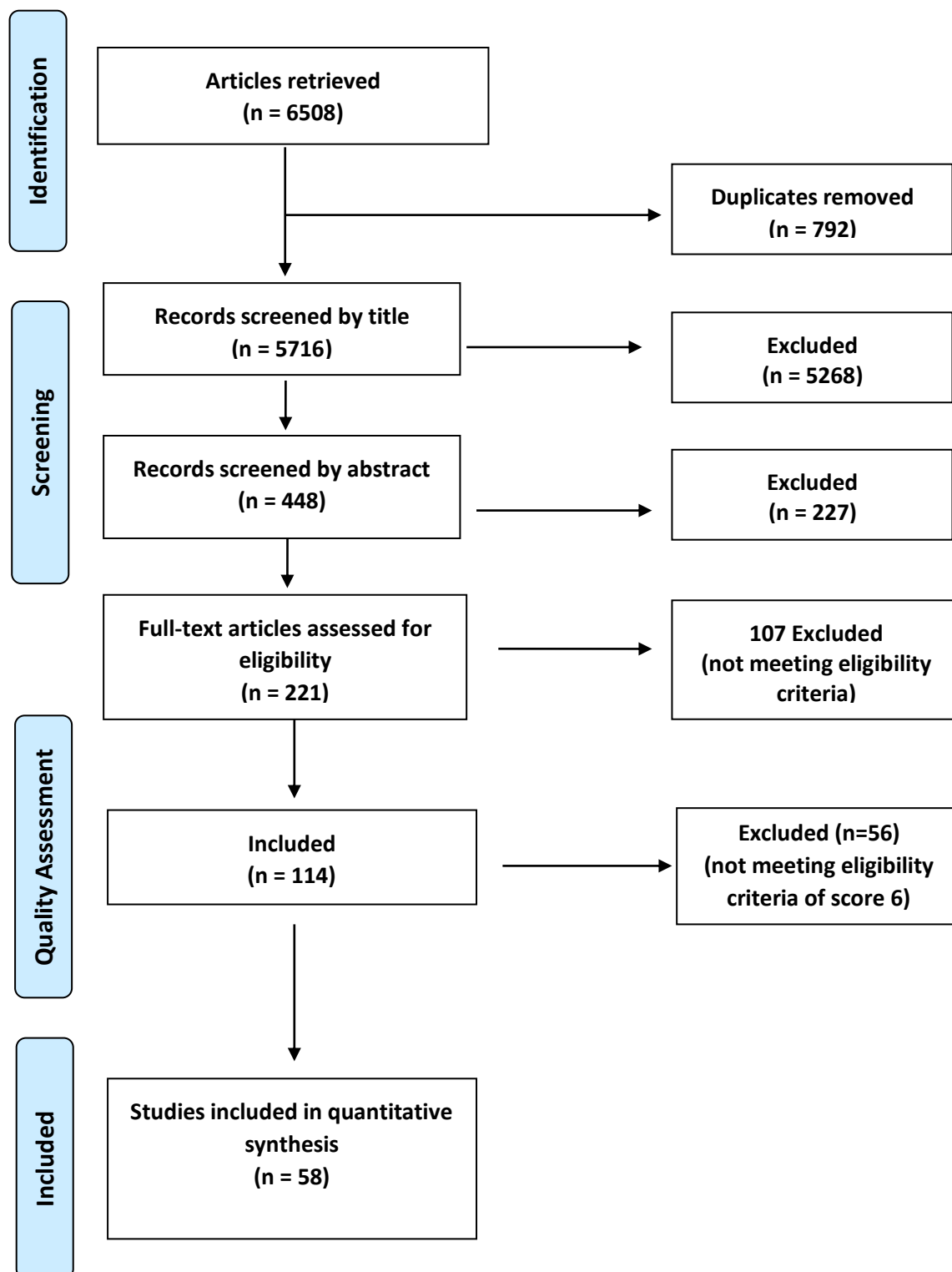
Study
Year
Journal
Country(s)
Study Aim
Hypothesis
Study design
Population characteristics
Participants sample
Assessment of diet alone or diet +
Diet quality index
Data collection methods (e.g. FFQ, food
Characteristics of dietary tool
Timing of ascertainment (antenatal,
Physical activity
Outcomes - maternal
Outcomes - fetal
Outcomes - infant
Key findings
Comment
Potential mechanism
Strengths and limitations of the study
Recommendations made by authors

3.7 Results

Study selection

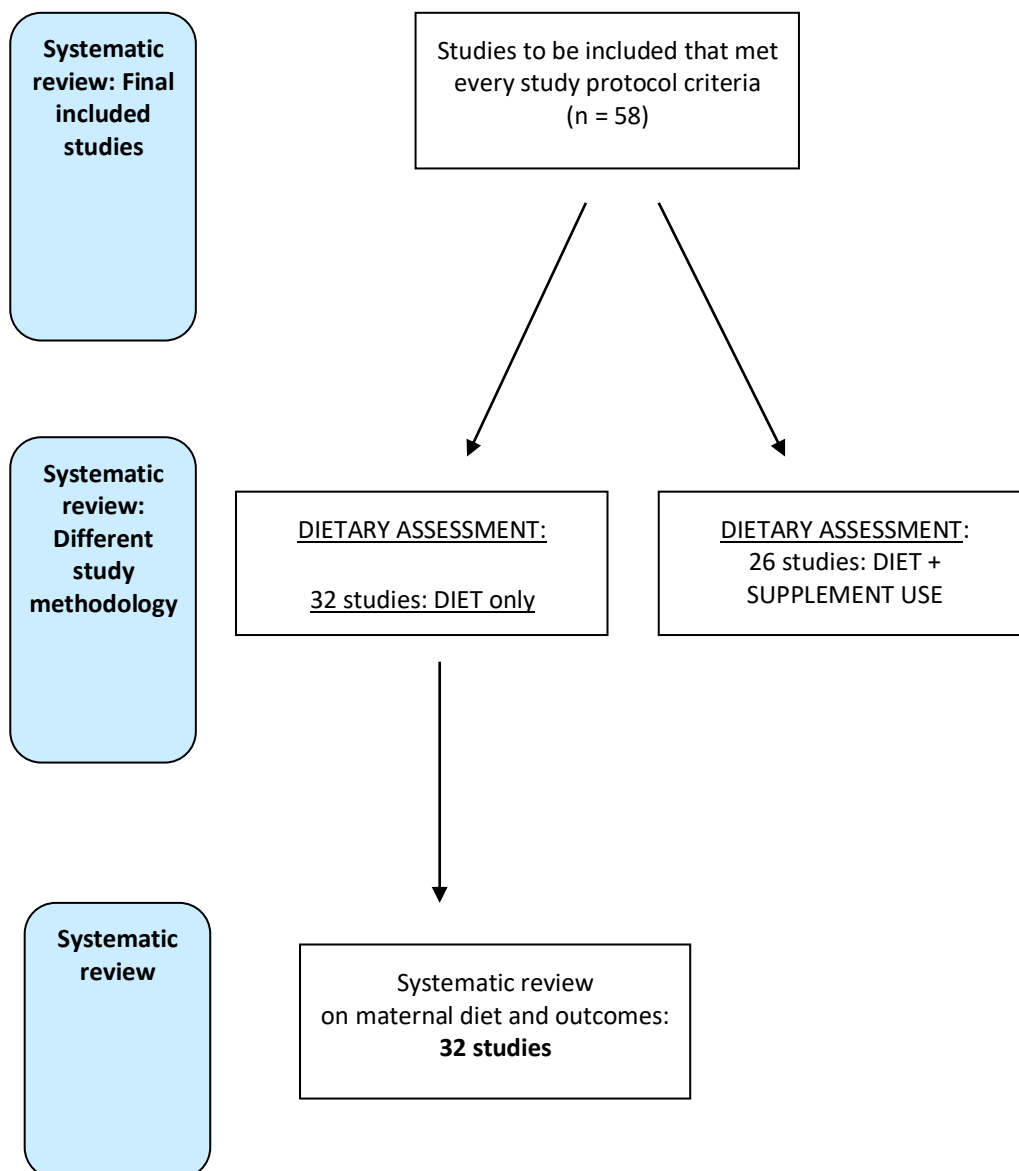
Figure 3-1 illustrates the original search findings after removal of duplicates: 5716 studies were retrieved from the four different databases (PubMed, CINAHL, Scopus and Maternity and Infant Care). Following screening by title, abstract and full text, 114 studies were included in the QA and 58 studies (that scored a total mark of 6 stars) were included for data analysis. There were eight non-English language studies.

Figure 3-1: Prisma flow diagram



Aware of the complexity and heterogeneity of the results in this SR, it was agreed that only studies that measured diet alone should be included (n=32) as they would fit better with the objectives of my study (Figure 3-2). The other studies (studies that measured diet supplemented with any type of multivitamin and/or mineral) could be used for a potential future systematic-review on maternal diet and dietary supplement use during pregnancy.

Figure 3-2: Studies about “Diet only” vs “Diet and supplement use”



3.8 Description of the included studies

A total of 32 studies, involving 137,300 pregnant women, were included. Almost all of them were prospective cohort studies, except for Ebrahimi *et al.* (2015), which was a cross-sectional study. The included studies were conducted as primary individual studies or as part of larger cohort studies (Table 3-4).

Table 3-4: Studies included in the review

Author	Type of study	# of papers	Population sample (largest one/or total from single studies)
Blumfield <i>et al.</i> 2012b	Women and Their Children's Health Study (WATCH study)	1	179 participants
Duarte-Salles <i>et al.</i> 2013	Norwegian Mother and Child Cohort Study (MoBa study)	4	66000 participants (Englund-Ogge <i>et al.</i> 2014)
Englund-Ogge <i>et al.</i> 2012			
Englund-Ogge <i>et al.</i> 2014			
Haugen <i>et al.</i> 2008a			
Conway <i>et al.</i> 1999	Single studies	7	62 participants
Ebrahimi <i>et al.</i> 2015			308 participants
Eshriqui <i>et al.</i> 2016			191 participants
Karamanos <i>et al.</i> 2014			1076 participants
Langhoff-Ross <i>et al.</i> 1987			56 participants
Moore <i>et al.</i> 2004			557 participants
Sartorelli <i>et al.</i> 2014			88 participants = 2338 participants
Godfrey <i>et al.</i> 1996	Medical Research Council Environmental Epidemiology Unit (University of Southampton)	2	539 participants (Godfrey <i>et al.</i> 1996)
Godfrey <i>et al.</i> 1997			

Halldorsson <i>et al.</i> 2007	The Danish National Birth Cohort (DNBC study)	8	59334 participants (Halldorsson <i>et al.</i> 2010)
Halldorsson <i>et al.</i> 2010			
Knudsen <i>et al.</i> 2008			
Knudsen <i>et al.</i> 2013			
Maslova <i>et al.</i> 2015			
Mikkelsen <i>et al.</i> 2006			
Mikkelsen <i>et al.</i> 2008			
Olsen <i>et al.</i> 2007			
Ramón <i>et al.</i> 2009	Mother-Infant Prospective Cohort Study (INMA study)	2	787 participants (both studies had a sample of 787 participants)
Rodríguez-Bernal <i>et al.</i> 2010			
Miyake <i>et al.</i> 2006	Osaka Maternal and Child Health Study (OMCHS study)	4	865 participants (all studies except for Okubo <i>et al.</i> 2012 had a sample of 865 participants)
Murakami <i>et al.</i> 2008			
Okubo <i>et al.</i> 2011a			
Okubo <i>et al.</i> 2012			
He <i>et al.</i> 2015	Born in Guangzhou Cohort Study (BIGCS)	1	3063 participants
Radesky <i>et al.</i> 2008	Project VIVA	1	1733 participants
Saldana <i>et al.</i> 2004	Pregnancy, Infection, and Nutrition Study (PIN study)	1	1698 participants
Starling <i>et al.</i> 2017	Healthy Start Study	1	764 participants
Total: 10 study groups and 7 single studies		32	137300 participants

Almost half of the studies reported outcomes regarding fetal body composition/birth weight/measures at birth/other anthropometric measures (n=15) (Table 3-5).

Table 3-5: Type of outcome and number of studies

Fetal body composition/birth weight/measures at birth/other anthropometric measures	N = 15
Gestational weight gain and postpartum weight retention	N = 7
Gestational diabetes and glucose intolerance	N = 5
Preterm birth	N = 5
Postnatal depression and depressive symptoms during pregnancy	N = 3
Antenatal blood pressure changes	N = 1

3.9 Characteristics of the included studies - by outcome

Appendix 3-3 presents the characteristics of the studies included in this SR and Appendix 3-4 presents the studies' outcomes.

3.10 Synthesis of results by outcome

3.10.1 Fetal body composition/birth weight/measures at birth/other anthropometric measures (N = 15)

The association between maternal diet and fetal body composition/birth weight/measures at birth and other anthropometric measures was reported in 15 studies, dating from 1987-2017. Studies were conducted in Australia (Blumfield *et al.* 2012b), Norway (Duarte-Salles *et al.* 2013), Sweden (Langhoff-Ross *et al.* 1987, Moore *et al.* 2004), the UK (Godfrey *et al.* 1996, Godfrey *et al.* 1997), Denmark (Mikkelsen *et al.* 2006, Halldorsson *et al.* 2007, Olsen *et al.* 2007, Knudsen *et al.* 2008, Knudsen *et al.* 2013); Spain (Ramón *et al.* 2009, Rodríguez-Bernal *et al.* 2010); Japan (Okubo *et al.* 2012); and the United States of America (USA) (Starling *et al.* 2017). Altogether the 15 studies involved 104,453 pregnant women.

Physical activity was not assessed in any of these studies. The most common assessment tool used to measure maternal diet was food frequency questionnaires (FFQ), which were used in twelve studies. A food diary was used by Langhoff-Ross *et*

al. (1987), a diet history questionnaire was used by Okubo *et al.* (2012) and a monthly web-based 24-hour food recall was used by Starling *et al.* (2017). Results of these last three studies could not be meta-analysed with the others due to their use of a unique tool.

The first study to investigate the relationship between diet and the range of different outcomes at birth dates back to 1987, when Langhoff-Ross *et al.* (1987) investigated the “Energy intake and physical activity during pregnancy in relation to maternal fat accretion and infant birthweight” with 56 healthy Swedish pregnant women (although physical activity was not assessed in this study). No significant associations were found in this study.

Two studies investigated the association between the intake of fruits and vegetables and birth weight (Mikkelsen *et al.* 2006) and anthropometric measures at birth (Ramón *et al.* 2009). Mikkelsen *et al.* (2006) recruited 43,585 pregnant women in Denmark and found a statistically significant relationship for all exposure to fruit and/or vegetable consumption during pregnancy and birthweight in well-nourished Danish women, particularly among lean women (BMI < 20 Kg/m², n=7,169). Birth weight in those women’s babies increased 14.6g (95% CI 6.4–22.9) per quintile increase in fruit intake. The strongest association observed, in the whole sample, was for fruit intake, increasing birth weight by 10.7g (95% CI 7.3-14.2) per quintile.

Ramón *et al.* (2009) concluded that the ingestion of vegetables during pregnancy could have a positive impact on fetal growth. A linear association was found between the maternal consumption of vegetables during pregnancy and baby birth weight and length, and therefore decreased the risk of small for gestational age (SGA): multivariable analysis revealed that women had higher odds of having a SGA (weight) baby if they were in the lowest quintile of vegetable intake during the first trimester of pregnancy when compared to women in the highest quintile (odds ratio (OR), 3.7; 95% CI 1.5–8.9; P-trend < 0.001) and had higher odds of the baby having an SGA (length) in the third trimester (OR, 5.5; 95% CI 1.7–17.7; P-trend = 0.04). Unlike the previous study, no statistically significant association was demonstrated with the intake of fruits. The two studies could not be meta-analysed due to differences in the quintiles used.

Duarte-Salles *et al.* (2013) reported that women in the highest quartile of acrylamide intake during pregnancy had, compared to women in the lowest quartile, an adjusted

odds ratio (AOR) of 1.11 (95% CI 1.02-1.21) for SGA and lower mean coefficient for birth weight of -25.7 g (95% CI 35.9 -15.4).

The association between fetal growth and fish consumption was examined by Halldorsson *et al.* (2007). Measuring fetal growth by birth weight, length and head circumference, and based on data from the Danish National Birth Cohort (DNBC), this study concluded that only the intake of fatty fish (and not lean fish) four times per month, or more, was statistically significantly associated with a higher risk of SGA (birth weight and birth length): women who ate more than 60g per day compared to those who ate 5g or less per day were more likely to have infants classified below the 10th percentile for gestational age and gender.

Olsen *et al.* (2007), also as part of the DNBC cohort study, concluded that the intake of milk was inversely associated with the risk of SGA, and directly with both large-for-gestational age (LGA) and mean birth weight (P-trend <0.001). The authors stated that it was the protein fraction of milk that caused the effect, not the fat content.

Diet quality (measured by the Alternate Healthy Eating Index (AHEI)) in early pregnancy (first trimester) and its effects on fetal growth outcomes (birth size, birth length and head circumference - adjusted for gestational age) was investigated by Rodriguez-Bernal *et al.* (2010), as part of the INMA study. The high quality of maternal diet in the first trimester was found to be associated with fetal size at birth and fetal growth (especially weight). Maternal age was the only sociodemographic variable significantly associated with the quality of diet, where older women had higher mean scores (P= 0.001). The AHEI used in the study was modified for pregnancy and a high diet quality was expressed in quintiles, having a maximum score of 100. It measured and quantified the intake of fruits and vegetables, soy and nuts, white meat/red meat ratio, cereal fibre, transfat, and polyunsaturated/saturated fat ratio, as well as the total dietary consumption of three specific micronutrients (Folate, Iron and Calcium).

Furthermore, Moore *et al.* (2004) examined the association between macronutrient intakes in early and late pregnancy and the weight of the placenta as well as weight and thinness of the baby at birth. The authors found that the percentage of energy derived from protein in early pregnancy was statistically significantly associated both with birth weight (P= 0.02) and placental weight (P= 0.07), independent of energy intake and weight gain during pregnancy (and after adjustment for potential confounders, including maternal age, parity, and smoking). On the other hand, baby's

ponderal index was not found to be related to the amount of energy derived from CHOs ($P = 0.04$), both in early and late pregnancy. Dietary composition in late pregnancy was substantially unrelated to birth size, nevertheless there was evidence of a negative association between ponderal index and high CHO intake in late pregnancy: a decrease of 0.04kg/m^3 (95% CI, $-0.07 - 0$) in ponderal index for every 1% increase in CHO intake among the group of participants with reliable data.

Although meta-analysis could not be performed, due to differing measurements and types of protein, five studies that examined the effects of protein in the diet are combined in narrative format in Table 3-6.

Table 3-6: Effects of protein in the diet on birth weight and abdominal fat

Blumfield <i>et al.</i> 2012b	In linear mixed-model regression analysis, maternal intake of protein ($P = 0.13$; $P = 0.04$) was associated with the percentage of abdominal fat.
Godfrey <i>et al.</i> 1996	Birth weight fell by 3.1 g (0.3 g to 6.0 g; $P = 0.03$) for each g decrease in meat protein intake in late pregnancy.
Godfrey <i>et al.</i> 1997	Women who had a low intake of dairy protein in late pregnancy tended to have infants that were thin at birth ($P = 0.03$)
Knudsen <i>et al.</i> 2008	The Western diet, composed of 13.8% protein, resulted in a lower mean birth weight (3583g ($n = 515$)) than the Health Conscious diet group, where diet was composed of 16% protein (birth weight 3616g ($n = 486$)) ($p < 0.05$ (Tukey–Kramer test))
Olsen <i>et al.</i> 2007	Mean birth weight was 100g higher in babies of women who consumed 4–5 glasses of milk per day compared with those who consumed no milk. Birth weight was related to intake of protein, but not of fat, derived from milk.

Maternal diet was appraised, as a whole, in seven papers. Blumfield *et al.* (2012b), as part of the Women and Their Children’s Health Study (WATCH), examined the relationship between diet during pregnancy and fetal body composition, as measured by ultrasound conducted at weeks 19, 25, 30, and 36 of pregnancy. As a result of the different macronutrient intakes, the parametric response surfaces for fetal adiposity were maximised with a low content in maternal dietary protein as well as intermediate protein (18–21%), high fat ($>40\%$), and low CHOs ($<40\%$). As maternal dietary intake

could be related to the development of fetal mid-thigh fat, the authors concluded that it was not only about the total content of fat but also the quality of fat consumed.

Knudsen *et al.* (2008), as part of the DNBC study cohort, examined possible associations between maternal dietary patterns in pregnancy and fetal growth. Two major dietary patterns were defined: the first consisted of red and processed meat, high-fat dairy, and the second pattern consisted of vegetables, fruits, poultry and fish. Women were then grouped in three classes according to their dietary pattern: women with a high intake of foods of the first dietary pattern, classified as 'the Western diet'; the second group was women with preferred foods of the second pattern, classified as 'Health Conscious'; and the third group of women who had eaten foods of both patterns, were classified as the 'Intermediate'. The adjusted odds ratio of having a SGA baby (birth weight <2.5th percentile for gestational age and gender) for women in the Health Conscious class compared with women in 'the Western Diet' class was 0.74 (95% CI 0.64–0.86) (parity, maternal smoking, age, height, pre-pregnancy weight and father's height were used to adjust analysis), revealing that a diet based on red and processed meat and high fat during pregnancy could increase the risk for SGA.

Knudsen *et al.* (2013), also as part of the DNBC, calculated glycaemic load (GL) from the diet reported, and obtained birth outcomes from birth registers. The risk of having a LGA baby increased by 14% in women who were in the highest GL quintile, compared to those in the lowest GL quintile. There was a mean increase of 36g in weight at birth from lowest to highest GL quintile (95% CI 19, 53g). No other study looked at GL, so no comparison could be made.

Two studies, both from the Medical Research Council Environmental Epidemiology Unit in Southampton University investigated the relationship between antenatal maternal diet and infant birth outcomes related to size. They showed that women who had a higher intake of CHOs in early pregnancy followed by a lower intake of dairy and meat protein in late pregnancy were more likely to have lower placental and birth weights (Godfrey *et al.* 1996) and infants who were thin at birth ($P = 0.01$ and $P = 0.03$) (Godfrey *et al.* 1997).

Okubo *et al.* (2012) assessed maternal dietary patterns and fetal growth in 803 women from the Osaka Maternal and Child Health Study (OMCHS) in Japan. Study results show that a diet high in bread, confectioneries and soft drinks, and low in fish and vegetables during pregnancy might be associated with a small birth weight and an

increased risk of having an SGA infant, reinforcing previous observations that maternal diet quality is related to fetal growth.

Starling *et al.* (2017), in a prospective cohort study of 764 mother-infant pairs, concluded that maternal dietary patterns during pregnancy may be a significant determinant of newborn body composition, independent of maternal obesity, total energy intake and physical activity. Women in the highest tertile of adherence to dietary pattern 1 (higher intake of solid fats, added sugars, cheese, nuts, poultry, fruits and whole grains) had newborns with 61g higher fat-free mass at birth (95% CI 12, 110 g) compared with women in the lowest tertile. Adherence to dietary pattern 2 (higher intake of non-whole grains, fruits and solid fats, eggs and starchy vegetables) was associated with greater newborn fat mass, birth weight, and adiposity. Women in the highest tertile of adherence to dietary pattern 2 had offspring with 33g higher fat mass (95% CI 8, 59 g), 80g higher birth weight (95% CI 15, 145 g), and 0.9% higher adiposity at birth (95% CI 0.3%, 1.6%) compared with women in the lowest tertile.

Due to differing dietary patterns, the results from these seven studies could not be combined and meta-analysed.

3.10.2 Preterm birth (N = 5)

Five different studies (Haugen *et al.* 2008a, Mikkelsen *et al.* 2008, Halldorsson *et al.* 2010, Englund-Ögge *et al.* 2012, Englund-Ögge *et al.* 2014) investigated the relationship between maternal diet and the risk of preterm birth. Three were part of the MoBa study (Haugen *et al.* 2008a, Englund-Ögge *et al.* 2012, Englund-Ögge *et al.* 2014) and two were from the DNBC study (Mikkelsen *et al.* 2008, Halldorsson *et al.* 2010). Altogether, they involved 125,334 pregnant women and investigated the risk of preterm birth in relation to the intake of artificially-sweetened (AS) and sugar-sweetened (SS) beverages (Halldorsson *et al.* 2010, Englund-Ögge *et al.* 2012), maternal diet measured as a whole (Englund-Ögge *et al.* 2014), and the Mediterranean-type diet (MD) (Haugen *et al.* 2008a, Mikkelsen *et al.* 2008). FFQs were the dietary assessment tool used in all five studies. Table 3-7 presents the different definitions given for preterm birth.

Table 3-7: Preterm birth definition

Author	Englund-Ogge et al. (2012)	Englund-Ogge et al. (2014)	Halldorsson et al. (2010)	Haugen et al. (2008a)	Mikkelsen et al. (2008)
Definition for preterm birth	<u>Preterm birth</u> <37weeks	<u>Preterm birth</u> 22< weeks <37	<u>Birth</u> <37 weeks (study primary outcome) AND <u>Late preterm birth</u> 34 < weeks <37, <u>Moderately Preterm birth</u> 32 < weeks <34, <u>Early preterm birth</u> <32 weeks (study secondary outcomes)	<u>Late preterm birth</u> 35 < weeks <36 <u>Early preterm birth</u> <35 weeks	<u>Preterm birth</u> 22 < weeks< 37 <u>Early preterm birth</u> 22 < weeks< 35

Englund-Ogge *et al.* (2012) found that women with higher pre-pregnancy BMI and energy intake had higher consumption of both artificially sweetened (AS) and sugar-sweetened (SS) beverages during pregnancy. High intake of AS and SS increased the risk for preterm birth; the adjusted OR for women who had one serving of AS per day was 1.11 (95% CI 1.00, 1.24), and 1.25 (95% CI 1.08, 1.45) for women who had one serving of SS.

A similar study on the intake of AS soft drinks and risk of preterm birth (Halldorsson *et al.* 2010) also found a significant relationship between the risk for preterm and the intake of artificially sweetened (AS) soft drinks: the adjusted OR for women who had one serving per day of AS carbonated soft drinks was 1.38 (95% CI 1.15, 1.65), and 1.78 (95% CI 1.19, 2.66) for women who had four servings per day (in women who were normal weight and overweight before pregnancy). No association was found between the intake of SS soft drinks and preterm birth.

Englund-Ogge *et al.* (2014) explored the relationship between maternal dietary patterns and risk of preterm birth, also as part of the MoBa study cohort. Diet was classified into three patterns: “prudent” (vegetables, fruits, oils, water as beverage, whole grain

cereals, fibre rich bread), “western” (salty and sweet snacks, white bread, desserts, processed meat products), and “traditional” (potatoes, fish). Women following a “prudent” or a “traditional” dietary pattern had a lower risk of preterm birth compared with women following a “western” dietary pattern. After adjusting for covariates, women who scored high on the “prudent” pattern had a significantly lower risk of preterm birth: AOR 0.88, 95% CI 0.80 to 0.97 (hazard ratio for the highest versus the lowest third). Women with a “traditional” pattern also had a significantly lower risk of preterm birth: AOR 0.91, 95% CI 0.83 to 0.99 (hazard ratio for the highest versus the lowest third). No association was found between a “western” pattern and preterm birth.

Two studies, Haugen *et al.* (2008a) (from the MoBa study) and Mikkelsen *et al.* (2008) (from the DNBC study), explored associations between Mediterranean-type diet (MD) and the risk of preterm birth. Table 3-8 outlines the very similar criteria used to define a Mediterranean-type diet in each study.

Table 3-8: Mediterranean diet definition

Author	Haugen et al. (2008a)	Mikkelsen et al. (2008)
Definition of a Mediterranean diet	✓ Intake of fish ≥ 2 times a week, ✓ Intake of fruits and vegetables ≥ 5 times a day, ✓ Use of olive/canola oil, ✓ Intake of red meat ≤ 2 times a week, ✓ Intake of ≤ 2 cups of coffee a day.	✓ Intake of fish ≥ 2 times a week (lunch or dinner), ✓ Intake of fruits and vegetables ≥ 5 times a day, ✓ Intake of olive or rape seed oil, ✓ Intake of meat (other than poultry and fish) ≤ 2 times a week, ✓ Intake of ≤ 2 cups of coffee a day.

In Haugen *et al.*’s study (2008a), only 2.2% of the women (n=569) met all the MD criteria, 97.2% (25,397) met 1-4 criteria, and 0.01% (159) did not meet any of the MD criteria. Although the risk of preterm birth was not reduced in those women who met all MD criteria compared to women who met none of the MD criteria, the intake of fish two or more times a week reduced the risk for preterm birth (OR: 0.84; 95% CI 0.74, 0.95). Similarly, 3.2% (n=1,137) of the Danish women (Mikkelsen *et al.* 2008) met all the MD criteria, and 540 (1.5%) women did not meet any.

Unlike Haugen *et al.*’s (2008a) results, Mikkelsen *et al.* (2008) concluded that the risk of very early preterm birth could be reduced by shifting towards a MD diet during pregnancy: the OR for preterm birth (not significant) was 0.61 (95% CI 0.35-1.05), and

was 0.28 (0.11-0.76) for early preterm in women who met all the MD inclusion criteria (3.2%, n=1,137), compared to women who did not fulfil any of the MD criteria (1.5%, n=540). Moreover, the risk for preterm birth (<37 weeks gestation) was 29% lower in the MD group and 72% lower for early preterm (<35 weeks) birth. The results of these two studies were pooled together and they got a combined OR (as the definitions and the groups of women were so similar).

The combined OR for women who met all the MD criteria (75 out of 1706 (4.40%)) compared to women who did not fulfil any of the criteria (39 out of 699 (5.58%)) was 0.046 (95% CI 0.0279 to 0.0759), $p < 0.0001$. Similarly, no difference was seen in the preterm birth rate between the “all MD criteria” group and those who met 1-4 of the criteria OR 0.0461 (95% CI 0.0295 to 0.0720), $P < 0.0001$. The combined OR for women who met all the MD criteria (75 out of 1706 (4.40%)) compared to women who did not fulfil any of the criteria (39 out of 699 (5.58%)) was 0.8 (95% CI 0.5-1.2), P -value = 0.216. Similarly, no statistically significant difference was seen in the preterm birth rate between the “all MD criteria” group and those who met 1-4 (2613 out of 59,250 (4.41%)) of the criteria OR 1.0 (95% CI 0.8-1.3), P -value=0.978.

3.10.3. Postnatal depression and depressive symptoms during pregnancy (N = 3)

Three different studies (Miyake *et al.* 2006, Murakami *et al.* 2008, Okubo *et al.* 2011a), all from the same research group, the Osaka Maternal and Child Health Study (OMCHS) in Osaka, Japan, investigated associations between diet during pregnancy and postnatal depression. A diet history questionnaire (DHQ) was used to measure diet during pregnancy (completed at around week 20 and assessing diet prior to completion of pregnancy) and the Edinburgh Postnatal Depression Scale (EPDS), self-administered, was used to assess postpartum depression at 2-9 months.

Miyake *et al.* (2006) investigated dietary fish and fat intake and the risk of postpartum depression in a cohort of 865 pregnant women, Murakami *et al.* (2008) investigated dietary glycemic index (GI) and load (GL), and Okubo *et al.* (2011a) investigated dietary patterns (described as Healthy, Western and Japanese). A total of 14% (121 women) developed postpartum depression but none of the studies found a direct exposure-response relationship with dietary factors.

Despite this, Miyake *et al.* (2006) reported an inverted J-shaped relationship between the risk of postpartum depression and the intake of docosahexaenoic acid and n-3 polyunsaturated fatty acids; Murakami *et al.* (2008) found that dietary GI in the third quartile compared with dietary GI in the first quartile was significantly associated with a decreased risk of postpartum depression, and Okubo *et al.* (2011a) described how the second quartile, in relation to the first quartile of the 'Western' dietary pattern, was significantly associated with a lower risk of postpartum depression.

3.10.4 Gestational weight gain and postpartum weight retention (N = 7)

Seven studies, conducted between 1987 and 2015, explored associations with gestational weight gain (GWG) (Langhoff-Ross *et al.* 1987, Conway *et al.* 1999, Knudsen *et al.* 2013, Sartorelli *et al.* 2014, Ebrahimi *et al.* 2015, Maslova *et al.* 2015, Starling *et al.* 2017). The studies were undertaken in several countries and involved 48,281 pregnant women. Ebrahimi *et al.*'s (2015) was the only cross-sectional study, and all the others were investigating a potential association between GWG and diet, or some components of diet, with some taking physical activity into consideration: Langhoff-Ross *et al.* (1987), Knudsen *et al.* (2013), Ebrahimi *et al.* (2015), Maslova *et al.* (2015) and Starling *et al.* (2017). Table 3-9 shows the multiple types of dietary assessment methods used in these studies.

Table 3-9: Dietary assessment method used on each study

Study	Dietary assessment tool used	Gestational weight gain measurement	PA taken into consideration
Langhoff-Ross <i>et al.</i> (1987)	Three day food record (measured twice)	Weight measured at time of giving birth – pre-pregnancy weight (reported)	Yes
Conway <i>et al.</i> (1999)	Two dietary records (self-administered, 7-day weighed diet record)	GWG was an approximation from the weight recorded 6 days (mean) before giving birth and residual weight gain from the weight registered 10 days (mean) after giving birth	No
Knudsen <i>et al.</i> (2013) DNBC cohort	FFQ	Measured weight gain (mean) from gestational week 12 to week 30 and only included data from women who had 60 days at least in between the measurements	Yes – used to adjust for potential confounder
Sartorelli <i>et al.</i> (2014) DNBC cohort	FFQ	Measured weight gain in grams (mean) from gestational week 12 to week 30 (excluding women ≤60 days and >200 days)	Yes – used to adjust for potential confounder
Ebrahimi <i>et al.</i> (2015)	Two days 24hrs recall	Pre-pregnancy weight (1-2 month(s) before pregnancy booking) and last-measured weight before delivery (38-40 weeks)	Yes
Maslova <i>et al.</i> (2015) DNBC study	FFQ	Measured weight gain in grams (mean) from gestational week 12 to week 30	Yes – used to adjust for potential confounder
Starling <i>et al.</i> (2017)	24 hour recall (web monthly based)	Pre-pregnancy weight (either from medical records (about 90%) or self-reported at the first study visit (about 10%)) and last recorded maternal weight during pregnancy (5 days median number of days before giving birth)	Yes

Conway *et al.* (1999) found that women who were restrained eaters (assessed by a Revised Restraint Scale (RRS)) prior to pregnancy were significantly less likely to experience weight gain within the American Institute of Medicines (AIM) recommended range for their pre-pregnancy BMI ($P=0.026$), gaining either more or less than the recommendation. The authors concluded that restricting dietary intake pre-pregnancy

may have a negative impact on eating and weight gain during pregnancy, and identified the need for further investigation.

Ebrahimi *et al.* (2015) explored sociodemographic, diet and physical activity factors and associations with GWG among Iranian women. Diet was measured in the third trimester by using 2 x 24 hr recall. Univariate analysis revealed that women in the inadequate weight gain group, in relation to women in the adequate weight gain group, were younger (OR=0.892, 95% CI 0.806-0.987), had a lower pre-pregnancy BMI (OR=0.812, 95% CI 0.723-0.912), and spent less time sitting (OR=0.997, 95% CI 0.994-0.999). Women in the inadequate weight gain group, in relation to women in the excessive weight gain group, had a lower pre-pregnancy BMI (OR=0.629, 95% CI 0.532-0.745) and lower energy intake (OR=0.998, 95% CI 0.997–0.999). Finally, women who were in the adequate weight gain group, in relation to women in the excessive weight gain group, had a lower pre-pregnancy BMI (OR=0.840, 95% CI 0.777-0.909). After performing a cumulative logit model, the authors concluded that pregnant women who were older (OR=1.083, 95% CI 1.016–1.153) and had a higher pre-pregnancy BMI (OR=1.507, 95% CI 1.182-1.349; $P<0.0001$) were more likely to have higher GWG.

Knudsen *et al.* (2013) found higher GWG rates in the highest GL quintile (26 g/week (95% CI 19-34) and 30 g/week (95% CI 13-46), respectively), in women who were normal weight and overweight before pregnancy.

Maslova *et al.* (2015), also part of DNBC, investigated the relationship between protein:carbohydrate (P/C) ratio and protein substituted for CHOs, in pregnancy with GWG. Study findings demonstrated that a reduced GWG linked to a high protein:carbohydrate ratio diet, and that GWG was also strongly related to the intake of added sugar (Q5 vs Q1: 34, 95% CI 28-40 g/week, $P<0.0001$). These results concur with results from randomised trials in non-pregnant participants.

Sartorelli *et al.* (2014) investigated GWG in the second and third trimesters and weight gain ratio (observed weight gain/expected weight gain) in relation to the intake of fried food, estimated using a semi-quantitative FFQ and multiple 24-h dietary recalls, and tested associations using the multiple source method (MSM). The results suggested that: 1) the intake of fried food determined by MSM was related to excessive GWG ratio both with and without the frequency of intake as covariates, β 0.29 (95% CI 0.03, 0.54) and β 0.31 (95% CI 0.07, 0.55) respectively; 2) there was no association between

the intake of fried food determined by FFQ and weight gain β 0.40 (95% CI -0.68, 1.48); and 3) no association between the intake of fried food assessed by 24hr dietary recall and weight gain β 0.49 (95% CI -0.53, 1.52).

Langhoff-Ross *et al.* (1987) found that in their cohort of 56 healthy Swedish women, energy intake was statistically significantly associated with maternal fat accretion, defined as the difference between fat mass in early pregnancy and at week 37.

Starling *et al.* (2017) identified maternal dietary intake patterns that could potentially be associated with GWG (along with fasting glucose and newborn adiposity). Two dietary patterns were identified: pattern 1 with food groups with high factor loadings (≥ 0.20) i.e., healthy protein sources: poultry, nuts, and seeds; cheese; whole grains; citrus fruits, berries and melons; other fruits; added sugars and some discretionary solid fat, with no food groups that had low factor loadings (≤ -0.20); dietary pattern 2 comprised of high factor loading of foods such as eggs, potatoes, other starchy vegetables, discretionary solid fat, citrus, berries and melons, and non-whole grains combined with food with low factor loadings (≤ 0.20), i.e., yogurt, added sugars, soy products, whole grains, and dark-green vegetables. The authors found that a greater compliance to dietary pattern 1 (upper tertile compared to low tertile) correlated with a greater newborn fat-free mass (61 g; 95% CI 12, 110 g). A greater compliance to dietary pattern 2 (upper tertile compared to low tertile) was associated with greater newborn fat mass (33 g; (95% CI 8, 59 g), birth weight (80 g; 95% CI 15, 145 g), and 0.9% higher adiposity at birth (95% CI 0.3%, 1.6%).

3.10.5 Gestational diabetes and glucose intolerance (N = 5)

Five studies investigated the interaction between diet and gestational diabetes mellitus (GDM), glucose intolerance and/or fasting glucose: He *et al.* (2015) from the Born in Guangzhou Cohort Study (BIGCS) in China; Karamanos *et al.* (2014), a single study involving 10 Mediterranean countries; Radesky *et al.* (2008) as part of the VIVA project in the USA; Saldana *et al.* (2004) from the Pregnancy, Infection, and Nutrition Study (PIN study) in the USA, and Starling *et al.* (2017), also in the USA. Altogether, they included 8,335 women and diet was assessed antenatally in all studies. Karamanos *et al.* (2014) (diet history) and Starling *et al.* (2017) (web-based 24 hour recall) were the only studies not to use a FFQ as a dietary assessment tool.

Different cut-off points were used to diagnose GDM, measurements were taken at different time points and different components of the diet were measured in the five studies: dietary patterns (Radesky *et al.* 2008, He *et al.* 2015), MD (Karamanos *et al.* 2014) and intake of macronutrients (Saldana *et al.* 2004) (Table 3-10). As a result, meta-analysis could not be performed.

Table 3-10: Cut-off points used for diagnosis of GDM

Study	Dietary assessment tool used (diet component assessed)	Assessment of glucose intolerance	OGTT* and cut-off points for diagnosis of GDM
Saldana <i>et al.</i> (2004)	FFQ. Intake of macronutrients and total energy in the second trimester of pregnancy	Screening test measuring concentration of plasma glucose 1h after a 50-g glucose challenge test (non-fasting). Depending on the study site (clinic) specific protocols established different cut-off points for follow-up testing University of North Carolina and Wake medical centre: need for oral-glucose tolerance test (OGTT) if challenge test results were ≥ 140 mg/dL and ≥ 130 mg/dL respectively.	Fasting OGTT conducted, and plasma glucose measured after 1, 2, and 3 h after 100g oral glucose load. Cut-offs points: fasting (95 mg/dL); 1-h (180 mg/dL); 2-h (155 mg/dL) and for 3-h (135mg/dL)
Radesky <i>et al.</i> (2008)	FFQ Dietary patterns measured at 26-28 weeks gestation	Screening test measuring concentration of plasma glucose 1h after a 50-g glucose challenge test at 26-28 weeks gestation (non-fasting) and then, the OGTT when the results of the glucose challenge test was ≥ 140 mg/dL	100g oral glucose load administered in the morning (non-fasting). Blood glucose levels (normal fasting values): (<95 mg/dL), 1-h (<180 mg/dL), 2-h (<155 mg/dL) and for 3-h (<140 mg/dL). OGTT between 24-32 gestational weeks: 75g of glucose
Karamanos <i>et al.</i> (2014)	Dietary history Mediterranean diet Index (MDI) – assessed before OGTT		Two different cut-off points: 1) According to the American Diabetes Association (ADA)

			(2010) guidelines: fasting (≥ 5.3), 1-h (≥ 10.0) and 2-h (≥ 8.6) mm/l
			2) International Association of the Diabetes and Pregnancy Study Groups (IADPSG): fasting (≥ 5.1), 1-h (≥ 10.0) and 2-h (≥ 8.5) mm/l.
He et al. (2015)	FFQ Dietary patterns (4 main dietary patterns were identified) at 24-27 weeks gestation		GDM: pregnant women were routinely given a 75g, 2-h OGTT at an antenatal visit Cut-off points (International Association of Diabetes and Pregnancy Study Groups (IADPSG)): fasting (5.1 mmol/l), 1-h (10.0 mmol/l) and 2-h (8.5 mmol/l).
Starling et al. (2017)	Monthly web- based 24-h recall	<u>Fasting glucose</u> : glucose concentration measured in a fasting serum sample collected at a median of 27 weeks gestation	Not stated

*Oral glucose tolerance test (OGTT)

He et al. (2015), Karamanos et al. (2014) and Saldana et al. (2004) found a direct association between diet and the risk of being diagnosed with GDM: in He et al. (2015), the highest tertile of vegetable dietary pattern was associated with a decreased risk of GDM (RR 0.79, 95% CI 0.64, 0.97) compared to the lowest tertile (tertile 1), and the highest tertile of the sweets and seafood pattern was associated with an increased risk of GDM (RR 1.23, 95% CI 1.02, 1.49). Karamanos et al. (2014) found that women diagnosed with GDM had a lower Mediterranean diet index (MDI) and that a MD had a protective effect against the development of GDM, while Saldana et al. (2004)

concluded that a low-carbohydrate and high-fat diet increased the risk of developing impaired glucose tolerance (IGT) and GDM.

Starling *et al.* (2017) aimed to determine whether maternal diet had any impact on fasting glucose concentration, measured in a fasting serum sample collected at a median of 27 weeks gestation. As mentioned above, two dietary patterns were identified. A greater compliance to dietary pattern 1 (upper tertile compared to intermediate tertile) correlated with greater GWG ($r = 0.22$, $P < 0.01$) but lower fasting glucose in mid-pregnancy ($r = -0.14$, $P < 0.01$), while a greater compliance to dietary pattern 2 (upper tertile compared to intermediate tertile) correlated with higher fasting blood glucose ($r = 0.16$, $P < 0.01$) with greater GWG ($r = 0.09$, $P = 0.02$).

3.10.6 Blood pressure (N = 1)

Eshriqui *et al.* (2016) was the only study to explore a potential relationship between maternal dietary patterns during pregnancy and changes in antenatal and postnatal blood pressure measurements (BP). This Brazilian prospective cohort enrolled 191 healthy women early in pregnancy (<13 weeks gestation) and used an 82-food item FFQ interview, administered in the third trimester, to assess diet in the 6 months prior to the interview. Three maternal gestational dietary patterns were determined: healthy, common Brazilian and processed. Systolic and diastolic BP were measured multiple times during pregnancy (at the 5th–13th, 20th–26th, 30th–36th gestational weeks) and once postpartum (with 30–45 days). No association was found between any of the three dietary patterns and changes in the systolic or diastolic BP.

3.11 Excluded studies

A list of excluded studies is in Appendix 3-5. Reasons for excluding include: abstracts, commentaries, errata, evidence summaries, protocols, RCTs, review, recommendations; studies with no proper data on diet during pregnancy; case control studies; studies in another language (other than English); ineligible data on diet measurement; ineligible (non-comparable) population; and ineligible (non-comparable) population.

3.12 Discussion

This SR included 32 observational studies and was conducted up to September 2017 and published in the English language, on diet during pregnancy and associations with a broad range of maternal, fetal and infant outcomes. Most of the studies included in this SR found a statistical significance between maternal diet during pregnancy, or a particular food or nutrient intake during pregnancy, and the primary outcome being investigated, which may indicate some publication bias if studies that did not find significant results were not accepted for publication.

Individual studies included in this SR showed that fetal body composition, birthweight or length measures, and other anthropometric measures, are significantly associated with fruit and vegetable intake (Mikkelsen *et al.* 2006) or vegetable intake only (Ramón *et al.* 2009), and Blumfield *et al.* (2012b) revealed how the macronutrient profile of a diet, the protein:carbohydrate ratio, was significantly associated with body composition at birth (the less protein in the diet, the more abdominal fat).

Some other studies included in this SR found a statistically significant relationship between a higher risk of small for gestational age and a higher intake of fatty fish (Halldorsson *et al.* 2007), lower intake of milk (Olsen *et al.* 2007), higher intake of processed meat and fat (Knudsen *et al.* 2008), or even the statistically significant relation between higher risk for LGA and GL (Knudsen *et al.* 2013). Moreover, other studies found a statistically significant association between the quality of maternal diet in the first trimester and fetal size (Rodríguez-Bernal *et al.* 2010), and how dietary acrylamide can negatively affect fetal growth (Duarte-Salles *et al.* 2013). Okubo *et al.* (2012) was one of the studies to demonstrate that a diet rich in bread, confectioneries and soft drinks, and low in fish and vegetables, is statistically significantly associated with small birth weight and increased risk of small for gestational age.

Duarte-Salles *et al.* (2013) results are in line with other studies that found a statistically significant association between the intake of AA and birth weight and head circumference of newborns (Tayel *et al.* 2015), and fetal length and weight (Kadawathagedara *et al.* 2016). In contrast, for instance, Langhoff-Ross *et al.* (1987) was the only included study that failed to show a relationship between diet and fetal body composition, birthweight and other anthropometric measures. A possible reason why Langhoff-Ross *et al.* (1987) did not find an association might be because it was a

small cohort (n=56) of well-nourished pregnant women, and was one of the few studies that considered the impact of physical activity during pregnancy.

Measuring energy intake is complex, and there are many influencing factors, including biologic, socioeconomic and demographic factors (Abu-Saad & Fraser 2010). It is therefore important to try to understand underlying relationships better so that dietary interventions can be developed in order to improve not only short-term birth outcomes but also long term quality of life, reduced morbidity and mortality and health care costs (Abu-Saad & Fraser 2010, Aizer & Currie 2014).

Another outcome analysed was preterm birth. Preterm birth is defined as birth before 37 completed weeks gestation (Gernand *et al.* 2016, Quinn *et al.* 2016, Delnord *et al.* 2017). It remains a leading global cause of infant morbidity and mortality (Lee *et al.* 2019, Burris *et al.* 2015, Dunlop *et al.* 2015, Martin *et al.* 2015, Delnord *et al.* 2017), with approximately 15 million infants born preterm every year (Lee *et al.* 2019, Quinn *et al.* 2016). Although preterm births occur primarily in low and middle income countries (LMIC) (Quinn *et al.* 2016), one in every nine babies born in the USA, nearly half a million infants, is born preterm (Dunlop *et al.* 2015). According to Englund-Ögge *et al.* (2014), the proportion of preterm births in the USA is 12% and 6% in Nordic countries. Preterm birth is linked to greater chances of neonatal mortality (Gernand *et al.* 2016); it contributes directly to an estimated one million neonatal deaths annually and is a significant contributor to childhood morbidity (Quinn *et al.* 2016). Unfortunately the aetiology for preterm birth is still largely unknown (Englund-Ögge *et al.* 2014, Martin *et al.* 2015).

Whilst the relationship that maternal diet during pregnancy has on fetal growth is acknowledged, the relationship with preterm birth is still unclear (Martin *et al.* 2015). Yet, five of the included studies (as part of two large cohort studies) investigated the possible link between diet and risk of preterm. Measuring diet as a whole and categorising different diet patterns, Englund-Ogge *et al.* (2014), from the MoBa cohort, found a significant association between specific dietary patterns (“prudent” and “traditional”) and a lower risk of preterm birth. This statistically significant correlation is in line with two other large cohort studies (Rasmussen *et al.* 2014, Martin *et al.* 2015). Two Scandinavian longitudinal studies, both with large cohorts, had conflicting results: Haugen *et al.* (2008a), from the MoBa cohort, found no association between Mediterranean-type diet (MD) and the risk of preterm birth, raising questions about whether the study population selection criteria influenced those results (exclusion of

cigarette smokers and women with low BMI) and how MD was assessed. On the other hand, Mikkelsen *et al.* (2008), from the DNBC study, concluded that adopting a Mediterranean-type diet during pregnancy had the potential to decrease the risk of preterm birth in Danish women. Both studies were published in the same year and, as both measured diet during pregnancy with a DHQ, meta-analysis of their results showed that the risk of preterm birth was significantly lower for women who followed a MD. Furthermore, according to Mikkelsen *et al.* (2008), a MD can have multiple definitions as the Mediterranean area comprises at least 16 nations by the Mediterranean Sea, so it can be complex to compare studies that have used different definitions.

Postnatal depression, another outcome assessed in this SR, is defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM) as a major depressive episode with postpartum onset if the onset is within four weeks postpartum (Shorey *et al.* 2018, Miller *et al.* 2013). It has been suggested that the prevalence of postpartum depression (PPD) ranges from 10-15% but can reach up to 30% depending on the diagnosis criteria used (Brummelte & Galea 2016). A recent systematic review and meta-analysis on the prevalence and incidence of postpartum depression among healthy mothers found that the incidence of PPD was 17% among healthy mothers without a history of depression (Shorey *et al.* 2018).

The effect of maternal diet on postnatal depression was explored in three of the studies in this SR, all from the same cohort, the OMCHS study, and none of the studies reported a significant association between diet and symptoms of postnatal depression (PND), measured using the Edinburgh Postnatal Depression Scale (EPDS). In contrast, a study undertaken in Greece in 2011 on “Dietary patterns during pregnancy and the risk of postpartum depression: the mother-child ‘Rhea’ cohort in Crete, Greece” showed that, according to the different dietary patterns, women in the “health conscious” diet group were statistically significantly less likely to have postnatal depression (Chatzi *et al.* 2011). However, recent studies failed to find an association between diet in pregnancy and PPD (Nathanson *et al.* 2018, Baskin *et al.* 2017). In relation to nutrition research, additional studies are necessary to evaluate whether there is a significant cause-effect association between maternal diet and postpartum depression (Nathanson *et al.* 2018, Baskin *et al.* 2017).

Knudsen *et al.* (2013) found higher GWG rates in the highest GL quintile (26 g/week (95 % CI 19-34) and 30 g/week (95 % CI 13-46), respectively, in women who were normal weight and overweight before pregnancy. A possible explanation is that GL is linked to excessive GWG and postpartum weight retention (PPWR), particularly in women who are overweight or obese. On the contrary, another cohort study in the US did not find any association between GL and GWG (Deierlein *et al.* 2008).

It has been nearly 30 years since the IOM published their first guidelines about GWG in pregnancy (based on women's pre-pregnancy BMI) in an attempt to avoid excessive weight gain during pregnancy (Muktabhant *et al.* 2015). Moreover, according to a Cochrane review, several studies in the USA and Europe found that around 20-40% of pregnant women gain weight above the recommendations and that this proportion is increasing (Muktabhant *et al.* 2015). All studies about GWG in this SR found an association between diet (or a component of diet) during pregnancy and GWG. The negative outcomes of inadequate and excessive GWG were reported on chapter 2.

A recent Irish cohort found that 62.5% of pregnant women did not comply with the IOM recommendations for pregnancy weight gain (Heery *et al.* 2015), and diet was always one of the predictors of inappropriate gestational weight gain, both for Irish nationals and foreign nationals. Also in Ireland, McGowan & McAuliffe (2013) explored "Maternal dietary patterns and associated nutrient intakes during each trimester of pregnancy". Two dietary patterns were identified by using cluster analysis: "healthy" and "unhealthy" throughout the different trimesters, reinforcing that once dietary patterns can be distinguished early in pregnancy, the necessary interventions regarding their diet can be made (McGowan & McAuliffe 2013).

According to the International Association of Diabetes in Pregnancy Study Groups (IADPSG), the risk of adverse maternal and perinatal outcomes, such as fetal macrosomia, shoulder dystocia, birth injury, pre-eclampsia, and preterm birth are increased in pregnant women who are overweight, obese or have GDM (Black M.H *et al.* 2013). It is estimated by IADPSG criteria that around 10-25% of pregnant women are diagnosed with GDM and of those, 50-60% are overweight or obese at the start of their pregnancy. This makes it difficult to identify what could be contributing to the onset of GDM: the high pre-pregnancy BMI or the maternal glycemia during pregnancy (Black M.H *et al.* 2013).

The four studies included in this SR on gestational diabetes and glucose intolerance were conducted between 2004 and 2015. The more recent study, He *et al.* (2015), used the IADPSG diagnosis criteria and found that almost 18% of women were diagnosed with GDM. Employing a prospective design with a large sample of 3063 women, the study analysed diet as a whole, enabling a more comprehensive analysis. The authors found that a high intake of vegetables could attenuate the harmful effects of other risk factors for GDM (such as family history of DM) and that a “sweets and seafood diet pattern” could possibly increase the risk of GDM based on the fact that a high-sugar diet can reduce insulin sensitivity and insulin secretion (He *et al.* 2015).

A second study to investigate diet as a whole found that 5% of women developed GDM, and concluded that pre-pregnancy BMI, age, race/ethnicity, diet before pregnancy, history of GDM and family history of DM, were more likely to be predictors of glucose tolerance and GDM other than diet quality in early pregnancy (Radesky *et al.* 2008). The authors suggested that the quality of the diet over the long term (a pre-pregnancy diet) might be more influential on DM and GDM as diet during pregnancy might not have enough time to affect the risk for a GDM.

A recent SR on “Primary prevention of gestational diabetes mellitus through nutritional factors: a systematic review” (Donazar-Ezcurra *et al.* 2017), reviewed literature on the effectiveness of nutritional dietary factors before or during pregnancy to prevent GDM. Out of all the 14 clinical trials (dietary factors and supplements), only two nutritional interventions were found to reduce the incidence of GDM significantly: intervention on lifestyle (including diet) and a non-randomised controlled pragmatic trial aiming to prevent childhood obesity that had the intervention (individual diet and physical activity counselling by a public health nurse, and two group counselling sessions by a dietician and a physiotherapist) on pregnant women (Donazar-Ezcurra *et al.* 2017). The 22 observational studies included in this SR suggested that a higher adherence to a healthier dietary pattern (such as “a Mediterranean dietary pattern, and lowering the intake of foods with high haem iron content, sugar sweetened cola, potatoes, fatty foods and sweets”) could reduce the incidence of GDM (Donazar-Ezcurra *et al.* 2017). Other dietary factors (specific dietary patterns such as Mediterranean) may have also have some influence on the development of GDM, however further studies are needed in order to generate higher quality evidence (Donazar-Ezcurra *et al.* 2017).

Findings from these studies are in line with Starling *et al.* (2017), who showed the relation between aspects of maternal diet and fasting glucose concentration, more specifically between the intake of dietary fibre or whole grains and insulin resistance. Literature from non-pregnant populations also show that a diet high in fibre (>25 g/d in women and >38 g/d in men) is linked to a 20-30% decreased risk of developing diabetes type 2 (insulin resistance) (Weickert & Pfeiffer 2018). However, the type of fibre (soluble vs. insoluble) eaten is also important (Weickert & Pfeiffer 2018).

Radesky *et al.* (2008) state that factors such as pre-pregnancy BMI, age, race/ethnicity, history of GDM and family history of DM, and long-term diet, and not just diet during pregnancy, are more likely to be predictors of glucose tolerance and GDM. Bearing in mind all the adverse outcomes that GDM presents to women and babies, it is critical to have a full understanding of predictors and risks that they might have for developing it. A proper diagnosis (typically around 24 weeks) is key to avoiding short term complications in pregnancy (Sweeting *et al.* 2017), however international guidelines now suggest even earlier screening for women at high risk in order to avoid potential long-term effects to the offspring (Sweeting *et al.* 2017).

Eshriqui *et al.* (2016) found that “the dietary food intake does not exert a significant role on blood pressure variation during healthy, normotensive pregnancy since only a small variability in BP is expected” (Eshriqui *et al.* 2016, p.30). This finding is in line with Oken *et al.* (2007) who did not find a lower risk of gestational hypertension associated with diet (Oken *et al.* 2007). Other observational studies suggest a potential effect of some nutrients, such as omega-3 fatty acids, fish oils, magnesium, antioxidant vitamins, and a potential risk with trans fatty acids, but results are still inconsistent (Oken *et al.* 2007), similar to results from randomised trials.

3.13 Strengths and limitations of the systematic review

Strengths of this review lie in its rigorous SR methodology: a protocol was devised *a priori*, independent screening of studies was conducted, an adapted version of the Newcastle Ottawa Scale (NOS) was used to assess the methodological quality of the studies and a list of excluded studies and reasons for it was also presented. Another strength is the inclusion of studies that reported maternal diet during pregnancy as a whole (or some food groups).

This SR played an important role in informing some of the methodological decisions that were taken: out of the six core outcomes groups (infant measurements at birth, gestational weight gain and postpartum weight retention, gestational diabetes and glucose intolerance, preterm birth, postnatal depression and depressive symptoms during pregnancy, and antenatal blood pressure changes), I explored three variables in my study: birth weight, length of gestation and postpartum depression. The absence of the variable 'mode of birth' was striking, and led to the inclusion of this as the primary outcome for my study. Similar to 'mode of birth', there were no studies exploring a possible association between diet during pregnancy and breastfeeding practices. That also inspired and motivated me to examine this relationship in this study.

Moreover, this SR also informed the dietary assessment methods used in the thesis: a diet quality index, P:NP ratio, and the need to use a more global method to analyse dietary patterns, such as cluster analysis. This SR highlights the fact that despite including studies of high methodological quality, most of them did not investigate diet during pregnancy from a whole-diet approach.

The SR also showed that only six out of 32 high quality studies included PA as a variable, reinforcing the importance of including it in this study. Finally, in this SR, 23 out of 32 studies used an FFQ as a diet assessment method, demonstrating that FFQs are the most frequently used tool to assess diet, and supporting my decision to use it as my study tool.

Notwithstanding these strengths, limitations exist. First of all, it is important to note that all dietary assessment tools are prone to measurement errors and therefore misreporting dietary intake can never be ruled out. Second, studies analysing diet as a whole, specific nutrient(s) of diet, dietary patterns or specific diet styles classify diets differently, use different indexes of overall quality, measure maternal diet at different time points in pregnancy, over different lengths of time periods with different dietary assessment tools. All these factors make meaningful comparisons, and meta-analyses of results, difficult.

A potential bias can result from the exclusion of case-control studies, nevertheless, the fact that case-control studies are at particular risk of biased patient selection that could favour the outcome being measured in favour of the exposure also under evaluation (Etminan *et al.* 2003, Sarkhy *et al.* 2011). Moreover, excluding studies that considered micronutrient supplement use during pregnancy and diet was a limitation of this SR.

A possible additional limitation of this systematic review is the inclusion of English language only studies. This may introduce language bias and incorrect assumptions (Morrison *et al.* 2012).

3.14 Conclusions

This systematic review brings together a range of results from studies deemed to be of high methodological quality and, despite the heterogeneity found, their results add to the evidence on how maternal diet during pregnancy may be associated with different outcomes for the mother, fetus and infant. Most of the studies in this SR showed the diet-health relationship to be statistically significant: such as maternal diet/diet components during pregnancy and the six core groups of pregnancy outcomes found in this SR: infant measurements at birth, gestational weight gain and postpartum weight retention, gestational diabetes and glucose intolerance, preterm birth, postnatal depression and depressive symptoms during pregnancy, and antenatal blood pressure changes.

From the results of this SR, it is important to make inferences about some foods and nutrients that were reported to have a statistically significant relationship with the outcome being measured: diets with fruits and vegetables (a higher intake would have a positive impact on birth weight and fetal growth), fatty fish (a higher intake was found to be statistically significantly associated with higher risk for SGA), milk (intake was inversely associated with SGA and directly associated with LGA and weight at birth), macronutrient balance (GWG and infant's body composition and weight at birth, placental weight and IGT), quality of fat and n-3 fatty acids (intake was inversely associated with the risk of postpartum depression), as well as diet measured as a whole: "vegetable pattern" (protective effect on GDM and GWG), "prudent pattern", "traditional pattern" (diet quality (measured by AHEI), "health conscious pattern" (higher quality diet was statistically significantly associated with increased fetal size at birth and fetal growth), both GI and GL diet (intake was inversely associated with the risk of postpartum depression), and MD-type diet (and the risk of preterm birth as well as a protective effect on GDM). However, due to the heterogeneity of the methodologies and measurement tools used in most of the different studies, it was only possible to combine the results (OR) from two studies on MD type of diet and risk of preterm birth.

Because of the complexity of diet, there is a critical need to improve the accuracy of, and to standardise, dietary intake assessment criteria and diet measurement tools. Studies with a whole-diet approach are necessary as food is eaten as a complex combination of nutrients, not as isolated nutrients. Assessing the overall diet, rather than studying single macro or micronutrients, and taking biological complexities and other factors into consideration, is becoming increasingly common to identify the risks and predictors to developing chronic diseases.

This SR contributes to the body of evidence on the relationship between maternal diet during pregnancy and outcomes related to the mother, fetus and infant up to 12 months and informed some of the methodological decisions that were taken in this study. Three of the six core outcomes (birth weight, length of gestation and postpartum depression) were included, as were mode of birth, breastfeeding, and PA, because of their notable absence in the world literature. The SR also facilitated my decision to use an FFQ as my study tool, and informed the dietary assessment methods used in the thesis: a diet quality index, P:NP ratio, and the need to use a more global method to analyse dietary patterns, such as cluster analysis.

Chapter Four: Methodology

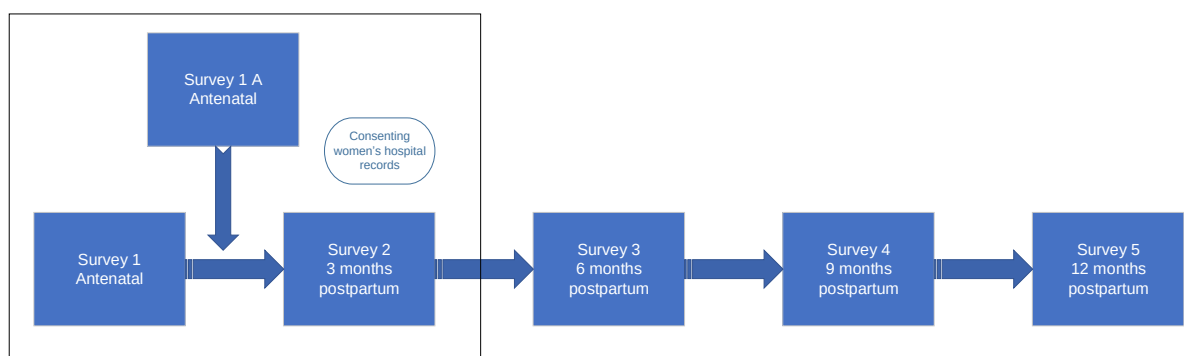
4.1 Introduction

This chapter describes the methodology used in this PhD study. A rationale for the study is outlined, which was based upon both the literature review (chapter 2) and systematic review (chapter 3). It provides a detailed description of the research approach, study design and methodology including designing, validation, administration and analysis of the study surveys. Ethical issues, recruitment and retention of participants are discussed and all decisions justified.

4.2 The Nutrition and Physical Activity strand of the MAMMI study

The Nutrition and Physical Activity strand comprises a single site study embedded within the MAMMI study, a longitudinal mixed methods multi-site study exploring the health and health problems experienced by women before and during pregnancy and during the first year after the baby's birth (Figure 4-1).

Figure 4-1: Study questionnaire flowchart



The Nutrition and Physical Activity strand utilises data on some of the variables collected in the MAMMI study survey 1, consenting women's maternity records, and the 3 months postpartum survey, and includes the purposefully designed self-administered 'Diet and Physical Activity survey' (Survey 1A), which provided data for the PhD study on diet, dietary patterns and exercise in pregnancy.

4.3 Aims and objectives of the 'Diet and dietary patterns during pregnancy in nulliparous women in Ireland' study.

4.3.1 Aim

To identify the diet, dietary patterns, and physical activity levels of nulliparous women during pregnancy, analyse associations with pre-pregnancy and pregnancy factors, and explore associations with pregnancy, birth, neonatal and postpartum outcomes.

4.3.2 Objectives

- 1) Determine the nutritional adequacy of the diet of nulliparous women during pregnancy;
- 2) Identify diet adequacy/balance of nulliparous women during pregnancy, assessed by two different methods;
- 3) Identify dietary patterns of nulliparous women during pregnancy, using two different methods of assessment;
- 4) Identify the changes, if any, that women make to their diet during pregnancy;
- 5) Identify the social behavioural changes in terms of alcohol intake, smoking behaviour and amount of exercise, that women make when they know they are pregnant;
- 6) Identify the predictors of dietary patterns of nulliparous women during pregnancy using two different methods of assessment;
- 7) Analyse the associations, if any, between diet during pregnancy (including the influence of amount of physical activity during pregnancy), as measured by four different methods, and pregnancy, birth, neonatal and postpartum outcomes.

4.4 Study methodology

4.4.1 Study Design

Choosing the right research design is essential not only to answer the research question but also to advance knowledge and understanding (Sousa *et al.* 2007, Akotia *et al.* 2016). The aim of this study was to identify the diet, dietary patterns and physical activity levels of nulliparous women during pregnancy, analyse associations with pre-pregnancy and pregnancy factors, and explore associations with pregnancy, birth, neonatal and postpartum outcomes. Therefore a quantitative approach was appropriate (Walker 2005). Within the post-positivist paradigm, quantitative methods can be used on their own. Investigators employing this approach are trying to produce knowledge/findings, by using methods such as surveys and/or experiments, or by collecting data using validated and reliable instruments, that can be analysed (Creswell & Creswell 2017). A quantitative method is the best approach when identifying factors linked with an outcome (Creswell & Creswell 2017).

Three levels of quantitative research have been identified: descriptive, which aims to discover, describe and determine frequency and categorise the information obtained; correlational, which tests hypotheses and determines associations between variables (but no intervention is made); and experimental research, where a cause-effect relationship is studied (Walker 2005, Wildemuth 2016). As this study aimed to explore predictors and outcomes, a descriptive and correlational design was chosen.

4.5 Working at the MAMMI study

The MAMMI study was established in 2011 in one site (maternity hospital) and extended to a second site in 2013. Since I joined the team in 2014, I contributed to recruitment and follow-up of participants in the first and second sites (sending web-texts and e-mails as reminders) and retention (preparing the survey packs to be sent to participants, and maintaining the database). I also helped to extend the MAMMI study to the third study site (CWIUH), through survey and database preparation, recruitment, follow-up and retention of participants, from September 2015.

In 2014/15, I developed the overall Nutrition and Physical Activity strand, and developed and tested for validity and reliability the 'Diet and Physical Activity survey' (Survey 1A), which would be embedded within the MAMMI study in the CWIUH when it started in August 2015.

4.6 Sampling, Selection criteria & Sample size

The women who participated in the 'Diet and dietary patterns during pregnancy in nulliparous women in Ireland' study were recruited from the cohort of participants who were recruited to the larger MAMMI study, in the CWIUH only.

4.6.1 Inclusion and exclusion criteria

Table 4-1: Inclusion and exclusion criteria: MAMMI study and 'Diet and dietary patterns during pregnancy in nulliparous women in Ireland' study

	MAMMI study	'Diet and dietary patterns during pregnancy in nulliparous women in Ireland' study – Eligibility criteria
Inclusion	Nulliparous women, aged 18 or over who were able to read and understand English sufficiently to complete surveys and gave consent to take part	Women who completed and returned survey 1 and gave consent to take part
	Women aged 17 years and less, and women who could not read or understand English sufficiently to complete surveys;	Women with a multiple pregnancy (twins)
Exclusion	Women who, following recruitment, experienced miscarriage, stillbirth or death of their baby were excluded from further participation	Data from women whose dietary intake was <500 and >3500 calories (misreporting: 'implausible reporters') were excluded from the final analysis

4.6.2 Sample size

The sample size for the 'Diet and dietary patterns during pregnancy in nulliparous women in Ireland' study was determined *a priori*, using SamplePower (<http://powerandsamplesize.com/Calculators/>).

Calculations were based on the likelihood of a difference being found in the primary outcome of 'spontaneous vaginal birth', between those having a 'healthy diet' and those having an 'unhealthy diet', as measured by the four methods used to assess diet during pregnancy. With an estimated probability of normal birth in the 'unhealthy diet' group of 0.35, and 0.50 in the 'healthy diet' group, an alpha level = 0.05 and power of 0.80, 167 participants were required in each group, giving a sample size of 334 nulliparous women.

4.7 Ethical considerations

Ethical approval

Ethical approval for the 'Diet and dietary patterns during pregnancy in nulliparous women in Ireland' study was obtained from the Faculty of Health Sciences' Ethics Committee (Trinity College Dublin) (Appendix 4-1) in February 2015 and from the CWIUH's Ethics Committee (Appendix 4-2) in May 2015.

Consent

All participants gave written informed consent prior to taking part in the study, using a purposively designed 15-item consent form.

Respect for autonomy and beneficence

Childbearing women may have concerns about their or their baby's health during pregnancy. While the information provided in participants' surveys may indicate their diet is unhealthy, the researcher assured participants their information would be kept in confidence. I acknowledged that participants were receiving care during the study period and might benefit from contact with the research team (i.e., this contact may help participants source otherwise unknown help). I planned that, should participants raise concerns with me, they would be encouraged to discuss these with the midwives

or doctors, as I am not qualified to advise in this area. This process was approved in the application to the CWIUH's Ethics Committee.

Data protection and confidentiality

When participants returned the consent form and completed the first antenatal survey, they were assigned a unique study identification (ID) number. The woman's personal details and their study ID number were stored in a database separate from the woman's survey information. The woman's survey information, identifiable by the study ID only, was entered into an SPSS file and stored in a separate password-protected folder in the MAMMI study folder on Trinity College Dublin's main server, and accessible to the MAMMI study research team only. Paper copies of the woman's surveys, identifiable by the study ID only, were stored separately from the woman's consent form in locked cabinets in a locked office.

Data are and will continue to be, stored according to the General Data Protection Regulation (GDPR 2018).

4.8 Recruitment

Nutrition and Physical Activity strand

The 'Diet and Physical Activity survey' (Survey 1A) was part of the MAMMI study in the CWIUH and detailed in the participant information leaflet (PIL). Participants consenting to take part in the MAMMI study consented to completing the 'Diet and Physical Activity survey' as part of the wider MAMMI study. Participants were recruited to the MAMMI study in early pregnancy, completed survey 1 in early pregnancy, and completed the 'Diet and Physical Activity survey' (survey 1A) in the late second/third trimester of pregnancy (between 28 and 36 weeks of pregnancy), approximately 2 months after they had completed the first antenatal survey (survey 1).

At the first booking visit to the hospital/clinic in the CWIUH, at approximately 12 to 16 weeks gestation, all eligible nulliparous women were offered an information pack on the MAMMI study by the midwife conducting the booking visit. This pack included a letter of introduction about the research and researchers, and an information booklet detailing the purpose of the research, the potential benefits and harms, the data collection

methods, the time commitment, information on voluntary participation and the right to withdraw without prejudice to care, assurances of confidentiality, details of the researcher(s) and an offer from the researcher to discuss any questions. It also contained two copies of the consent form, the first antenatal survey (Survey 1) (Appendix 4-3) and an addressed FREEPOST envelope.

When the woman accepted the study information, the midwife sought her verbal consent to have her personal details (name and telephone number) passed on to the research team. One to two weeks later, a researcher telephoned each woman to answer questions and offer further details or clarity on the study. If the woman did not wish to take part, her personal details were removed from the study database and no further contact was made.

If the woman wished to participate, she was invited to complete the consent forms, keep one for her own records, and post the second copy with the completed first antenatal survey to the research team. Participants were recruited to the study when the consent form and first completed survey had been returned. If the woman had not returned the survey and consent form within 3-4 weeks, a web-text reminder was sent and, after that, if the consent form and survey were not returned, no further contact was made with the woman.

4.9 Data collection

The MAMMI study first antenatal survey was administered at 12 to 16 weeks gestation. The 'Diet and Physical Activity survey' was then posted to participants who remained eligible for follow-up when they were 28 weeks gestation, and the 3 months postpartum survey was posted to participants at 10 weeks postpartum. Figure 4-1 shows the data collection time points for the wider MAMMI study. A copy of survey 1 and survey 1A can be found in appendix 4-3 and appendix 4-4.

4.10 Follow-up and retention

A good retention rate is crucial to ensure the internal validity of a longitudinal study (Abshire *et al.* 2017). The study follow-up and retention strategy was as follows:

Survey 1: if the completed survey and consent form were not received from participants who indicated willingness to take part, one reminder text was sent four weeks after the phone call.

Survey 1A: posted to eligible participants at 28 weeks gestation. If the completed survey was not received within four weeks of posting, one reminder text was sent. If the completed survey was not received within four weeks, the survey was resent. No further follow-up was made.

Survey 2 (3 months postpartum): posted to eligible participants at 10 weeks postpartum. If the completed survey was not received within 4 weeks of posting, participants received a reminder telephone call. A second text reminder was sent two weeks later. If the completed survey was not received within two weeks, the survey was resent. No further attempt was made to contact participants.

All participants could withdraw from the study at any time, either verbally during any phone call, with a phone text, e-mail, or by ticking a box on each survey indicating that they wanted to withdraw from the study.

4.11 Dietary assessment tool

In nutrition and health research, accurate measurements of diet (food, drinks and dietary supplements) are essential as dietary patterns are difficult to measure (Kirkpatrick & Collins 2016), and an unreliable dietary assessment would compromise the understanding of diet-disease associations (Shim *et al.* 2014, Kirkpatrick & Collins 2016). Assessment of the intake of food and drinks includes retrospective or prospective survey methods, case control studies, food diaries, etc., depending on the purpose and design of the study (Ortega *et al.* 2015).

The characteristics, strengths and limitations of the various dietary assessment methods are summarised in Table 4-2:

Table 4-2: Characteristics of dietary assessment tools

Tool	Characteristics	Strengths	Limitations
Food frequency questionnaire (FFQ)	Predefined, self- or interviewer administered surveys. ¹	Cost-effective ^{1,2}	Close-ended questionnaires ^{1,2}
	Frequently used in epidemiology studies. ²	Time saving ²	May not represent usual intake or absolute daily intake ³
	Measure long-term intake. ^{1,2}	Better representation of usual diet (rather than a few days of observation) ³	Some literacy and cognitive skills (from respondent) are required. ³
	Advanced form of the diet history method. ³	Diet is not affected ³	
		Easy to complete ⁷⁻⁹	
		Less expensive compared to other tools ⁷⁻¹¹	
		Lower respondent burden ^{9,11}	
		Suitable for large epidemiological studies ^{9,11}	
		Enables the assessment and calculation of the usual/average nutritional intake over a certain period of time ^{9,11}	
		Respondents can be categorised and compared by their consumption, and associated health outcomes and morbidities assessed ¹²	
24-hour dietary recall	Subjective, retrospective (over the previous 24 hours) ^{1,5}	Detailed intake data ¹	Recall bias cannot be excluded ^{1,5}
	Open-ended questions, interviewer-administered ¹	Relatively small respondent burden ¹	Requires an interviewer (well trained) ^{1,5}
		High literacy is not required ^{1,5}	May not represent long-term diet ⁴
		Diet is not affected ⁵	At least two 24hour dietary recalls are needed ^{1,4,5}
		High precision ⁵	Possible tendency to underestimate intake ⁵
			Expensive and time consuming ¹

Dietary history	Subjective, open- and closed-ended interviewer-administered questions ¹ Measures long-term intake ¹	Measures usual dietary intake ¹	High cost and time-consuming ¹ Requires an interviewer (well trained) ⁶
Food diary (or dietary record)	Subjective, open-ended, self-administered questionnaires ¹ Current intake during a specific period ¹	Provides detailed intake data ¹ No interviewer required ¹ No recall bias ¹	Requires literacy skills and motivation: respondent burden ¹ Possible under-reporting ¹ Expensive and time-consuming Multiple days required to assess usual intake

^{*1}(Shim *et al.* 2014) ²(Dodd *et al.* 2006) ³(Pérez Rodrigo *et al.* 2015) ⁴(Raina 2013) ⁵(Salvador Castell *et al.* 2015) ⁶(Guallar-Castillón *et al.* 2014) ⁷(Carroll *et al.* 2012) ⁸(Svensson *et al.* 2014) ⁹(Rodrigo *et al.* 2015) ¹⁰(Collins *et al.* 2014) ¹¹(Kolodziejczyk *et al.* 2012) ¹²(Zhang *et al.* 2015).

4.12 Food frequency questionnaire

Self-administered food frequency questionnaires (FFQs), developed in the late 1980s when the first large scale epidemiological studies on diet-related health and morbidities were conducted (Willett 2001, Schatzkin *et al.* 2003, Illner *et al.* 2012), remain the most frequently used method to assess diet in large nutritional and epidemiological studies (Erkkola *et al.* 2001, Carroll *et al.* 2012, Pot *et al.* 2014, Svensson *et al.* 2014, Zhang *et al.* 2015), and in studies with pregnant women (Erkkola *et al.* 2001, Zhang *et al.* 2015).

A systematic review on “Food behaviours during pregnancy that contribute to risk factors in the mother, fetus and infant”, conducted as part of this PhD study, included 32 studies on diet. Twenty-three of these used FFQs, reinforcing the fact that, despite their limitations, FFQs remain the most frequently used dietary assessment tool in large epidemiological studies.

FFQs are frequently regarded as the most appropriate diet assessment method as they have the ability to reflect the usual diet in the longer-term, even when compared with food diaries (Erkkola *et al.* 2001, Zhang *et al.* 2015). They are also considered to be a valid and reliable method to assess nutrient and food intake in pregnant women in many countries (Zhang *et al.* 2015).

There are two types of FFQs: semi-quantitative where portion size information is collected, either as standardised portions or as a choice of portion sizes, and non-quantitative where portion size is not collected (Cade *et al.* 2002).

4.13 Developing Survey 1A (‘Diet and Physical Activity survey’)

The semi-quantitative self-administered ‘Diet and Physical Activity survey’ (survey 1A) was designed for use within the MAMMI study and used to gather information on nulliparous women’s general health, lifestyle and wellbeing, physical activity before and during pregnancy, food and food supplement consumption during pregnancy, and breastfeeding intention.

4.13.1 Survey development

The survey was developed from three previously validated instruments: the Irish Survey of Lifestyle, Attitudes, and Nutrition (SLÁN) questionnaire (Morgan *et al.* 2008), the Norwegian Mother and Child Cohort Study's diet questionnaire and the International Physical Activity Questionnaire (IPAQ).

1) Irish Survey of the Lifestyle, Attitudes and Nutrition (SLÁN)

The SLÁN study, a national survey of the lifestyle, attitudes and nutrition of people living in Ireland, is a self-administered questionnaire adapted from the semi-quantitative food frequency questionnaire (SQFFQ) used in the European Prospective Investigation of Cancer (EPIC) study. It was conducted in three waves, the most recent in 2007 with 10,354 people; 9,223 (89%) of whom completed a standard adapted FFQ. SLÁN reported that the SQFFQ used was previously validated in a study involving 156 women (Bingham *et al.* 1997), in another survey of diet and lifestyle of Irish women (NNSC, 1998), as well as validated in the Norwegian Mother and Child Cohort Study (MoBa) (Brantsæter *et al.* 2008).

In 2013, the SLÁN FFQ was validated in a cohort of pregnant women (n=130) in Ireland. Findings were compared with a 3 day food diary and showed that the FFQ had good relative validity and enabled diet to be ranked in accordance with their food intake during pregnancy (McGowan *et al.* 2014).

2) The Norwegian Mother and Child Cohort Study (MoBa)

The MoBa Study is a longitudinal prospective cohort study of pregnant women and their children in Norway. The study comprised eight questionnaires, one of which was an FFQ, a 255-food item dietary questionnaire administered during the first four months of pregnancy (Brantsæter *et al.* 2008). A total of 119 women participated in the validation study which compared the findings from the MoBa FFQ with findings from a 4-day weighed Food Diary (FD) using independent measures such as biological markers and motion sensors. The level of agreement (average correlation coefficient for daily intake) between the FD and FFQ was reasonable for all nutrients (0.36) and major foods (0.48), and 68% of the participants (on average) were ranked into the same or adjacent quintiles by the two methods; under-reporting was present more often in the FD than in the FFQ (Brantsæter *et al.* 2008). The FFQ was also capable of

differentiating high and low consumption of nutrients, according to biological markers and, overall, showed good validity.

3) The International Physical Activity Questionnaire (IPAQ)

The International Physical Activity Questionnaire (IPAQ) is open-access and publically available in different languages and, like the MoBa and SLÁN, no permission for use is required (Quinn *et al.* 2008). The IPAQ was initially pilot tested in 1998-1999 (Tierney *et al.* 2015) and is available in different formats, including self- and telephone-administered, and long and short versions (Craig *et al.* 2003). The most frequently used format for use is the short form (last 7-day recall) version (IPAQ-SF) (McGrady *et al.* 2007), which has been used in other studies in Ireland and Northern Ireland, in different populations (Brown *et al.* 2006, McGrady *et al.* 2007).

Physical activity levels are rarely included in diet assessment studies. Due to benefits of exercise during pregnancy (associated with diet during pregnancy) to both mother and fetus, the literature on exercise during pregnancy is now extensive (Owe *et al.* 2009, Gaston & Cramp 2011, Downs *et al.* 2012, Nascimento *et al.* 2012, Muktabhant *et al.* 2015, Oliveira *et al.* 2017). However, only six of the 32 studies included in a systematic review of “Food behaviours during pregnancy that contribute to risk factors in the mother, fetus and infant” assessed physical activity. Thus, it was decided that including the IPAQ and measuring activity and exercise during pregnancy would enable a more complete and accurate assessment of women’s lifestyles.

4.13.2 The ‘Diet and Physical Activity survey’ (survey 1A)

The ‘Diet and Physical Activity survey’ contains four sections: section A is on general health, eating habits and physical activity before pregnancy; section B asks about general eating habits since the start of pregnancy, the changes, if any, made to diet, and includes the FFQ; section C is about breastfeeding intention and section D asks about physical activity during pregnancy.

Section A: General health, diet and physical activity in the 12 months BEFORE pregnancy

This section contains 18 questions (Table 4-3) on general health and health perception in the 12 months before pregnancy, and is the same as those used in the SLÁN survey

(2002 and 2007). Also included in this section are questions about physical activity (source: IPAQ short format) (A13) before pregnancy.

Table 4-3: Questions in section A

#	Question	Assessment	Source
A1	"How would you describe your general health in the 12 months BEFORE your pregnancy?"	Multiple choice – 6-item scale ranging from very poor to excellent	SLÁN 2007
A5	"a) In the 12 months BEFORE your pregnancy, did you follow any specific diet?" "b) If YES, which of the following diets did you follow?"	A5 a) yes or no choice A5 b) range of type of diets	Adapted from SLÁN 2002
A6	"In the 12 months BEFORE your pregnancy, how would you describe your diet?"	Multiple choice – 7-item scale ranging from very bad to very healthy	
A7	"In the 12 months BEFORE your pregnancy, were you trying to lose weight?"	Yes or no choice	Adapted from SLÁN 2007
A8	"Did your weight change in the 12 months before your pregnancy?"	Multiple choice – 6-item scale from 'gained a lot of weight' to 'lost a lot of weight'	
A9	"In the 12 months BEFORE your pregnancy, were you satisfied with your body image?"	Multiple choice – 3-item scale: always, sometimes and never	From MAMMI survey 3
A11	"In the 12 months BEFORE your pregnancy, how often did you have the following meals per week? (Please tick ONE response on EACH line)"	For each meal: a 4-item multiple choice with the following response options: every day; 1-3 times a week; 4-6 times a week and, never.	Adapted from the MoBa
A13	A13 a) "How many times did you walk continuously, for at least 10 minutes, for recreation, exercise or to get from place to place?"	A13 a. state number of times or tick box "none"	
	A13 b) "What do you estimate was the total time you spent walking in this way?"	A13 b. amount in hours and minutes	

Section B: Diet since the start of pregnancy

There are 32 questions in this section. Questions B1 to B8 are about nausea and vomiting in pregnancy (NVP), taken from the MoBa survey. According to literature, 85% of pregnant women suffer nausea and/or vomiting and their quality of life can be negatively affected (Maltepe 2014). There are a number of factors that could be associated with this such as weight loss, dehydration, pre-pregnancy BMI, diet, micronutrients and use of dietary supplements (Maltepe 2014).

Some questions from section A are repeated in section B (during pregnancy) so that (i) perceptions of health before and during pregnancy can be compared; (ii) associations between nutrients and/or supplements intake, perception of health and well-being and outcomes in pregnancy can be examined, and (iii) changes in the diet and social behaviour can be examined (as part of objective 3 and 4) (Table 4-4).

Table 4-4: Similar questions in section A and section B

#	Before pregnancy	#	During pregnancy
A5	"a. In the 12 months BEFORE your pregnancy, did you follow any specific diet?"	B9	"a. During your pregnancy have you been following/followed any specific diet?"
	"b. Which of the following diets did you follow?"		"b. If YES, which of the following diets did you follow?"
A9	"In the 12 months BEFORE your pregnancy, were you satisfied with your body image?"	B11	"Now that you are pregnant, are you satisfied with your body image?"
A11	"In the 12 months BEFORE your pregnancy, how often did you have the following meals per week?"	B12	"How often have you had the following meals per week since you became pregnant?"
A12	"Can you afford to buy enough food for your household?"	B20	"Now that you are pregnant, can you afford to buy enough food for your household?"

Question B21 is from the SLÁN FFQ (Morgan *et al.* 2008) which asks about the frequency of consumption, ranging from "never or less than 1 per month" to "6 or 7 times a day" (Figure 4-2). Moreover, an open ended question was added to the survey and asks if there is anything else that is usually consumed and was not asked about in the FFQ (Figure 4-3).

Figure 4-2: FFQ frequency of consumption/servings

Potatoes, Rice and Pasta (medium serving)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Boiled, instant or jacket potatoes				✓					

Figure 4-3: List of other food items that were not asked in the FFQ

Other foods									
<u>Name of food AND average use during your pregnancy</u>	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day

Question B25 was taken from MoBa and is also associated with objective 3 of my study: dietary changes. Finally, questions around the use of dietary supplements before and during pregnancy, from MoBa, and dietary advice received, are also in this section (Q.B30-B31). A table was constructed to assess dietary supplement use during pregnancy (Table 4-5).

Table 4-5: Describing dietary supplement use during pregnancy

Supplement	Times a week/day e.g. 1 a day or twice a week	Quantity	Where did you buy it? e.g. Chemist/ pharmacy, hospital, other	When did you start taking it?	When did you stop taking it? (if you have stopped) e.g. 'when I became pregnant' or at x weeks pregnant
Supplement (name)					
Supplement (name)					
Other - name and brand					

Section C: Breast-feeding intention

Section C has two questions about breastfeeding, due to its importance and strong association with better health for the mother and baby (Godfrey & Lawrence 2010, Binns *et al.* 2016).

Section D: Physical activity during pregnancy

The short form (SF) of the IPAQ was used to measure physical activity in the 12 months before pregnancy. In the section on pregnancy (section D), the IPAQ-SF was adapted to measure physical activity during pregnancy: the questions regarding strenuous-intensity physical activity were removed as there are controversies about their recommendations during pregnancy (Kehler & Heinrich 2015). Section D, together with physical activity before pregnancy, measures changes in the practice of physical activity as part of objective 4 of this study (A13-A18 and D1-D5).

4.14 Validity and reliability of Survey 1A

The complete survey was then validated and tested for reliability (Polit & Beck 2006b, Scholtes *et al.* 2011).

4.14.1 Validation of the ‘Diet and Physical Activity survey’ (survey 1A)

Validity assesses whether the instrument is measuring what it is supposed to measure (Kristal & Potter 2006), and was undertaken during January and February 2015.

There are three different types of validity: content validity, construct validity and criterion validity (Heale & Twycross 2015). In a quantitative study, validity can be interpreted as the extent to which a concept is correctly measured (Polit & Beck 2006a, Heale & Twycross 2015).

Face validity

Face validity is a measure of an instrument’s relevance to participants, and a measure of how easy it is to understand (Kristal & Potter 2006, Polit & Beck 2006a). If the

purpose or clarity of such an instrument is not very clear to the respondent, then it will have low face validity (Lewis-Beck *et al.* 2003).

First, the antenatal 'Diet and Physical Activity survey' was administered to five researchers, non-midwives, who were asked to assess and comment on its structure and layout, content, readability, etc. On average, it took less than 30 minutes to complete, and only minor changes were suggested (Appendix 4-5).

Subsequently, 13 pregnant women who were participating in the MAMMI study in site 1, and who had consented to being contacted about future research, were telephoned and asked if they would be willing to assess the acceptability of the survey and comment on the content, structure, style and note the length of time it took to complete. All 13 women agreed to participate and a copy of the survey with a cover letter (Appendix 4-6) was posted to their home address, with a freepost addressed envelope for returning the completed survey.

Eight women returned the survey, six of whom made comments. Feedback was mainly positive, on average it took them from 30 minutes to over an hour to answer the survey (Appendix 4-7) and only minor changes were suggested. Suggestions were taken into account and corrections were made.

Content validity

Content validity concerns the extent to which a given construct is properly represented by the items (Polit & Beck 2006a, Polit *et al.* 2007), usually measured by content validity indices (CVIs) (Polit *et al.* 2007, Schilling *et al.* 2007).

Content validity is a key element in the design of a tool (Rico *et al.* 2012) and appraises if the instrument really measures what it is intended to measure (Grant & Davis 1997, Rothman 2008). Experts should review the instrument so items can be improved and modified, and irrelevant items deleted (Rothman 2008).

Four dietitians from three large maternity hospitals in Ireland were asked to assess the survey's content. Once they agreed to collaborate, they were sent an information pack containing a cover letter (Appendix 4-8), the 'Diet and Physical Activity survey', a protocol explaining the wider MAMMI study and the purpose of my survey (Appendix 4-

9), a freepost envelope and the content validity assessment tool, based on Lynn's (1986) relevance rating scale (Table 4-6, Appendix 4-10).

Table 4-6: Example of Lynn's rating scale

Rate	Comment
1. The item is NOT RELEVANT to the aim of this study	Comments on scores 1-3 helped me decide on the inclusion, exclusion or revision of a particular item (question).
2. The item NEEDS MAJOR REVISION to be relevant to the aim of this study	
3. The item NEEDS MINOR REVISION to be relevant to the aim of this study	Please write your concerns about the clarity of the instructions, responses and options in this column.
4. The item is RELEVANT to the aim of this study	A score of 4 requires no comment

Only minor changes were required, and the results from all four experts are shown in Appendix 4-11 and 4-12, and a summary of their feedback in Appendix 4-13.

4.14.2 Reliability of the 'Diet and Physical Activity survey'

Reliability concerns the consistency and accuracy of an instrument and permits an assessment of the reproducibility of the results (Rico *et al.* 2012). It evaluates how free from error an instrument is, and if it will give the same results, under the same circumstances and conditions, for the same respondents (Scholtes *et al.* 2011). Therefore, reliability is higher whenever measurement error is low (Scholtes *et al.* 2011). The reliability of the 'Diet and Physical Activity survey' was assessed using test-retest analysis (Fagarasanu & Kumar 2002, Scholtes *et al.* 2011).

A possible limitation of this method is that findings could be affected by changes that might occur during the time between the pre-test and post-test (Fagarasanu & Kumar 2002, Scholtes *et al.* 2011). For this reason, reliability was tested on 15 pre-selected questions (Appendix 4-14) from sections A and B of the survey that were expected to remain stable over time, and the re-test was performed approximately one week after the pre-test.

Reliability was measured by administering the survey on two occasions, at least one week apart, with the same group of volunteering participants recruited in the third

trimester of pregnancy. The aim was to recruit 25 participants to complete the surveys on both occasions.

In September 2015, permission was gained from the CWIUH to invite pregnant women from the parent education classes to join the test-retest validation study. Five parent education classes were attended, and at each class, women were informed about the MAMMI study, the introduction of the 'Diet and Physical Activity survey' and the importance of testing it, and the purpose of the reliability study. A total of 60 women in the late second/third trimester of pregnancy were recruited during the five classes.

Participants who agreed to take part in the study were offered the 'Diet and Physical Activity survey' information pack including a cover letter inviting them to take part (Appendix 4-15), a study poster (Appendix 4-16), the study information booklet (Appendix 4-17), two consent forms (Appendix 4-18), two copies of survey 1A and two freepost envelopes for returning the surveys.

Women were asked to leave a one-week interval between completing each survey: time 1 (T1) and time 2 (T2). If the T1 survey was not returned two weeks after the recruitment date, a reminder e-mail was sent asking women if they were still willing to take part and, if so, to complete and return the T1 survey. No further contact was made. If the T2 survey was not received two weeks after T1 survey, a gentle reminder e-mail was sent, thanking women for completing T1 survey and asking if they were still willing to complete the T2 survey. After both surveys were received, a thank you e-mail was sent (Appendix 4-19).

In total, 60 women were recruited and 28 completed surveys at both time points (Table 4-7). A database on Statistical Package for Social Sciences (SPSS) software was created to input the data and only data from women who completed the survey at T1 and T2 were used to test reliability.

Table 4-7: Recruitment for reliability testing

	No of surveys issued*	No of surveys returned	% of sent surveys returned 11/11/2015
SURVEY TIME 1 (TEST)	60	36	60%
SURVEY TIME 2 (RETEST)	36	28	77.8%

Each of the selected questions for test-retest was tested using Cohen's Kappa and Intraclass correlation coefficient (ICC) (for agreement) (Table 4-8). Agreement and correlation are both used to show the strength of the association between the variables, and the use of at least two measures is recommended (Liu *et al.* 2016). Results demonstrate that the survey 1A was a reliable instrument (Appendix 4-20 and 4-21). The questions tested for reliability by both Cohen's Kappa and ICC showed that: the average Kappa value was 0.748, indicating good agreement and the average ICC value was 0.785, indicating strong correlation agreement.

Table 4-8: Cohen's Kappa and Intraclass correlation coefficient values

	Kappa	ICC
Values	>0.5: moderate agreement;	0-0.2: poor agreement;
	>0.7: good agreement;	0.3-0.4: fair agreement;
	>0.8: strong agreement.	0.5-0.6: moderate agreement;
		0.7-0.8: strong agreement;
		>0.8: almost perfect agreement.

4.15 Measuring dietary patterns

Nutrition research traditionally focused on single nutrients or specific foods (Hu 2002, Hsiao *et al.* 2013, Cespedes & Hu 2015) but the limitations of these approaches are now recognised (Hu 2002, Cespedes & Hu 2015) as nutrients and foods are not consumed in isolation (Hsiao *et al.* 2013, Cespedes & Hu 2015), making it very challenging to outline a single nutrient-disease association (Jacques & Tucker 2001, Cespedes & Hu 2015). There has been a recent shift in nutritional epidemiology and research and the focus now is on the analysis of dietary patterns (or overall diet), on the food groups and nutrients, and on the frequency and amount consumed (Oude Griep *et al.* 2013, Cespedes & Hu 2015). Dietary patterns cannot be directly measured from dietary assessment tools, therefore some specific approaches are used to assess dietary patterns based on the dietary data collected (Hu 2002, Keding *et al.* 2011, el Bilbeisi *et al.* 2017). Furthermore, in the past few decades, indices have been developed and validated, and they also are a powerful way to assess the quality of diet, and compliance with dietary guidelines (Guenther *et al.* 2013, Kim *et al.* 2013, Murray *et al.* 2013). Some methods to assess dietary patterns are described below (Table 4-9).

Table 4-9: Dietary patterns assessment methods*

Methods	Characteristics	Examples
Theoretical methods	Also known as <i>a priori</i> methods	Diet Quality Index (DQI), Diet Quality Index Revised (DQI-R) and Diet Quality Index International (DQI-I)
	Dietary scores based on prior knowledge and scientific evidence of guidelines and recommendations	Healthy Eating Index (HEI), the Alternate Healthy Eating Index (AHEI) and the Alternate Healthy Eating Index for Pregnancy (AHEI-P)
	A variety of different dietary indices (or scores) have been suggested as an estimate of overall “healthy” eating pattern	Diet Quality Score (DQS) Mediterranean Diet Quality Index (MDQI), Mediterranean Diet Scale (MDS), Modified Mediterranean Diet Scale (MMDS), Eating Choice Index (ECI) Glycaemic Index (GI) and Glycaemic Load (GL)
	Also known as <i>a posteriori</i> methods	Protein: Non-protein ratio (P:NP ratio) Protein: Carbohydrate ratio (P:C ratio) Factor analysis (or principal component analysis): identify the common and principal dietary traits in the population
	Patterns are extracted from a statistical approach	Cluster analysis: groups individuals into subgroups with similar dietary patterns
Hybrid methods	In order to establish the dietary patterns, it employs both theoretical knowledge and statistical approaches	Reduced Rank Regression (RRR) Partial least squares regression

Adapted from (Hu 2002, McNaughton *et al.* 2008, Kourlaba & Panagiotakos 2009, Reedy *et al.* 2009, Ocké 2013, Carvalho *et al.* 2016, Thorpe *et al.* 2016)

4.15.1 Choosing the methods to assess dietary patterns/quality and adequacy/balance:

In order to assess diet from a perspective of dietary patterns/quality as well as from adequacy/balance, four different methods were used:

- 1) The Alternate Healthy Eating Index for Pregnancy (AHEI-P) – adapted for use in Ireland;
- 2) Cluster analysis

Currently, together with hypothesis-driven analysis, data-driven analysis has been extensively used as a method to assess dietary patterns (Previdelli *et al.* 2016). Cluster analysis (as well as principal component analysis) is labelled as a “data-driven” statistical approach from which an *a posteriori* pattern can be extracted (Reedy *et al.* 2010, Carvalho *et al.* 2016, Previdelli *et al.* 2016). The systematic review performed as part of my PhD work showed that principal component analysis (PCA) was one of the most popular methods used to assess dietary patterns in the included studies, reinforcing the *a posteriori* method as an increasingly popular statistical method to assess dietary pattern. However, cluster analysis was chosen because it enables grouping of people who have similar diet patterns (Reedy *et al.* 2010, Ocké 2013, Carvalho *et al.* 2016), producing mutually exclusive dietary clusters/patterns (Hearty & Gibney 2008, McGowan & McAuliffe 2013, Ocké 2013, Carvalho *et al.* 2016). Cluster analysis has been used previously to predict dietary patterns in a cohort of Irish pregnant women (McGowan & McAuliffe 2013), therefore meaningful comparison would be possible. Moreover, another Irish cohort study, Hearty & Gibney (2009), used both methods (PCA and cluster) to compare dietary patterns in Irish adults and concluded that cluster analysis offers an advantage over the PCA as it creates “mutually exclusive clusters with relatively homogeneous dietary patterns” (McGowan & McAuliffe 2013, p.98).

- 3) Macronutrients adequacy:

The adequacy of macronutrients was explored by creating two groups: participants who were in the recommended range for all three macronutrients, ‘adequacy of all macronutrients’ (CHOs, fat and protein) versus participants who did not meet the recommendations. To our knowledge, this one was used for the first time, and was

designed to explore the strength of meeting, or not meeting, the recommendations of all macronutrients and any possible association with pregnancy, birth, neonatal and postpartum outcomes.

4) Macronutrients ratio/balance:

A macronutrient ratio, the Protein: Non-protein (P:NP) ratio, was used to explore ratio/adequacy (and also as a method of exploring dietary pattern).

Some research has linked the dietary P:NP energy ratio (either low protein or high protein diets) to deleterious effects on the offspring (impact on offspring's health-disease) (Blumfield & Collins 2014), as well as macronutrient balance to the health of the mother and offspring in the short-term and long-term (Blumfield *et al.* 2012a, Blumfield *et al.* 2012b, Blumfield & Collins 2014, Danielewicz *et al.* 2017). However, more research is required to evaluate the optimal macronutrient ratio (Blumfield & Collins 2014).

4.15.2 Micronutrients

In order to investigate adequacy of micronutrients specific to pregnancy also, the 'Nutrient adequacy ratio' (NAR) for Calcium, Iron, Folate and Vitamin D was calculated and from those four micronutrients, the 'Mean adequacy ratio' (MAR) was created.

A systematic review of the literature of the methods used to evaluate the adequacy of nutrient intake revealed that assessment of NAR and MAR was one of the methods used to check micronutrient adequacy (Román-Vinas *et al.* 2009).

Micronutrient adequacy was also compared in relation to the guidelines (the European Food and Safety Authority, 2017, and the UK Scientific Advisory Committee on Nutrition/Committee on Medical Aspects of Food and Nutrition Policy, 2017). Their adequacy in relation to specific birth outcomes was not explored for two reasons:

First, the whole idea of this thesis was to explore diet as a whole (as much as possible) and not try to relate specific micronutrients to health outcomes (birth outcomes) as if they were consumed in isolation;

Second, it would not make sense to investigate dietary micronutrients when participants could be taking some pregnancy dietary supplementation. Roman-Vinas

(2009) also states the need to include the use of dietary supplements, fortification and medication as an important condition to validate the investigation.

Therefore, in order to analyse dietary patterns, two more complex and common statistical analysis were used: *a priori* and *a posteriori* statistical approaches. In the *a priori* approach, the food pattern is pre-defined based on the scores/values/indices according to different recommendations and the AHEI-P, adapted for use in Ireland, was used as it measures the degree to which participants' diet is in agreement with those recommendations. *A posteriori* is a more complex statistical exploratory method that uses techniques of multivariable analysis which aims to explore the dietary patterns of the participants even if they do not reflect healthy patterns (Carvalho *et al.* 2016).

These approaches, as well as the P:NP ratio and the macronutrient adequacy ratio, were measured not only in comparison with the recommendations and guidelines but also to explore possible associations with birth outcomes. By using different methods to evaluate dietary patterns, balance and adequacy, it would give my research more reliability and the possibility to assess the totality of women's diet from multiple perspectives. Moreover it also enables to compare the similarities and differences between the findings, the possibility for comparison with the existing literature as well as within future studies that could also be using the same analysis used in this study.

4.15.3 Choosing the pregnancy, birth, neonatal and postpartum outcome variables:

The pregnancy, birth, neonatal and postpartum outcome variables analysed in this study were chosen because they were found to be statistically significant in previous studies on diet during pregnancy (except for mode of birth and breastfeeding, which are very clinically significant). Research has shown the importance of selecting, collecting and reporting outcomes that are relevant to clinical practice (Duffy *et al.* 2019). Therefore, this supported the need to explore important outcome variables either shown previously to be related to diet, or those of high clinical significance, from a whole diet perspective.

Mode of birth (spontaneous vaginal birth) was chosen to be the primary outcome variable of this study. Mode of birth has been shown to be affected by excessive GWG (Goldstein *et al.* 2016, McDonald *et al.* 2018), overweight and obesity (Simko *et al.*

2019, Mohammadi *et al.* 2019) and other nutrition-related diseases such as GDM (Wang *et al.* 2019, Sweeting *et al.* 2016). As these are all linked to diet in pregnancy and are of great clinical importance, a decision was made to explore mode of birth as a primary outcome related to diet during pregnancy.

Breastfeeding initiation and breastfeeding at 3 months postpartum were included because, as discussed in chapter two (section 2-10), a healthy diet during pregnancy and breastfeeding practice are two important behaviours that could have a positive impact for the babies and there is a need to ascertain if there could be an association between them.

In conclusion, length of gestation, infant's weight at birth, anxiety episodes and postpartum depression were explored further in this study from four different dietary methods (diet as a whole perspective). Additionally, this study also included three more variables (mode of birth, breastfeeding initiation and breastfeeding at 3 months postpartum) that not only could potentially show a statistically significant association with diet during pregnancy but also due to their clinical importance.

4.16 Preparing the data and data inputting

Data from surveys 1, 1A and 2 were coded and entered into SPSS Version 25.0 (IBM Corp. 2017). The data from the FFQ were managed and analysed using Nutritics software Version 5.0 (2018) as described below.

Choosing Nutritics as a dietary data analysis tool:

The use of nutrition analysis software is important in the dietary assessment process to organise the dietary data and evaluate the diet composition more efficiently and with more accuracy (Stumbo 2008), and high quality results depend on the food composition database used for computing the nutrient values. According to Stumbo (2008), data quality refers to “the appropriateness of the food values”, i.e., being representative of the composition of the foods described in the database and foods that are consumed by the population (p.2). Accuracy refers to whether the food composition data values are accurate for its purpose and, in a way, it can be hard to guarantee that a single set of food values will be the same in all situations: for instance, fruits and vegetables can differ in their nutrition values because of the variability in maturity, length and method of storage, variety and method of analysis, and normally just one

value for each food component is provided in the food database (Stumbo 2008). Therefore, it is important to choose a nutrition software that uses a reliable food composition database.

After careful consideration, the nutritional software chosen was Nutritics (Nutritics v5.02, 2018). The food composition table in Nutritics used for the analysis is derived from McCance and Widdowson's food composition table 7th edition, 2015 (Nutritics, 2008).

Nutritics was developed as a tool to log in food diaries and the FFQ was designed to cover the whole usual diet. The first step was to:

- 1) Develop a codebook with a reference table for conversion of the 'Diet and Physical Activity survey' FFQ food portion servings into Nutritics portion servings (Appendix 4-22).
- 2) Then, the FFQ portion for each food/drink item was translated into a "one-day" portion. The one-day portion was taken as a reference and the frequency of intake of each food/drink item was translated into the corresponding daily intake. A Nutritics conversion sheet was developed to facilitate data inputting (Appendix 4-23). Information on the dietary intake (macronutrients and micronutrients) was obtained from the FFQ. Participants indicated the number of servings and frequency of use of each of the 147 food/drink items listed and their average/usual consumption since the start of their pregnancy. The nine response options are shown in Table 4-10.

Table 4-10: Conversion of FFQ data into Nutritics “daily serving” portion

Average use during pregnancy (from FFQ)	Conversion to Nutritics daily portion
Never or less than 1 month	X divided by 28 (X/28)
1-3 times month	X divided by 14 (x/14)
1 time per week	X divided by 7 (x/7)
2-4 times per week	3 times X divided by 7 (3x/7)
5-6 times per week	5.5 times X divided by 7 (5.5x/7)
1 a day	1 or X
2-3 times a day	2.5 times X value
4-5 times a day	4.5 times X value
6-7 times a day	6.5 times X value

*Where X stands for the portion converted from FFQ to a daily portion.

4.17 Data quality

Prior to analysing the data, data cleaning, spot-checking and double-checking were performed. Data cleaning involves a series of actions such as detecting, correcting or removing replicate data, errors and inconsistencies such as missing values in order to avoid *dirty data* and guarantee the quality of data (Rahm & Do 2000, Chu *et al.* 2016). Following data cleaning, a proportion of all surveys were randomly selected for ‘double-checking’: 5% (n=44/872) of survey 1, 5.3% (n=38/721) of survey 1A, 5.7% (n=36/631) of survey 2 in SPSS, and 25.5% (n=184/721) of surveys in Nutritics.

Finally, descriptive analyses were performed to check discrepancies/outliers, and a further 8.3% (n=60/721) of survey 1A were double checked.

4.17.1 Misreporting exclusion criteria for the dietary data extracted from the Food Frequency Questionnaire

A potential source of bias in dietary assessment is misreporting i.e., over- or under-reporting food intake (Banna *et al.* 2015). It is one of the main sources of measurement error in dietary assessment and affects the validity of data and, therefore, the conclusions drawn from the study (Poslusna *et al.* 2009, Banna *et al.* 2015, Naska *et al.* 2017). Among adults, under-reporting seems to be more common than over-

reporting, especially in women with a higher BMI (Lutomski *et al.* 2011, Banna *et al.* 2015, Wehling & Lusher 2017, Tam & Veerman 2019), and in women with lower levels of education (Lutomski *et al.* 2011, Banna *et al.* 2015, Tam & Veerman 2019). Misreporting cannot be eliminated and it must be acknowledged in the study methodology, along with a standard procedure demonstrating how it is addressed (Poslusna *et al.* 2009). There are a variety of methods that can be used to calculate cut-off points (Table 4-11).

Table 4-11: Cut-off equations and methods to account for the plausibility of reported energy intake

Method/Equation	Cut-off point methods	Strengths	Limitations
Goldberg equation 2000	Classifies under, acceptable and over-reporting; Cut-off values are the confidence limit of agreement between Energy Intake (EI): Basal metabolic rate (BMR) and Physical Activity Level (PAL) [95% CL= $PAL \times \exp(\pm 2 \times S/100) / \sqrt{n}$]	A more individualised method to assess the plausibility of reported Energy Intake (rEI)	Possibility of error in assigning PAL as well as tends to identify mainly the extremely inaccurate reports – so prone to misclassification and bias
To exclude from the analysis/sample participants with an energy intake at the low and high end	A commonly used approach is to exclude those whose energy intake is less than 500 and greater than 3,500 calories per day**	Consistency	Not individualised and might not be able to identify all implausible reports of EI

*Adapted from (Tooze *et al.* 2012, Yang *et al.* 2014, Banna *et al.* 2017) where, AR, acceptable reporter; BMR, basal metabolic rate; CL, confidence limit; EE, energy expenditure; EI, energy intake; OR, over-reported; PAL, physical activity level; UR, under-reported.

** (Banna *et al.* 2017)

According to the National Cancer Institute, outliers in a dataset are extreme values that occur because of very high or low dietary intake or because of errors (NIH 2019). Extreme values will cause non-symmetrical data distribution, and identifying and excluding outliers needs careful consideration so that important data are not omitted through the use of arbitrary exclusion criteria (Banna *et al.* 2017, NIH 2019). The chosen method was to establish *a priori* low and high cut-off points for energy only and exclude all the data outside these cut-off values. This was also the method used in the

MoBa study and the European Prospective Investigation into Cancer and Nutrition study (Meltzer *et al.* 2008). Another study also advised caution on excluding dietary misreporters on weight-dependent equations in studies assessing diet and health outcomes (Rhee *et al.* 2015).

A recent study highlighted that it has not been proven which method is the most appropriate for excluding participants with implausible dietary reports (Banna *et al.* 2017) and while further studies are needed to investigate which method is superior, studies on dietary intake should be making use of one of the available methods to address this issue (Banna *et al.* 2017).

4.17.2 Preparing the data for analysis

As part of the data management process, variables and categories were combined and/or recoded (and re-categorised). A full list of all the variables used is presented in Table 4-12. A full list of the variables used and how they were managed and analysed is provided in Appendix 4-24.

Table 4-12: Variables used in the analysis

Pre-pregnancy variables	Pregnancy variables	Birth/postpartum outcomes variables
Age group	Smoking behaviour	Gestational length
Relationship status	Drinking behaviour	Mode of birth
Education level	Walking during pregnancy	Infant's weight at birth
Employment status	Moderate physical activity	Breastfeeding at 3 months postpartum
Country of birth	Depression episodes	Depression episodes after birth
Pre-pregnancy BMI	Anxiety/panic attacks	Intense anxiety/panic attacks after birth
Type of care	Relationship problems	Breastfeeding initiation
Exercise	Body image	
Depression episodes	Experienced nausea	
Anxiety/panic attacks	Experienced vomiting	
Difficulties to put on weight	Food cravings	
Difficulties to lose weight	Food aversion	
History of eating disorders	Weight gain concern	
Body image	Dietary advice received	
Reads food labels	Dietary supplement intake	
Dietary supplement intake		

4.18 Data analysis

Data from the MAMMI surveys (Survey 1, Survey 1A, Survey 2 and hospital dataset) were analysed using IBM statistical software SPSS version 25.0, and data from the FFQ were analysed using both Nutritics Professional Nutrition Analysis Software, University edition, 2018, V5.02. (<https://www.nutritics.com/>), and SPSS.

4.18.1 Descriptive data analysis

The socio-demographics characteristics of the full sample (n=862), and the socio-demographics characteristics of the sample included in this thesis (n=557) will be presented descriptively, and include analyses of participants' health, health perception, etc., before and during pregnancy and an overview of diet intake and adequacy.

Inferential statistics (such as cross-tabulation, univariate and multivariable analysis and multinomial) were applied in order to explore associations: pre-pregnancy and pregnancy predictors of diet during pregnancy and pregnancy, birth, neonatal and postpartum outcomes of diet during pregnancy – having mode of birth as the primary outcome.

4.18.2 Dietary data analysis

Diet adequacy/balance and dietary patterns were analysed.

Adequacy/Balance: as defined by two different variables/methods

1. Protein/Non-protein ratio (P:NP):

A binary variable was constructed by calculating the ratio of protein:non protein (CHOs and fat) intake. The two groups were participants who were below the median versus participants who were above the median P:NP ratio. The median was used as the cut-off point, to create two groups, those above and below the median, and to identify outliers.

- 2) Participants whose diet met ('adequacy of all macronutrients') versus did not meet the recommendations for all three macronutrients: protein (12-20%), CHOs (45-60%) and fat (20-35%)

Dietary pattern: as defined by two different variables/methods

- 3) Diet quality: defined using the AHEI-P adapted and validated for use in Ireland. Participants were divided into two groups according to the diet score: 'high-quality diet' group and 'needs improvement diet' group. Other studies have used other methods to create the diet quality groups, but in this study it was decided to follow the groups stated by the score classification (given by the AHEI-P (Ireland)). The detailed data analysis process is described below.

- 4) Cluster analysis: statistical methodology was applied to categorise participants into different clusters/groups, based on the similarity of their dietary pattern. Two clusters were created by using k-means (non-hierarchical approach) cluster analysis. These are described in detail below (sub-section 4.18.3).

4.18.3 Physical activity data analysis

Physical activity and exercise, before and during pregnancy, was assessed. Before pregnancy was measured as a 'yes' for participants who exercised for at least 10 minutes at a time at least once per week. During pregnancy was measured by two variables: amount of time spent walking and amount of time spent doing moderate exercise, and was categorised as none, <150 minutes and ≥150 minutes. These two variables were then used to explore physical activity and exercise with dietary patterns.

4.19 Developing, adapting and use of the Alternate Healthy Eating Index for Pregnancy (AHEI-P) in Ireland – Diet Quality

The AHEI-P was originally adapted for pregnancy from the Alternate Healthy Eating Index, which was created to assess the American population's diet (Rifas-Shiman *et al.* 2009). The AHEI-P, modified to represent a better diet during pregnancy, excluded some components that were included in the AHEI e.g., alcohol, nuts and soy protein and included other components e.g., Calcium and Iron (Rifas-Shiman *et al.* 2009).

The AHEI-P has nine components, each scoring a maximum of ten points on a 90-point scale (Rifas-Shiman *et al.* 2009) (Table 4-13).

Table 4-13: The Alternate Healthy Eating Index for Pregnancy (AHEI-P)

Component	Minimum Score (0)	Maximum score (10)
Vegetables (servings/day)	0	≥5
Fruit (servings/day)	0	≥4
Ratio white meat/red meat	0	≥4
Fibre (g/day)	0	≥25
Trans fats	≥4% RDA	≤0.5% RDA
Ratio Polyunsaturated/saturated	≤0.01	≥1
Calcium (mg)	0	≥1,200
Folate (ug)	0	≥600
Iron (mg)	0	≥27

Each component can be scored between 0-10 points according to how far the intake of each component is from the maximum score. For example, participants who eat three or more portions of fruits will get the maximum score of 10 points for this component (as in meeting fully the recommendations), participants who do not eat any fruit will get a score of 0 (the most unhealthy dietary behaviour), and when fruit intake is between zero and two portions, values are calculated proportionately according to an equation i.e., multiplying the number of daily servings consumed by 10, and then dividing by the criterion for a maximum score. The same calculations are used for all nine components, and then totalled so that an individual will receive a diet quality score between 0-90 points. The cut-off scores (for the total score) are: poor quality diet (score <45 points); diet needs improvement (score = 45-72 points), and high quality diet (score >72 points).

The AHEI-P was adapted for use in this study, and with pregnant women in Ireland, by including, combining or excluding some components. Table 4-14 shows which components of the AHEI-P were modified.

Table 4-14: The AHEI-P (Ireland)

Component	Minimum Score (0)	Maximum score (10) (20)*	AHEI-P in Ireland
Vegetables (servings/day)	0	≥2	Lowered portion size
Fruits (servings/day)*	0	≥3	Lowered portion size
Ratio white meat/red meat	0	≥4	Unchanged
Fibre (g/day)	0	≥25	Unchanged
Trans fats	≥4% RDA	≤0.5% RDA	Unchanged
Ratio Polyunsaturated/saturated	≤0.01	≥1	Unchanged
Calcium (mg)	0	≥1,000	Lowered
Folate (ug)	0	≥400	Lowered
Iron (mg)	0	≥16	Lowered

The fruits and vegetables were initially combined as one component; however, following suggestions from the experts who validated the AHEI-P in Ireland, it was kept as two separate components with their specific recommendation portions and scores.

In order to calculate the portion of fruits and vegetables, both discrete portions and disaggregated portions (as in composite foods) were considered (dried fruits, smoothies, vegetable soups and juices). One portion of dried fruits equalled 30g, 150ml of fruit juices equalled one portion, and one portion of fruits equalled 80g. Intake of vegetables was assessed in the same way: one portion equalled 80g, 350ml for vegetable soup, and for vegetable dishes 20% of the total intake in grams (as vegetable content) (Table 4-15).

Table 4-15: Fruit and vegetable portion equivalence

1 portion of fruits equals to	1 portion of vegetables equals to
30 grams of dried fruit	80 grams of vegetables in general
150 ml of fruit juice	350 ml of vegetable soup
80 grams of fruits in general	20% of vegetable dishes

In order to comply with the European and Irish micronutrients recommendations and score maximum 10 points, participants needed a Calcium intake of at least 1000mg,

according to the population reference intakes, the European Safety Authority (PRIs EFSA), instead of the American recommendation of ≥ 1200 mg; a Folate intake of at least 400ug, following the recommendations for pregnant women in Ireland, instead of the American recommendations (≥ 600 ug); and an Iron intake of at least 16mg (PRIs, EFSA) instead of the American level of ≥ 27 mg.

4.19.1 Validation of the Alternate Healthy Eating Index for Pregnancy (AHEI-P) in Ireland

Five experts in Nutrition (from different maternity hospitals and universities in Ireland) agreed to assess the appropriateness of the modifications made to the AHEI-P. An e-mail was sent with a cover letter (Appendix 4-25) and a protocol explaining how the original AHEI-P was constituted, the changes that were made and the reasons for the proposed changes (Appendix 4-26). For each component of the tool, they were asked to comment on the appropriateness and relevance of the changes made as well as on the components that were unchanged. A summary of their feedback can be found in Appendix 4-27.

Based on the feedback received, fruits and vegetables were classified as two separate items, each having a score ranging from 0-10 points.

4.20 Cluster analysis– Diet patterns and diet quality

Cluster analysis was performed using the FFQ data analysed in Nutritics. The first step was to export all the dietary data from Nutritics to Microsoft Excel®. The Nutritics database had 57 food group categories and were based on McCance & Widdowson's (2015) categories.

Clusters were created by following the methodology used in previous Irish studies (Hearty & Gibney 2008, McGowan & McAuliffe 2013). The 57 original food groups were combined and reduced to form 34 food groups (also very similar to the ones created in the two previous Irish studies). Each food item was carefully manually verified to determine if it had been assigned to the most suitable food group in an Excel sheet (see Appendix 4-28 for a list of all food items and their respective food group category) and then exported to SPSS.

Following the methods recommended in two Irish studies, food groups were expressed as a percentage of energy contribution to the total energy intake (%TE) for each participant, and clustering was based on the %TE of each food group (McGowan & McAuliffe 2013). Prior to performing the analysis, all 34 food group variables were standardised (z-scores with a mean of 0 and SD of 1) (McGowan & McAuliffe 2013). This was done in order to create a standard normal distribution and eliminate the effect of those variables with a large variance so they all can have a more even contribution to the scale.

The next step was to identify the optimal number of clusters so a number of runs (k-means analysis) were conducted using all the 34 standardised food group variables and alternating the number of clusters in the analysis from two to five (multiple attempts can be performed as you can specify how many clusters you want. However the more you specify, the smaller the cluster groups will be). The clusters were based on their similarity and participants were categorised into discrete groups (clusters). When finalising the specific number of clusters, considerations included: number of iterations or iteration history, amplitude of each cluster, the importance of each variable determining the cluster and the significance of their values determining which cluster they would be, the significant difference among the variables in each cluster, as well as size/distribution of the clusters created (McGowan & McAuliffe 2013). Based on these values, and the nutritional importance of the clusters, a two-cluster solution was deemed appropriate. Finally, in order to measure the reliability of the patterns created, discriminant analysis was performed and correctly classified 96.4% of participants (McGowan & McAuliffe 2013). The food groups in each cluster are presented in the next chapter, chapter five (findings).

4.21 Assessing possible predictors (pre-pregnancy and pregnancy variables) of diet quality and dietary patterns during pregnancy

Univariate logistic regression analysis (as well as chi-square and phi test) was conducted to assess potential predictors of diet during pregnancy, measured by the AHEI-P (Ireland) (diet quality) and cluster analysis (diet quality/dietary patterns). The variables used to assess predictors were divided into two groups, pre-pregnancy (Table 4-16) and pregnancy variables (Table 4-17).

Only statistically significant variables (univariate logistic regression analysis) ($p \leq 0.05$) were included in the multivariable model.

Table 4-16: Pre-pregnancy predictor variables

Objectives: to determine the pre-pregnancy predictors of dietary pattern/quality during pregnancy				
Pre-pregnancy variables (predictors)	Source of data	Method of analysis	Method of analysis	Outcomes (dependent variable)
Age group (Up to 29 years, 30 to 34 years and 35 years or more)	S1	Univariate logistic regression	Multivariable logistic regression	Diet pattern/quality
Relationship status (Married/living together, single/not living together)	S1	Analyse all variables separately	Analyse all variables that are found to be statistically significant and/or are clinically significant. Variables will be entered stepwise. Consideration will be given to including variables that other researchers found to be statistically significant, even if they are not statistically significant in this analysis	(i) Assessed using AHEI-P (Ireland) (ii) Assessed using clusters (defined as 'Healthy diet', 'diet needs improvement')
Educational qualification (4 categories)	S1			
Employment status (full time paid work, part-time paid work and casual paid work/unemployed)	S1			
Country of birth (Ireland, non-Irish)	S1			
BMI (4 categories)	S1			
Type of healthcare (private, public)	S2			
Exercise (yes, no)	S1A			
Depression	S1			
Anxiety	S1			
Difficulty with weight (weight loss, weight gain)	S1A			
History of eating disorders (yes, no)	S1			
Satisfaction with body image (always, sometimes, never)	S1A			
Reads food labels (yes, no)	S1A			
Took dietary supplements (yes, no)	S1A			

Table 4-17: Pregnancy predictor variables

Objectives: to determine the pregnancy predictors of dietary pattern/quality during pregnancy				
Pregnancy variables (predictors)	Source of data	Method of analysis	Method of analysis	Outcomes (dependent variable)
Smoking behaviour (3 categories)	S1	Univariate logistic regression	Multivariable logistic regression	Diet pattern/quality
Drinking behaviour (3 categories)	S1	Analyse all variables separately	Analyse all variables that are found to be statistically significant and/or are clinically significant. Variables will be entered stepwise. Consideration will be given to including variables that other researchers found to be statistically significant, even if they are not statistically significant in this analysis	(i) Assessed using AHEI-P (Ireland) (ii) Assessed using clusters (defined as 'Healthy diet', 'diet needs improvement')
Walking (3 categories)	S1A			
Moderate PA (3 categories)	S1A			
Depression (yes, no)	S1			
Anxiety (yes, no)	S1			
Relationship problems (yes, no)	S1			
Body image during pregnancy	S1A			
Nausea (yes, no)	S1A			
Vomiting (yes, no)	S1A			
Cravings (yes, no)	S1A			
Food aversion (yes, no)	S1A			
Weight gain concern (yes, no)	S1A			
Received dietary advice (yes, no)	S1A			
Dietary supplement intake (yes, no)	S1A			

4.22 Assessment of diet quality, diet balance, diet adequacy and dietary pattern and associations with pregnancy, birth, neonatal and postpartum outcomes

Univariate logistic regression analysis (as well as chi-square and phi test) was conducted to assess potential outcomes of diet during pregnancy (having mode of birth as the primary outcome), as measured by Protein: Non-protein ratio (P:NP), diet adequacy, AHEI-P (Ireland) and cluster analysis. Only statistically significant variables (univariate logistic regression analysis) ($p \leq 0.05$) were included in the multivariable model.

Table 4-18: Pregnancy, birth, neonatal and postpartum outcomes of diet during pregnancy

Objectives: to analyse the association, if any, between diet during pregnancy, and length of gestation, mode of birth, infant's weight at birth, breastfeeding initiation, infant feeding practice at 3 months postpartum, postpartum depression and anxiety episodes.				
Diet variables (predictors)	Method of analysis (all 7 outcome variables)	Method of analysis: multivariable logistic regression	Outcome variables (dependent) – the ones that showed significance	Source of data
1. AHEI-P (Ireland)	Univariate logistic regression	For each analysis: analyse all variables that are found to be statistically significant and/or are clinically significant. Variables will be entered stepwise. Consideration will be given to including variables that other researchers found to be statistically significant, even if they are not statistically significant in this analysis	Length of gestation	Hospital dataset and S2
			Mode of birth	Hospital dataset and S2
2. Clusters (2 categories: diet needs improvement and healthy diet)	Univariate logistic regression		Infant's weight at birth	Hospital dataset and S2
			Breastfeeding initiation	S2
3. Protein: Non-Protein ratio (above the median and below the median)	Univariate logistic regression		Breastfeeding at 3 months postpartum	S2
			Postpartum depression	S2
4. Macronutrient adequacy (yes, no)	Univariate logistic regression		Anxiety episodes	S2

4.23 Conclusion

This methodology chapter provided a detailed description of the research approach, study design and methodology including designing, validation, administration and analysis of the questionnaires. It describes the very first steps of developing and validating the 'Diet and Physical Activity survey' and every tool and index included in the new survey; participants recruitment as well as collecting, inputting and handling the data. Moreover, the process of choosing the study variables (pre-pregnancy and pregnancy predictors and pregnancy, birth, neonatal and postpartum outcomes) that would be measuring achievement of the research aim and objectives. This chapter also detailed the four different dietary methods used to measure diet during pregnancy as well as physical activity. Finally, this chapter also outlined the ethical considerations that were taken into account in this study.

Chapter Five: Results from the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study

5.1 Introduction

This chapter presents the findings from the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study and is organised in five parts. Part I presents the characteristics of all participants recruited to and retained in the MAMMI Study, and part II describes the characteristics of participants whose data were included in the analysis of the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study. The dietary analysis results, in terms of adequacy, balance and patterns, are presented in part III. The descriptive findings from pregnancy, birth, neonatal and 3 months postpartum outcome variables (having mode of birth as the primary outcome) are in part IV. Finally, univariate and multivariable logistic regression analyses are presented in part V.

5.2 Recruitment and retention rates

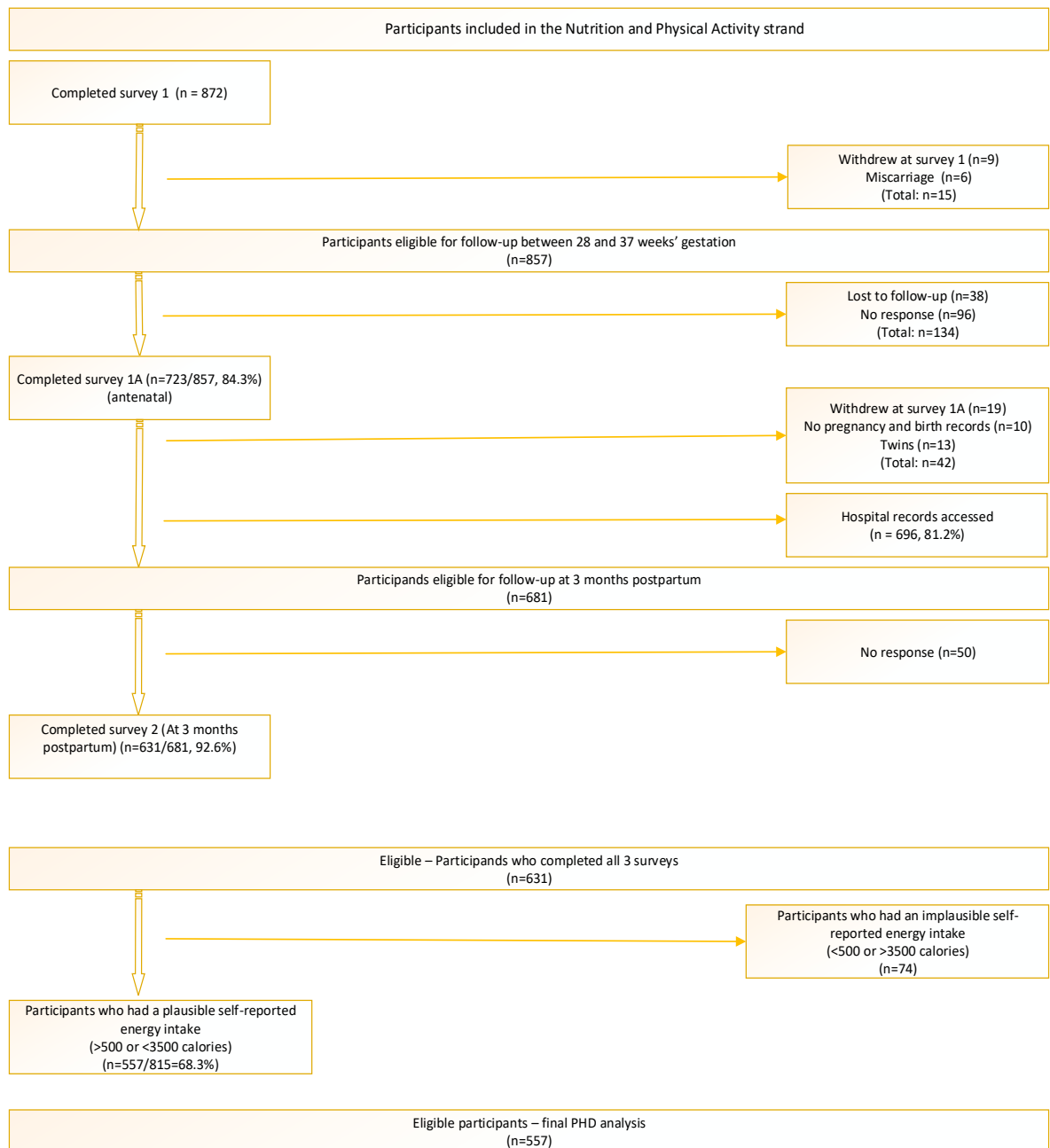
A total of 872 participants were recruited to the MAMMI study in the CWIUH between August 2015 and March 2017, and 721 (84.1% of those invited) were recruited to the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study (Table 5-1).

Table 5-1: Recruitment and retention rates

Survey	Number of surveys sent	Number of surveys returned	Response rate (February 2019)
Survey 1 (antenatal)	2687	872	32.5%
Survey 1A (antenatal)	857	721	84.1%
Survey 2 (3 months postpartum)	818	711	87.5%

Figure 5-1 shows the recruitment and follow-up rates, and the participants whose data were included in the analysis for the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study.

Figure 5-1: Flow chart of retention rates for the 557 participants included in this PhD study



5.3 Part I: Socio-demographic/economic characteristics of participants in the MAMMI study

The age of participants recruited to the MAMMI study ranged from 18 to 48 years (mean age = 32 years) and the majority were aged 30 years and older (76%, n=661).

Most participants (88.7%, n=765) were married (61.1%, n=527) or were living with their partner (27.6%, n=238). The 857 (98.2%) participants who stated their nationality were born in 46 different countries. Three-quarters (75.1%, n=644) were born in Ireland and 17.5% (n=150) were born in other European countries (Table 5-2).

Table 5-2: Age group, relationship status and region of birth

Characteristics	n	%
Age group (n=869)		
Up to 24	62	7.2
25 to 29	146	16.8
30 to 34	374	43.0
35 to 39	245	28.2
40 and over	42	4.8
Relationship status (n=862)		
Married	527	61.1
Divorced or separated	3	0.4
Single	15	1.7
Living with partner	238	27.6
In a relationship - not living together	74	8.6
Other	5	0.6
Region of birth (n=857)		
Ireland	644	75.1
United Kingdom	31	3.6
Other European countries	119	13.9
Africa	17	2.0
North America	8	0.9
South America	11	1.3
Asia	27	3.2

Table 5-3 shows participants' education level and living accommodation at time of recruitment. Three-quarters of the participants (74.4%, n=638) had either a primary degree/PG certificate or an MSc/PhD and over half (61.4%, n=532) lived in either a house or an apartment with a mortgage (52.5%, n=453) or without a mortgage (9.1%, n=79).

Table 5-3: Education level and living accommodation

Characteristics	n	%
Highest qualification level (n=859)		
Junior Certificate or less	17	1.9
Leaving Certificate/Vocational	204	23.7
Primary degree/PG certificate	412	48.0
MSc/PhD	226	26.4
Living accommodation (n=863)		
House or apartment - with a mortgage	453	52.5
House or apartment - without mortgage	79	9.1
Rented house or apartment - privately rented	366	30.9
Rented house or apartment - local authority	34	4.0
Caravan / mobile home	3	0.3
No fixed accommodation	1	0.1
Other	27	3.1

5.4 Part II: Descriptive findings from the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study

This part describes the characteristics of participants whose data were included in this PhD study’s analysis (n=557). The pre-pregnancy data refers to the time period of 12 months before this pregnancy. Data included in the analysis were obtained from participants’:

- (i) First antenatal survey (survey 1)
- (ii) Nutrition and Physical Activity survey (survey 1A)
- (iii) Hospital records (of consenting women)
- (iv) 3 months postpartum survey (survey 2)

Additionally, the final sample included in this study’s analysis were from participants whose energy intake was greater than 500 kcal/day and less than 3500 kcal/day and

deemed 'plausible' in the way they reported their usual food intake (Mendez *et al.* 2011, Rhee *et al.* 2015).

Variables used in this study were assessed at different time points as shown in Tables 5-4-5-6:

Table 5-4: Pre-pregnancy variables as predictors of diet

Pre-pregnancy predictors of dietary pattern/quality during pregnancy	
Pre-pregnancy variables (predictors): Socio-demographic/economic, mental health before pregnancy and physical activity (PA) before pregnancy group	Source of data
Age group (Up to 29 years, 30 to 34 years and 35 years or more)	S1
Relationship status (Married/living together, in a relationship but not living together and single)	S1
Educational/qualification level (Junior Certificate or less, Leaving Certificate/Vocational, Primary degree/PG certificate and MSc/PhD)	S1
Employment status (Full-time paid work, part-time paid work and casual paid work/unemployed)	S1
Country of birth (Ireland, non-Irish)	S1
Self-reported BMI pre-pregnancy (Underweight, normal weight/Ideal, overweight and obese)	S1
Type of healthcare (Private health care, public health care)	S2
Exercise before pregnancy (Yes, no)	S1A
Depression episodes (depression, low mood or sadness that lasted for two weeks or more) before pregnancy (Yes, no)	S1
Anxiety episodes (such as panic attacks) before pregnancy (Yes, no)	S1
Difficulty with putting on weight before pregnancy (Yes, no)	S1A
Difficulty with losing weight before pregnancy (Yes, no)	S1
History of eating disorders before pregnancy (Yes, no)	S1
Body image satisfaction before pregnancy (Always, sometimes, never)	S1A
Read food labels before pregnancy (Yes, no)	S1A
Took dietary supplements before pregnancy (Yes, no)	S1A

Table 5-5: Pregnancy variables as predictors of diet

Pregnancy predictors of dietary pattern/quality during pregnancy	
Pregnancy variables (predictors): Diet during pregnancy, mental health during pregnancy, physical activity (PA) during pregnancy group	Source of data
Smoking behaviour (Never smoked or stopped smoking before pregnancy, stopped smoking when finding out about the pregnancy and still smoking)	S1
Alcohol use (drinking behaviour) (Never drank alcohol or stopped drinking alcohol before pregnancy, stopped drinking alcohol when pregnant and still drinking alcohol)	S1
Amount of walking time per week (None, <150 minutes per week and ≥150 minutes per week)	S1A
Amount of moderate physical activity time per week (None, <150 minutes per week and ≥150 minutes per week)	S1A
Depression episodes during pregnancy (Yes, no)	S1
Anxiety episodes (such as panic attacks) during pregnancy (Yes, no)	S1
Relationship problems during pregnancy (Yes, no)	S1
Body image satisfaction during pregnancy (Always, sometimes, never)	S1A
Nausea during pregnancy (Yes, no)	S1A
Vomiting during pregnancy (Yes, no)	S1A
Food cravings during pregnancy (Yes, no)	S1A
Food aversion during pregnancy (Yes, no)	S1A
Weight gain concern during pregnancy (Yes, no)	S1A
Received dietary advice during pregnancy (Yes, no)	S1A
Took dietary supplement(s) during pregnancy (Yes, no)	S1A

Table 5-6: Diet during pregnancy as a predictor of pregnancy, birth, neonatal and postpartum outcomes

Diet during pregnancy as a predictor of pregnancy, birth, neonatal and postpartum outcomes – Mode of birth as the primary outcome			
Diet variables (predictors): 4 different diet assessment methods	Method of analysis: Univariate logistic regression and multivariable logistic regression	Pregnancy, birth, neonatal and postpartum outcome variables (dependent)	Source of data
1. AHEI-P (Ireland): 2 categories: Diet needs improvement and high quality diet	Univariate logistic regression analysis was performed for each of the 7 pregnancy, birth, neonatal and postpartum outcome variables in relation to each of the four diet methods Multivariable logistic regression analysis: all variables that were found to be statistically significant and/or were clinically significant in univariate analysis. Variables were entered stepwise. Consideration was given to including variables that other researchers found to be statistically significant, even if they were not statistically significant in these analyses.	Length of gestation: full-term and preterm	Hospital dataset (and S2)
		Mode of birth (as the primary outcome): Spontaneous vaginal birth Instrumental vaginal birth Caesarean section	Hospital dataset (and S2)
2. Clusters: 2 categories: Diet needs improvement and health conscious		Infants weight at birth: <4kg ≥4 kg	Hospital dataset (and S2)
		Breastfeeding initiation: Yes or no	S2
3. Protein to non-protein ratio: 2 categories: Above the median and below the median		Breastfeeding at 3 months postpartum: Yes or no	S2
		Depression episodes at 3 months postpartum: Yes or no	S2
4. Macronutrient adequacy: 2 categories: Adequate and not adequate for all macronutrients		Anxiety episodes (such as panic attacks) at 3 months postpartum: Yes or no	S2

5.4.1 Socio-demographic/economic characteristics

Table 5-7 presents the socio-demographic/economic characteristics of participants whose data were included in this analysis (n=557). The majority was aged 30 years and above (81.5%, n=454/557), married or living with their partner (90.3%, n=500), had either a primary degree or above (77.9%, n= 433) (see appendix 5-1 for the detailed breakdown of qualifications) and were working full time (86.5%, n=481).

Table 5-7: Socio-demographic characteristics

Socio-demographic characteristics	n	%
Age group (n=557)		
Up to 29 years	103	18.5
30 to 34 years	257	46.1
35 years or more	197	35.4
Relationship status (n=554)		
Married or living with partner	500	90.3
In a relationship - not living with partner	43	7.8
Single	11	1.9
Education level (n=556)		
Junior Certificate or less	10	1.8
Leaving Certificate/Vocational	113	20.3
Primary degree/PG certificate	267	48.0
MSc/PhD	166	29.9
Employment status (n=556)		
Full-time paid work	481	86.5
Part-time paid work	32	5.8
Casual paid work	43	7.7
Country of birth (n=550)		
Ireland	428	77.8
Non-Irish	122	22.2

Before pregnancy, 89.4% (n=496/555) of participants said that they could always afford to buy enough food for their household (Table 5-8). During pregnancy, this proportion was slightly higher, at 91% (n=506).

Table 5-8: Self-reported food affordability

Food affordability	Before pregnancy (n=555)	During pregnancy (n=556)
	n (%)	n (%)
Always	496 (89.4)	506 (91.0)
Usually	52 (9.3)	39 (7.0)
Sometimes	6 (1.1)	9 (1.6)
Rarely	0 (0.0)	1 (0.2)
Never	1 (0.2)	1 (0.2)

60% of participants (n=322/537) had private health insurance. However just 21.8% (n=117) used private care and another 16.4% (n=88) used semi-private care during their pregnancy. Therefore, 21.8% (n=117) of those who had had private health insurance used public care. The remaining participants (40%, 215/537) used the public care service (Appendix 5-2). As previously reported in the methodology chapter, analysis is based on participants having or not having private health insurance, not the type of maternity care used during pregnancy.

5.4.2 Health, health perception and mental health before and during pregnancy

Participants' three most frequently reported responses to the question "What, if anything, do you think could have improved your health?" were: less stress (47.9%, n=265), lose weight (28%, n=155) and more willpower (14.6%, n=81) (Appendix 5-3). The majority, 96.4% (n=532/552) self-rated their health before pregnancy as good, very good or excellent (Appendix 5-3).

Mental health was assessed at two different time points, before and during pregnancy, and by two different variables: depression was defined as 'Depression, low mood or sadness that lasted for two weeks or more' and anxiety was defined as 'intense anxiety (such as panic attacks)' (Table 5-9).

Table 5-9: Self-reported mental health before and during pregnancy

Mental health	Before pregnancy		During pregnancy	
	n	%	n	%
Depression, low mood or sadness (n=556)				
No (never and rarely)	473	85.1	522	93.9
Yes (occasionally and often)	83	14.9	34	6.1
Intense anxiety (such as panic attacks) (n=556)				
No (never and rarely)	495	89.0	528	95.0
Yes (occasionally and often)	61	11.0	28	5.0

5.4.3 Pre-pregnancy Body Mass Index (BMI) and satisfaction with body image before and during pregnancy

Pre-pregnancy self-reported height and weight were available from 97.3% (n=542/557) of participants, and BMI (kg/m²) was presented according to the WHO (2018) BMI ranges (Appendix 5-4). Two-thirds (64.9%, n=352) of participants were in the ideal BMI range, 3.7% (n=20) were underweight, 22.5% (n=122) were overweight and 8.9% (n=48) were in the obese range.

Table 5-10 shows that 39% (n=216/554) of participants were trying to lose weight before pregnancy and a total of 203 (36.4%) lost weight.

Table 5-10: Pre-pregnancy weight-loss and weight-changes

In the 12 months before pregnancy	n	%
Tried to lose weight (n=554)		
Yes	216	39.0
No	338	61.0
Weight changes (n=556)		
I lost a lot of weight	30	5.4
I lost a little bit of weight	173	31.1
I stayed about the same weight	278	50.0
I gained a little bit of weight	68	12.2
I gained a lot of weight	0	0.0
Other	7	1.3

Body image satisfaction did not change much from before to during pregnancy (Table 5-11). Almost one in three women were always satisfied with their body image both before (30.1%, n=167/557) and during pregnancy (31.3%, n=172/557).

Table 5-11: Body image satisfaction before and during pregnancy

Body image satisfaction	Before pregnancy (n=557)		During pregnancy (n=550)	
	n	%	n	%
Always satisfied	167	30.1	172	31.3
Sometimes	354	63.9	342	62.2
Never	33	6.0	36	6.5

5.4.4 Physical Activity before - during pregnancy

Pre-pregnancy, 88.4% (n=488/552) of participants exercised for at least 10 minutes at a time at least once per week. Table 5-12 shows the proportion of participants who exercised during pregnancy and the amount of exercise taken (estimated time walking or doing moderate physical activity) in minutes. Less than half of the participants (46.4%, n=254) stated that they received advice about exercise during pregnancy (Appendix 5-5).

Table 5-12: Physical activity during pregnancy

Physical Activity during pregnancy	n	%
Walking (n=493)		
<150 minutes	285	57.8
≥ 150 minutes	208	42.2
Moderate physical activity (n=308)		
<150 minutes	215	69.8
≥ 150 minutes	93	30.2

The following part of this chapter addresses objective four and five: to identify the changes, if any, that women make to their diet during pregnancy as well as the social behaviour changes in terms of alcohol intake, smoking behaviour and amount of exercise that women did during pregnancy.

5.4.5 Alcohol intake and cigarette smoking before and during pregnancy

Few participants (2.9%, n=16/551) never drank alcohol before pregnancy, 20% (n=110) of participants stopped alcohol use pre-pregnancy, 70.2% (n=387) stopped alcohol use when they found out they were pregnant and 6.9% (n=38) continue to drink alcohol once in a while (Appendix 5-5).

The majority of participants, 57.5% (n=317), never smoked cigarettes, 29.1% (n=160/550) stopped smoking pre-pregnancy and 3.8% (n=21) continued to smoke during their pregnancy (Appendix 5-5).

5.4.6 Nausea and vomiting, food cravings and aversions

During pregnancy, almost three-quarters of participants (73.2%, n=408/557) said that they experienced nausea and 45.6% (n=254) experienced vomiting during pregnancy. The majority of participants who experienced nausea also experienced vomiting during pregnancy (57.8%, n=236/408), 55.7% (n=309/555) had cravings for some food or drink and 54.7% (n=302/552) developed an aversion to some food or drink (Appendix 5-6).

5.4.7 Advice on diet, dietary supplements and physical activity during pregnancy

The majority of the participants (71.4%, n=395/553) had received advice on what to stop eating/drinking rather than on what to start eating/drinking (42.7%, n=237/555). Moreover, two-fifths (40.5%, n=224/553) of participants agreed when asked: “Would you have liked more information about what to eat/drink or what NOT to eat/drink during pregnancy” (Appendix 5-7). The three main sources of dietary advice were from the internet (67.4%, n=316), general practitioner (GP) (53.9%, n=253) and midwife (41.2%, n=193) (Appendix 5-7).

5.4.8 Dietary supplement intake before and during pregnancy

Table 5-13 shows the proportion of participants who used any type of dietary supplement before pregnancy and during pregnancy.

Table 5-13: Self-reported dietary supplement use before and during pregnancy

Dietary supplement use	n	%
Before pregnancy (n=555)	358	64.5
During pregnancy (n=551)	520	94.4

Of those participants who took some type of dietary supplement before pregnancy (n=358), 41.3% took Folic Acid (n=148), 45.3% (n=162) took multivitamin supplements containing Folic Acid and the remaining 13.4% (n=48) took dietary supplements that

did not contain Folic Acid. Therefore, only 55.9% (n=310) of the participants took Folic Acid pre-pregnancy. During pregnancy, 80.6% (n=444) took some type of multivitamin containing Folic Acid, 12.9% (n=71) took Folic Acid supplements alone and the remaining 0.9% (n=5) took dietary supplements that did not contain Folic Acid.

5.4.9 Breastfeeding intention

The vast majority of participants (88.9%, n=488/549) were planning to breastfeed their baby when asked between 28 and 37 weeks' gestation, and the majority (64.2%, n=355/553) had received advice on breastfeeding (Appendix 5-8).

5.4.10 Diet changes: before and during pregnancy

Over one-quarter of participants (27.6%, n=153/555) followed a specific type of diet before pregnancy, with half of these (51.6%, n=79/153) following a 'weight loss' diet. While two of the participants had been diagnosed with diabetes mellitus (DM), only one woman reported following a diet to control diabetes (Appendix 5-8). During pregnancy, the number of participants following a particular type of diet was lower (14.9%, n=83/556) and none of the participants said that they were trying to lose weight. Moreover, the majority of participants (67.5%, n=325) thought that their diet before pregnancy was very healthy (8.8%, n=49) or healthy (58.7%, n=326) (Appendix 5-8).

The proportions of participants who ate each meal of the day, every day, increased during pregnancy (Appendix 5-8). In general, there was an increase in the number of meals participants ate every day during pregnancy compared to before pregnancy. An additional 13.1% (n=70) of participants ate breakfast during pregnancy; 16.4% (n=87) ate a morning snack; 7.4% (n=39) ate lunch; 16.8% ate an afternoon snack (n=90), and 12.1% (n=65) ate a night snack.

The three most common food groups that participants ate/drank more of during pregnancy were fruits (60.2%, n=333), milk and dairy products, cheese (52.4%, n=290) and bread and cereals (47.6%, n=263). The three most common items that participants ate/drank less of were tea (45%, n=250), coffee (40.2%, n=223) and soft drinks with sugar (27.7%, n=153). A total of 19.3% (n=107) of participants said that they stopped drinking coffee during pregnancy. Dietary (nutrient) analysis of the FFQ data revealed that only 3.1% (n=17) of participants had an intake of >200mg caffeine (maximum intake was 309.48 mg). The vast majority (96.9%, n=540) had an intake of ≤200mg and

more than half of the participants started drinking more water during pregnancy (51.9%, n=288) (Appendix 5-8).

Milk intake was not included in the FFQ, but questions on the type and frequency of milk consumption were added to the 'Diet and Physical Activity survey'. Just 2.5% (n=14/554) of participants reported not consuming any type of milk during pregnancy. The type of milk used most often was full fat/whole milk (32.1%, n=178/554), followed by low-fat milk (30.1%, n=167/554) and super/fortified (18.2%, n=101/554). Almost eight in 10 participants (77.4%, n=384/496) drank approximately half a pint (250 ml, or ¼ litre) and 20.6% (102/496) drank approximately one pint of milk (568 ml) every day. The intake of water varied from none to more than eight glasses of water per day (Table 5-14).

Table 5-14: Self-reported water intake during pregnancy

Water intake during pregnancy	n	%
Water intake (n=541)		
0-2 glasses of water	28	5.2
2-8 glasses of water	309	57.1
>8 glasses of water	204	37.7

5.5 Part III: Dietary analysis: diet adequacy, diet balance, diet quality and dietary patterns during pregnancy

Diet during pregnancy was assessed by:

- Dietary pattern/quality as determined by the AHEI-P (Ireland) adapted for use in Ireland: Needs improvement group and High quality group;
- Dietary pattern/quality as defined by k-means cluster analysis, where two different groups/clusters were created: Diet needs improvement group and Health conscious diet group;
- Macronutrient adequacy: participants who met 'adequacy of all macronutrients' versus participants who did not meet the recommendations for all three macronutrients (CHOs, fat and protein);
- Dietary pattern/dietary balance: Protein to non-protein ratio (P:NP ratio): participants who were below median and above the median.

5.5.1 Objective one: to determine the nutritional adequacy of the diet of nulliparous women during pregnancy (general adequacy: macro and micronutrients according to the guidelines)

5.5.1.2 Diet adequacy

This part presents the key results of the nutritional adequacy of diet during pregnancy in terms of macronutrients (CHOs, proteins and fat), macronutrients: micronutrients ratio (balance), dietary pattern/quality. Nutritics and SPSS software were used to perform analyses on data from the FFQ, which were then compared with national and international dietary guidelines and recommendations.

The mean energy intake was 2390 calories (SD 495.4, range 834-3487 calories). The mean glycaemic load was 150.5 (SD 42.27, range: 60.5-308) and the mean fibre intake was 29.9 g/day (SD 8.8). Participants' level of macronutrient adequacy was compared with the European Food and Safety Authority's (EFSA) dietary reference values for macronutrients (EFSA 2017) (Appendix 5-9).

Over one-third (38.2%, n=213) of participants met the recommendations for all three macronutrients but the majority (61.8%, n= 344) did not. Table 5-15 shows participants' level of adequacy for the different types of fat, according to the EFSA (EFSA 2017).

The vast majority of participants (93.9%, n=523/557) were above the recommendations for saturated fat (0-10%) according to the European Food and Safety Authority 2017 guidelines (Table 5-15). On the other hand, all participants either met or were above the recommendations for both MUFA (0-12%) and PUFA (0-6%) also according to EFSA guidelines.

Table 5-15: Fat adequacy (in relation to the different types of fat)

Fat adequacy	Saturated fat		MUFA		PUFA	
	n	%	n	%	n	%
Adequacy (n=557)						
	(0-10%)		(0-12%)		(0-6%)	
Meets recommendations	34	6.1	321	57.6	424	76.1
Above recommendations	523	93.9	236	42.4	133	23.9

The mean intake of cholesterol was 295.4 g/day (100.45 SD), Omega 3 was 0.6 g/day (0.19 SD) and Omega 6 was 5.6 g/day (2.44 SD).

Table 5-16 shows participants' micronutrients intake alongside the recommendations from the European Food and Safety Authority (EFSA 2017) and the UK Scientific Advisory Committee on Nutrition (SACN)/Committee on Medical Aspects of Food and Nutrition Policy (COMA), 2017. The mean intake was above the EFSA's (2017) recommended intake for Vitamins A, B1, B2, B3, B5, B6, B7, B12, C, and Vitamin K and for some minerals: Calcium (average requirement (AR), only for age group ≥ 25 years old), Copper, Iron (AR only), Magnesium, Phosphorus, Potassium, Selenium and Zinc.

Table 5-16: Micronutrient mean, minimum and maximum intake and micronutrient recommendations according to two different guidelines

Micronutrient	Recommendation EFSA* for pregnancy	Recommendation SACN (RNI)** for pregnancy	Participants (n=557) (mean, minimum and maximum and Std. deviation - excluding supplement intake)
Vitamin A ($\mu\text{g RE}$)	540 $\mu\text{g/day}$ (≥ 18 y/o) (AR****) 700 $\mu\text{g/day}$ (≥ 18 y/o*****) (PRIs*****)	700 $\mu\text{g /d}$ (≥ 18 y/o)	1257.03 $\mu\text{g /d}$ (mean) 305.7-8576.9 $\mu\text{g /d}$ (Min-Max) 618 (Std. deviation)
Vitamin D (μg)	15 $\mu\text{g/day}$ (≥ 18 y/o) (AI*****)	20 $\mu\text{g /day}$ (≥ 18 y/o) ** new report from 2016	2.64 $\mu\text{g /day}$ (mean) 0.45-12.23 $\mu\text{g /day}$ (Min-Max) 1.02 (Std. deviation)
Vitamin E (α- Tocopherol) (mg)	11 mg/day (≥ 18 y/o) (AI)		10.28 mg/day (mean) 3.6-20.3 mg/day (Min- Max) 2.6 mg/day (Std. deviation)
Vitamin K (μg)	70 $\mu\text{g /day}$ (≥ 18 y/o) (AI)		210.88 $\mu\text{g/day}$ (mean) 38-1682 $\mu\text{g/day}$ (Min- Max) 183.8 (Std. deviation)
Vitamin C (mg)	105 mg/day (PRIs)	50 mg/day (≥ 18 y/o) (increased in +10 mg/d in the last trimester)	351.63 mg/day (mean) 64-1696 mg/day (Min- Max) 208.6 mg/day (Std. deviation)
Vitamin B1 (Thiamin) (mg/MJ)	0.072 mg/MJ (≥ 18 y/o) (AR) 0.1 mg/MJ (≥ 18 y/o) (PRIs)	0.9 mg/day (≥ 18 y/o) (increased in +0.1 mg/day in the last trimester)	2.36 mg/day (mean) 0.87-4.68 mg/day (Min- Max) 0.66 mg/day (Std. deviation)

Vitamin B2 (Riboflavin) (mg)	1.5 mg/day (AR) 1.9 mg/day (PRIs)	1.4 mg/day	1.65 mg/day (mean) 0.55-3.5 mg/day (Min- Max) 0.37 mg/day (Std. deviation)
Vitamin B3 (Niacin) (mg)	1.3 mg/day NE/MJ (≥ 18 y/o) (AR) 1.6 mg/day NE/MJ (≥ 18 y/o) (AR)	14 mg/day (18 y/o) 13 mg/day (≥19-50 y/o)	54.23 mg/day (mean) 13.1-104 mg/day (Min- Max) 13.35 mg/day (Std. deviation)
Vitamin B5 (Pantothenic acid) (mg)	5 mg/day (≥ 18 y/o) (AI)		7.26 mg/day (mean) 2.5-18.7 mg/day (Min- Max) 2.48 mg/day (Std. deviation)
Vitamin B6 (Pyridoxine) (mg)	1.5 mg/d (AR) 1.8 mg/d (PRIs)	1.2 mg/day (≥18 y/o)	2.85 mg/day (mean) 1.1-6.6 mg/day (Min- Max) 0.81 mg/day (Std. deviation)
Vitamin B7 (Biotin) (μg)	40 μg/day (≥ 18 y/o) (AI)		46.40 μg/day (mean) 15.4-216.9 μg/day (Min- Max) 18.00 μg/day (Std. deviation)
Vitamin B9 (Folate) (μg)	600 μg/day (AI)	400 μg/day** updated 2017	428.52 μg/day (mean) 147.3-1161.8 μg/day (Min-Max) 142.8 μg/day (Std. deviation)
Vitamin B12 (Cobalamin) (μg)	4.5 μg/day (AI)	1.5 μg/day (≥18 y/o)	6.35 μg/day (mean) 1.1-14.8 μg/day (Min- Max) 1.64 μg/day (Std. deviation)
Calcium (mg)	860 mg/day (18-24 y/o) (AR) 750 mg/day (≥ 25 y/o) (AR) 1000 mg/day (18-24 y/o) (PRIs) 950 mg/day (≥ 25 y/o) (PRIs)	800 mg/day (18 y/o) 700 mg/d (≥18 y/o)	804.71 mg/day (mean) 264-1976 mg/day (Min- Max) 232.75 mg/day (Std. deviation)
Cooper (mg)	1.5 mg/day (AI)	1.0 mg/day (18 y/o) 1.2 mg/day (≥ 19 y/o)	1.54 mg/day (mean) 0.6-2.7 mg/day (Min- Max) 0.36 mg/day (Std. deviation)

Fluoride (mg)	2.9 mg/day (≥ 18 y/o) (AI)		1.97 mg/day (mean) 0.8-12.6 mg/day (Min-Max) 1.41 mg/day (Std. deviation)
Iodine (μg)	200 $\mu\text{g/day}$ (≥ 18 y/o)	140 $\mu\text{g/day}$ (≥ 18 y/o)	212.35 $\mu\text{g/day}$ (mean) 40.80-792.55 $\mu\text{g/day}$ (Min-Max) 91.49 $\mu\text{g/day}$ (Std. deviation)
Iron (mg)	7 mg/day (≥ 18 y/o premenopausal) (AR) 16 mg/day (≥ 18 y/o premenopausal) (PRIs)	14.8 mg/day (15-50 y/o)	13.54 mg/day (mean) 4.9-30.5 mg/day (Min-Max) 3.1 mg/day (Std. deviation)
Magnesium (mg)	300 mg/day (≥ 18 y/o) (AI)	300 mg/day (18 y/o) 270 mg/day (≥ 18 y/o)	389.94 mg/day (mean) 154-738 mg/day (Min-Max) 92.30 mg/day (Std. deviation)
Sodium (mg)		1600 mg/day ² (≥ 18 y/o)	2538.58 mg/day ² (mean) 624.6-6353.8 mg/day ² (Min-Max) 746.15 mg/day ² (Std. deviation)
Phosphorus (mg)	550 mg/day (≥ 18 y/o) (AI)	625 mg/day (18 y/o) 550 mg/day (≥ 18 y/o)	1659.40.94 mg/day (mean) 485-2993.8 mg/day (Min-Max) 351.70 mg/day (Std. deviation)
Potassium (mg)	3500 mg/day (≥ 18 y/o) (AI)	3500 mg/day ³ (≥ 18 y/o)	4541.11 mg/day (mean) 1998.5-9909.3 mg/day (Min-Max) 1177.46 mg/day (Std. deviation)
Selenium (μg)	70 $\mu\text{g/day}$ (≥ 18 y/o) (AI)	60 $\mu\text{g/day}$ (≥ 18 y/o)	76.30 $\mu\text{g/day}$ (mean) 11.5-205.2 $\mu\text{g/day}$ (Min-Max) 24.79 $\mu\text{g/day}$ (Std. deviation)
Zinc (mg)	300 mg/day (LPI*****) – 6.2 mg/day (AR/PRI) 600 mg/day (LPI) – 7.6 mg/day (AR/PRI) 900 mg/day (LPI/PRI) – 8.9 mg/day (AR) 1200 mg/day (LPI) – 10.2mg/day (AR/PRI)	7.0 mg/day (≥ 18 y/o)	12.90 mg/day (mean) 3.7-27.2 mg/day (Min-Max) 2.87 mg/day (Std. deviation)

*European Food Safety Authority (EFSA) 2017 ** United Kingdom Scientific Advisory
Committee on Nutrition (Reference Nutrient Intake) 2017 ***Phytate Intake Levels (LPI) – EFSA
(2017) recommendation for zinc intake is according to LPI **** Average requirement (AR) *****
Population reference intake (PRI) ***** Adequate Intake (AI) ***** Level of phytate intake
***** Years old (y/o).

The mean micronutrients intake was below the recommendations for Calcium, Iron, and Vitamin D (Table 5-17).

Table 5-17: Participant's adequacy of micronutrients according to EFSA (2017) recommendations

Micronutrients	Mean	Standard deviation	Recommended value per day	Lower value	Upper value
Calcium (mg/day)*	804.7	232.7	1000	767.3	1232.7
Iron (mg/day)**	13.5	3.1	16	12.9	19.1
Folate B9 (ug/day)**	428.5	142.8	400	257.2	542.8
Vitamin D (ug/day)**	2.6	1	15	0.5	12.2

* Calcium = 1000mg (source: AHEI-P for all age groups)

**according to FSAI recommendations

Compared to the EFSA (2017) recommendations for specific micronutrient intake in pregnancy, half of the participants met the recommendations for Calcium (54.4%, n=254) and Iron (53%, n=295), and almost three-quarters met the recommendation for Folate (73.4%, n=409) from diet alone. All participants were below the recommendation for Vitamin D, and 8.3% (n=46), 44.5% (n=248) and 49.9% (n=278) participants were below the recommendations for Folate, Iron and Calcium, respectively (Table 5-18).

Table 5-18: Adequacy of specific micronutrients according to EFSA (2017) recommendations for pregnancy (Mean and SD)

Micronutrient adequacy	Calcium		Iron		Folate		Vitamin D	
	n	%	n	%	n	%	n	%
Adequacy (n=557)								
Below recommendations	278	49.9	248	44.5	46	8.3	557	100
Meets recommendations	254	54.4	295	53	409	73.4	0	0.0
Above recommendations	25	4.5	14	2.5	102	18.3	0	0.0

As described in the methodology chapter, the nutrient adequacy ratio (NAR) was calculated for those micronutrients and the mean was higher for Folate (0.91) and very low for Vitamin D (0.176). The mean adequacy ratio (MAR), also detailed in the previous chapter, was calculated by averaging the NAR. Results are presented in Table 5-19.

Table 5-19: Adequacy (for Calcium, Iron, Vitamin B9 and Vitamin D) according to NAR and MAR (Mean and SD)

Micronutrients	Mean NAR	Standard deviation	Lower value	Upper value
Calcium	0.775	0.172	0.264	1
Iron	0.820	0.149	0.305	1
Folate B9	0.901	0.139	0.368	1
Vitamin D	0.176	0.068	0.030	0.82
Mean adequacy ratio (MAR)	0.668	0.109	0.260	0.94

5.5.2 Objective two: to identify diet adequacy/balance of nulliparous women during pregnancy, assessed by ‘adequacy of all macronutrients’ and P:NP ratio

5.5.2.1 Diet adequacy: ‘Adequacy of all macronutrients’

To assess diet adequacy, participants were divided into two groups: those whose diet met the recommendations (38.2%, n=213) for all three macronutrients (CHOs (45-60%), protein (12-20%) and fat (20-35%)), versus those who did not (61.8%, n=344).

5.5.2.2 Diet balance: Protein to non-protein ratio

The last approach to measuring diet adequacy/balance used was the protein to non-protein (P:NP) ratio. Each participant's P:NP ratio was calculated, based on their energy contribution (E%). The P:NP ratio ranged from 0.09 to 0.45 (SD 0.044). Just over half of the participants (52.4%, n=292) were below the median (0.09-0.22) and the remainder (47.6%, n=265) were above the median (0.23-0.45).

5.2.3 Objective three: to identify dietary patterns of nulliparous women during pregnancy using the AHEI-P (Ireland) and cluster analysis

Dietary pattern/quality was measured using the Alternate Healthy Eating Index for Pregnancy (AHEI-P) (Rifas-Shiman *et al.* 2009, Melere *et al.* 2013), which was adapted and validated for use in this study. The AHEI-P (Ireland) has nine components and each one of them can score between 0-10 points, with 10 being the maximum score. The maximum total score is 90 points, and the cut-off points are: poor quality (<45 points), needs improvement (45-72 points) and high quality (>72 points) (Appendix 4-26).

5.2.3.1 Dietary pattern/quality during pregnancy as measured using the Alternate Healthy Eating Index for Pregnancy in Ireland (AHEI-P (Ireland))

Just over half the participants (52.6%, n=293) were in the “needs improvement” diet group and the remainder (47.4%, n=264) were in the “high quality” diet group. The mean total score for the whole group was 70.8 (range: 47.4-87.0 points, SD 5.6). None of the participants were in the ‘poor quality’ diet group. There were statistically significant differences in the intake of eight of the nine of the diet components between the two groups, the exception being trans fats (p -value = 0.06).

Table 5-20: Dietary pattern/quality during pregnancy according to the Alternate Healthy Eating Index for pregnancy (AHEI-P (Ireland))

Components	Whole sample (n=557)		‘Needs improvement’ diet group (n=293)		‘High quality’ diet group (n=264)		p- value
	Mean score	SD	Mean score	SD	Mean score	SD	
Fruits	9.3	1.5	8.9	1.9	9.8	0.8	0.000
Vegetables	9.9	0.7	9.8	0.9	9.9	0.3	0.000
Ratio white meat:red meat	3.0	1.5	2.6	1.3	3.4	1.7	0.000
Fibre (g/day)	9.5	1.0	9.0	1.3	10.0	0.1	0.000
Trans fats	10.0	0.1	10.0	0.1	10.0	0.1	0.060
Ratio							
Polyunsaturated: saturated fat	4.1	1.0	4.0	0.9	4.3	1.2	0.004
Calcium (mg)	7.7	1.7	6.8	1.5	8.8	1.3	0.000
Folate (ug)	9.0	1.4	8.3	1.5	9.9	0.4	0.000
Iron (mg)	8.2	1.5	7.3	1.3	9.2	0.9	0.000
Total	70.8	5.6	66.7	4.5	75.3	2.4	0.000

In this part of the chapter (as well as in Part IV), the student’s t-test was used to compare the means of two independent samples. According to the Central Limit Theorem (Israel 1992, Kwak & Kim 2017), the size of the sample in this PhD study is large enough to justify/support the use of the t-test. The t-test for independent samples was used to compare the differences in mean nutrient intake between the two different AHEI-P (Ireland) dietary groups. There were no statistically significant differences in the mean intakes of Glycemic Load, Energy, Sodium, Phosphorus, Zinc, Vitamin E,

Niacin, Pantothenate, Vitamin B6, Caffeine, Cholesterol, Protein, Fat, CHOs, Saturated fat, and Monounsaturated fat between the two groups (Table 5-21).

Table 5- 21: Mean energy and nutrient intake – AHEI-P (Ireland) dietary groups

Components	'Needs Improvement' diet (n=293)		'High quality' diet (n=264)		p-value
	Mean intake	SD	Mean intake	SD	
Glycemic Load	133.6	36.3	169.2	40.5	0.058
Energy (calories)	2144.5	424.4	2662.8	421.1	0.308
Fibre	24.7	6.3	35.7	7.6	0.000
Omega 6 (g)	5.1	1.7	6.8	2.7	0.000
Omega 3 (g)	0.5	0.2	0.7	0.2	0.002
Sodium (mg)	2333.3	694.9	2766.4	736.1	0.339
Potassium (mg)	3915.3	886.2	5235.7	1067.0	0.001
Calcium (mg)	693.3	195.3	928.3	207.4	0.027
Magnesium (mg)	331.9	63.6	454.4	74.8	0.002
Phosphorus (mg)	1462.4	274.9	1878	292.3	0.082
Iodine (ug)	199.9	81.0	226.2	100.2	0.008
Iron (mg)	11.8	2.5	15.5	2.5	0.000
Zinc (mg)	11.7	2.7	14.2	2.5	0.950
Vitamin A (ug)	1042.1	398.8	1495.6	722.7	0.000
Vitamin D (ug)	2.3	0.8	2.9	1.1	0.001
Vitamin E (mg)	9.0	2.2	11.7	2.3	0.164
Vitamin K (ug)	154.7	143.2	273.2	203	0.000
Thiamin B1 (mg)	2.0	0.5	2.8	0.6	0.000
Riboflavin B2 (mg)	1.5	0.3	1.9	0.3	0.038
Niacin B3 (mg)	48.2	11.3	61.0	12.3	0.203
Pantothenate B5 (mg)	6.4	2.3	8.2	2.4	0.533
Vitamin B6 (mg)	2.5	0.7	3.2	0.7	0.820
Vitamin B7 (ug)	38.5	12.2	55.2	19.3	0.000
Vitamin B12 (ug)	5.9	1.4	6.9	1.7	0.030
Vitamin C (mg)	279.5	165.2	431.6	222.4	0.000

Caffeine (mg)	79.1	54.8	84.3	54.5	0.572
Vitamin B9 (Folate - ug)	350.9	105.0	514.7	129.3	0.000
Cholesterol (mg)	270.4	80.6	323.2	112.5	0.064
Protein (g)	97.6	19.7	120.8	21.4	0.132
Fat (g)	85.0	19.0	101.3	20.2	0.098
Carbohydrates (g)	247.5	62.3	316.9	70.2	0.051
Saturated fat (g)	32.7	8.8	38.1	9.3	0.070
Monounsaturated fat (g)	28.6	6.7	34.1	7.2	0.053
Polyunsaturated fat (g)	12.8	3.1	16.2	3.9	0.003

5.2.3.2 Dietary pattern/quality during pregnancy, as defined by cluster analysis

Two clusters were created to analyse the data: cluster 1, the 'Diet needs improvement' group (29.4%, n=164/557), included participants who had statistically significant higher median intakes of the following food groups: refined breakfast cereal, sugar and preserves, butter/full fat spread, white bread and rolls, high-energy beverages, potato chips, white pasta and rice, other meat/meat products, white meat, fruit juices and savouries. Cluster 2, the 'Health conscious diet' group (70.6%, n=393/557), included participants who had statistically significant higher median intakes of the following food groups: oils, low-energy beverages, white fish and shellfish, brown bread and rolls, yoghurt, wholemeal pasta and rice, beans/lentils and pulses, soup, eggs/egg dishes, cheese, wholegrain breakfast cereal, oily fish, other vegetables and fruits. There were statistically significance differences in all but seven of the 34 food groups examined (Table 5-22 and Appendix 5-10).

Table 5- 22: Daily food group intakes across the two dietary patterns identified by cluster analysis

Food groups (%E)	Cluster 1 – “Diet needs improvement”						Cluster 2 – “Health conscious diet”						P-value
	n	Min	Max	Mean	Median	Standard Deviation	n	Min	Max	Mean	Median	Standard Deviation	
White bread and rolls	164	0	10.1	2.5	1.9	2.2	393	0	9.6	1.1	0.7	1.3	0
Brown bread and rolls	164	0	8.2	0.9	0.4	1.3	393	0	13.8	1.2	0.5	1.7	0
Wholemeal/grain bread and rolls	164	0	10.4	1.1	0.5	1.5	393	0	13.1	1.7	1.2	2.1	0.04
White pasta and rice	164	1.1	35.4	4.5	3.5	3.6	393	0	18.5	3.8	3	2.5	0
Wholemeal pasta and rice	164	0	10.9	1.5	0.9	1.5	393	0	17.7	2.9	2	2.6	0.013
Refined breakfast cereal	164	0	22	1.4	0.4	2.3	393	0	6.9	0.5	0.2	0.8	0
Wholegrain breakfast cereal	164	0	11.9	2.7	2.4	1.9	393	0	27.2	4.3	4.1	2.9	0
Biscuits/buns/pastries/cakes	164	0	23.6	5.9	4.9	3.9	393	1.3	25.2	5.4	4.1	3.7	0.113
Cream/Ice cream/desert and pudding	164	0.5	10.9	3.3	2.9	1.7	393	0.3	16.6	3.4	2.9	1.8	0.628
Yoghurt	164	0	7.5	1.3	0.6	1.5	393	0	16	2.8	2.6	2.8	0
Cheese	164	0	8.5	2.1	1.5	1.7	393	0	19.5	3.1	2.9	2.6	0
Sugar and preserves	164	0.1	8.8	1	0.6	1.2	393	0	5.9	0.7	0.5	0.8	0.002
Confectionery	164	0.1	40.9	5.2	4.6	4.7	393	0	26.1	4.7	3.8	4.4	0.285
Eggs/Egg dishes	164	0	6.1	1.4	1.2	0.8	393	0	21.6	2.1	1.8	1.9	0
Butter/full fat spread	164	0	9.4	1.3	0.9	1.4	393	0	6.6	0.9	0.7	1	0.001
Lower fat spread	164	0	1.9	0.1	0.1	0.2	393	0	2.9	0.2	0.1	0.3	0.19
Oils	164	0	0.8	0.1	0	0.1	393	0	2.9	0.1	0	0.3	0.037
Potatoes	164	0.8	15.9	4.5	4.1	2.5	393	0	12.6	3.6	3.2	2	0
Potatoes chips	164	0.5	15.4	4.7	3.3	3.2	393	0	10.7	1.9	1.7	1.2	0

Beans, lentils and pulses	164	0.2	7	1.4	1.1	0.9	393	0.1	8.3	1.7	1.4	1.2	0.001
Other vegetables	164	1.7	9.8	3.9	3.7	1.4	393	1.9	16	5.6	5.2	2	0
Fruits	164	0	18.6	5.1	4.6	3.1	393	1	31.3	9.1	8.2	4.7	0
Fruit juices	164	0	36.5	7.3	6	6.6	393	0	28.1	4.3	2.2	4.7	0
White fish and shellfish	164	0	1.1	0.2	0.2	0.2	393	0	2	0.4	0.3	0.3	0
Oily fish	164	0	10.4	2.9	2.6	1.4	393	0	17.8	3.6	3.3	1.9	0
White meat	164	0	26.6	6	5.6	3.1	393	0	19.9	5	4.7	2.4	0
Red meat	164	0	9.5	3.7	3.3	1.8	393	0	12	3.9	3.5	1.8	0.347
Other meat/meat products	164	0	17.1	4	3.5	2.1	393	0	12.7	3.3	3	1.7	0
Savoury snacks	164	0.2	17.8	4.6	3.7	3.6	393	0.7	35.6	4.8	3.4	4.1	0.563
Sauces, herbs and spices	164	0.5	14.4	3.7	2.9	2.3	393	0.1	13.1	3.5	3.1	1.8	0.286
Soup	164	0	9.3	1.5	1.2	1.1	393	0	18.7	2.2	1.5	1.8	0
Savouries	164	2.3	22.6	6.8	6.2	3.1	393	0	24.8	6.2	5.9	2.2	0.025
Low-energy beverages*	164	0	0.3	0.1	0.1	0.1	393	0	0.6	0.1	0.1	0.1	0.001
High-energy beverages**	164	0.3	29.7	3.5	2.2	4	393	0	16	1.5	0.8	1.8	0

* Includes tea, coffee, sugar free cordials and diet fizzy drinks

** Includes non-diet fizzy drinks, fruit squashes/cordials, hot chocolate, malted drinks made from milk, etc.

There was a statistically significant difference (t-test for independent samples) in the mean intake of 22 of the 33 nutrients between the two cluster dietary groups (Table 5-23).

Table 5-23: Mean energy and nutrient intake – Cluster dietary groups

Components	Needs improvement diet		Health conscious diet		p-value
	group (n=164)		group (n=393)		
	Mean score	SD	Mean score	SD	
Glycaemic Load	170.4	41.5	142.1	39.8	0.000
Energy (calories)	2507.3	462.6	2341.3	500.9	0.000
Fibre	25.5	6.4	31.8	9.1	0.000
Omega 6 (g)	5.6	1.8	6.1	2.7	0.023
Omega 3 (g)	0.6	0.2	0.6	0.2	0.445
Sodium (mg)	2688.2	734.9	2476.1	742.8	0.002
Potassium (mg)	4544.6	1113.8	4539.7	1204.4	0.963
Calcium (mg)	744.5	191.5	829.8	243.8	0.000
Magnesium (mg)	366.1	76.6	399.9	96.5	0.000
Phosphorus (mg)	1605.2	287.3	1682.0	372.5	0.018
Iodine (ug)	201.2	82.6	217.0	94.7	0.063
Iron (mg)	12.8	2.6	13.9	3.3	0.000
Zinc (mg)	12.6	2.8	13.0	2.9	0.113
Vitamin A (ug)	1041.4	370.1	1347.0	676.2	0.000
Vitamin D (ug)	2.3	0.7	2.8	1.1	0.000
Vitamin E (mg)	10.4	2.5	10.2	2.6	0.358
Vitamin K (ug)	128.4	101.6	245.3	198.9	0.000
Thiamin B1 (mg)	2.2	0.5	2.4	0.7	0.000
Riboflavin B2 (mg)	1.6	0.3	1.7	0.4	0.015
Niacin B3 (mg)	54.0	12.6	54.4	13.7	0.743
Pantothenate B5 (mg)	7.5	3.0	7.2	2.2	0.244
Vitamin B6 (mg)	3.0	0.9	2.8	0.7	0.025
Vitamin B7 (ug)	40.1	12.7	49.0	19.2	0.000
Vitamin B12 (ug)	6.1	1.5	6.4	1.7	0.058
Vitamin C (mg)	355.0	222.1	350.2	202.9	0.805
Caffeine (mg)	91.2	56.9	77.6	53.3	0.008
Vitamin B9 (Folate - ug)	391.4	119.7	444.0	148.8	0.000
Cholesterol (mg)	280.4	70.9	301.7	109.9	0.023
Protein (g)	106.9	20.7	109.3	24.6	0.271
Fat (g)	95.6	19.7	91.5	21.9	0.039
Carbohydrates (g)	304.9	73.4	270.2	72.9	0.000
Saturated fat (g)	36.1	8.5	35.0	9.8	0.209
Monounsaturated fat (g)	32.0	6.8	30.9	7.6	0.100
Polyunsaturated fat (g)	15.4	3.9	14.0	3.8	0.000

5.6 Part IV: Descriptive findings from pregnancy, birth, neonatal and postpartum outcome variables

The average gestational weight gain was 12.6 kg (Appendix 5-11). Participants who had an ideal pre-pregnancy BMI had the highest average gestational weight gain (13.7 kg), while those who were obese before pregnancy had the lowest average weight gain (5.4 kg). Student's t-test (for independent samples) to compare means showed statistically significant differences in average weight gained from pre-pregnancy to end of pregnancy in all BMI groups.

Two-thirds of participants (66.8%, n=371) birthed vaginally, either spontaneously (35.5%, n=197) or aided by instruments (31.3%, n=174) and 33.2% (n=185) had a caesarean section (CS) (Appendix 5-11).

The mean infant birth weight was 3.5 kg (SD 0.54, range: 0.48 to 5.50 kg). The majority (83.2%, n=463/556) of babies were in the normal birth weight range (2.5-4.0 kilograms) (Appendix 5-11). Two of the infant's weight categories (<2.5 kg and 2.5 to 4 kg) were merged for univariate and multivariable regression analysis, to give two categories: <4kg (87.2%, n=485) and ≥4kg (12.8%, n=71).

Table 5-24 shows that almost one in every three participants were never satisfied with their body image at 3 months postpartum.

Table 5-24: Self-reported body image satisfaction at 3 months postpartum

Body image satisfaction	n	%
At 3 months postpartum (n=552)		
Always satisfied	65	11.8
Sometimes	323	58.5
Never	164	29.7

5.6.1 Infant feeding mode at birth and at 3 months postpartum

64% (n=297/464) of participants were still breastfeeding at 3 months postpartum.

Table 5-25: Self-reported breastfeeding initiation and at 3 months postpartum

Breastfeeding	n	%
Ever breastfed (or expressed breast milk) (n=556)		
Yes	436	78.4
No	120	21.6
Still breastfeeding (or giving expressed breast milk) (at 3 months postpartum) (n=464)		
Yes	297	64.0
No	167	36.0

The majority of participants (64.2%, n=355) had received advice on breastfeeding (Appendix 5-11).

5.7 Part V: Findings from the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study - Univariate logistic regression analysis

This part addresses:

- Objective 6: to identify the predictors of dietary pattern/quality of nulliparous women during pregnancy using two different methods of assessment;
- Objective 7: to analyse the associations, if any, between diet during pregnancy (diet as determined by four different methods), and pregnancy, birth, neonatal and postpartum outcomes (i.e., length of gestation, mode of birth (as the primary outcome), infant’s birth weight, breastfeeding initiation, infant feeding practice at 3 months postpartum, postpartum depression episodes and intense anxiety episodes (such as panic attacks) at 3 months postpartum).

As previously stated, diet during pregnancy was assessed by four different methods: the AHEI-P (Ireland), cluster analysis, ‘adequacy of all macronutrients’ and protein to non-protein ratio (P:NP).

5.7.1 Dietary pattern/quality pre-pregnancy and during pregnancy as measured by the AHEI-P (Ireland)

Compared to relevant reference categories, the pre-pregnancy factors statistically significantly associated with having a diet in need of improvement were: being in casual paid work/other (OR 2.0, CI 95% 1.0-3.8, p=0.050) (borderline significance), being overweight (OR 2.2, CI 95% 1.5-3.4, p=0.000), being sometimes satisfied with body image (OR 1.4, CI 95% 1.1-2.1, p=0.042), reading food labels sometimes (OR 1.9, CI

95% 1.2-2.9, $p=0.002$) or never (OR 2.6, CI 95% 1.5-4.8, $p=0.001$) and not taking dietary supplements (OR 2.0, CI 95% 1.4-2.8, $p=0.000$). Participants who experienced intense anxiety episodes (such as panic attacks) (OR 0.5, CI 95% 0.3-0.9, $p=0.031$) or had a history of eating disorders (OR 0.4, CI 95% 0.2-1.0, $p=0.050$) (borderline significance) were less likely to have a diet that needed improvement (Table 5-26).

Table 5-26: AHEI-P (Ireland) during pregnancy and pre-pregnancy variables

AHEI-P (Ireland)											
	Total	High quality		Needs improvement							
	n	n	%	n	%	OR	95% CI	p -value	χ2	p -value	Phi
Age group											
Up to 29 years	103	44	42.7%	59	57.3%	1.2	0.8-1.9	0.414			
30 to 34 years	257	122	47.5%	135	52.5%	1.0 (ref)			4.060	0.131	0.085
35 years or more	197	98	49.7%	99	50.3%	0.9	0.6-1.3	0.631			
Relationship status											
Married or living with partner	500	239	47.8%	261	52.2%	1.0(ref)					
In a relationship but not living with partner	43	20	46.5%	23	53.5%	1.1	0.6-2.0	0.871	0.595	0.743	0.033
Single	11	4	36.4%	7	63.6%	1.6	0.5-5.5	0.456			
Education level											
Junior Cert or less	10	7	70.0%	3	30.0%	0.4	0.1-1.5	0.164			
Leaving Cert/Vocational	113	43	38.1%	70	61.9%	1.4	0.9-2.3	0.117	8.264	0.041	0.122
Primary degree/PG cert	267	125	46.8%	142	53.2%	1.0(ref)					
MSc/PHD	163	86	52.8%	77	47.2%	0.8	0.5-1.2	0.232			
Employment status											
Full-time paid work	481	233	48.4%	248	51.6%	1.0(ref)			0.702	0.704	0.036

Part-time paid work	32	17	53.1%	15	46.9%	0.8	0.4-1.7	0.608			
Casual paid work/others	43	14	32.6%	29	67.4%	2.0	1.0-3.8	0.050			
Country of birth											
Ireland	428	227	53.0%	201	47.0%	1.0(ref)			0.008	0.927	_0.004
Non-Irish	122	64	52.5%	58	47.5%	0.7	0.5-1.1	0.133			
Pre-pregnancy BMI											
Underweight	20	10	50.0%	10	50.0%	1.1	0.5-2.8	0.787	9.824	0.02	0.135
Ideal	354	188	53.1%	166	46.9%	1.0(ref)					
Overweight	119	40	33.6%	79	66.4%	2.2	1.5-3.4	0.000			
Obese	49	20	40.8%	29	59.2%	1.6	0.9-3.0	0.109			
Type of care											
Public care	215	103	47.9%	112	52.1%	1.0(ref)			0.137	0.712	0.016
Private health insurance	322	154	47.8%	168	52.2%	1.0	0.7-1.4	0.985			
Exercise before pregnancy*											
Yes	488	239	49.9%	249	51.0%	1.0(ref)			3.857	0.050	0.084
No	64	23	35.9%	41	64.1%	1.7	0.9-3.0	0.051			
Depression episodes before pregnancy**											
No	473	227	48.0%	246	52.0%	1.0(ref)			0.330	0.566	0.024
Yes	83	37	44.6%	46	55.4%	1.1	0.7-1.8	0.566			
Intense anxiety episodes (such as panic attacks) before pregnancy***											
No	495	227	45.9%	268	54.1%	1.0(ref)			4.768	0.029	0.093

Yes	61	37	60.7%	24	39.3%	0.5	0.3-0.9	0.031			
Difficulties in gaining weight									0.885	0.347	0.40
No	537	252	46.9%	285	53.1%	1.0(ref)					
Yes	19	11	57.9%	8	42.1%	0.6	0.3-1.6	0.350			
Difficulties in losing weight											
No	476	223	46.8%	253	53.2%	1.0(ref)			0.273	0.601	0.022
Yes	80	40	50.0%	40	50.0%	0.8	0.5-1.4	0.602			
History of eating disorders											
No	530	245	46.2%	285	53.8%	1.0(ref)			4.087	0.043	0.086
Yes	22	15	68.2%	7	31.8%	0.4	0.2-1.0	0.050			
Body image satisfaction											
Always	167	90	53.9%	77	46.1%	1.0(ref)			4.192	0.123	0.087
Sometimes	354	157	44.4%	197	55.6%	1.4	1.1-2.1	0.042			
Never	33	15	45.5%	18	54.5%	1.4	0.6-3.0	0.376			
Reads food labels											
Yes, always	123	75	61.0%	48	39.0%	1.0(ref)					
Yes, sometimes	361	162	44.9%	199	55.1%	1.9	1.2-2.9	0.002	13.190	0.001	0.154
No, never	73	27	37.0%	46	63.0%	2.6	1.5-4.8	0.001			
Dietary supplement intake											
Yes	358	191	53.4%	167	46.6%	1.0(ref)			14.392	0.000	0.161
No	197	72	36.5%	125	63.5%	2.0	1.4-2.8	0.000			

*Exercise before pregnancy as determined by "Did you do any regular exercise for 10 minutes or more at least ONCE a week"

** During the 12 months BEFORE your pregnancy did you experience "feeling depressed, low mood or sad (lasting two weeks or more)?"

*** During the 12 months BEFORE your pregnancy did you experience "Intense anxiety (such as panic attacks)"

Table 5-27 shows the results for pregnancy variables as potential predictors of dietary pattern/quality during pregnancy according to the AHEI-P (Ireland). Compared to the relevant reference categories, participants more likely to have a diet in need of improvement were those who did not walk (as measured by the amount of walking time in minutes per week during pregnancy) (reported to not walk during pregnancy) (OR 1.8, CI 95% 1.1-3.9, $p=0.045$) or did not do any moderate physical activity per week (OR 1.9, CI 95% 1.2-3.1, $p=0.008$). Those who experienced food cravings during pregnancy (OR 0.6, CI 95% 0.4-0.8, $p=0.002$) were less likely to be in the diet needs improvement group.

Table 5-27: AHEI-P (Ireland) during pregnancy and pregnancy variables

	AHEI-P (Ireland)										
	Total	High quality		Needs Improvement		OR	95% CI	p -value	χ2	p -value	Phi
	n	n	%	n	%						
Smoking behaviour											
Never/stopped	476	231	48.5%	245	51.5%	1.0(ref)			3.177	0.204	0.076
Stopped smoking during pregnancy	53	21	39.6%	32	60.4%	1.4	0.8-2.6	0.220			
Still smoking	21	7	33.3%	14	66.7%	1.9	0.7-4.7	0.179			
Alcohol use											
Never/stopped	126	68	54.0%	58	46.0%	1.0(ref)			4.479	0.107	0.090
Stopped drinking alcohol during pregnancy	387	172	44.4%	215	55.6%	1.0	0.5-2.0	0.888			
Still drinking alcohol	38	21	55.3%	17	44.7%	1.5	0.9-2.1	0.063			
Walking*											
None	59	23	39.0%	36	61.0%	1.8	1.1-3.9	0.045	5.834	0.054	0.103
<150 minutes per week	285	128	44.9%	157	55.1%	1.4	0.9-2.0	0.050			
≥150 minutes	208	112	53.8%	96	46.2%	1.0(ref)					
Moderate PA**											
None	237	99	41.8%	138	58.2%	1.9	1.2-3.1	0.008	7.560	0.023	0.118
<150 minutes per week	215	106	49.3%	109	50.7%	1.4	0.9-2.3	0.158			
≥150 minutes	93	54	58.1%	39	41.9%	1.0(ref)					
Depression episodes during pregnancy											
No	522	250	47.9%	272	52.1%	1.0(ref)			0.577	0.447	0.032
Yes	34	14	41.2%	20	58.8%	1.3	0.6-2.7	0.448			

Intense anxiety episodes (such as panic attacks) during pregnancy											
No	528	250	47.3%	278	52.7%	1.0(ref)			0.075	0.784	_0.012
Yes	28	14	50.0%	14	50.0%	0.9	0.4-1.9	0.728			
Relationship problems with partner/spouse											
No	535	256	47.9%	279	52.1%	1.0(ref)			0.081	0.776	0.012
Yes	18	8	44.4%	10	55.6%	1.1	0.4-3.0	0.776			
Body image during pregnancy											
Always	172	85	49.4%	87	50.6%	1.0(ref)			0.459	0.795	0.029
Sometimes	342	160	46.8%	182	53.2%	1.1	0.8-1.6	0.573			
Never	36	16	44.4%	20	55.6%	1.2	0.6-2.5	0.587			
Experienced nausea during pregnancy											
No	149	67	45.0%	82	55.0%	1.0(ref)			0.482	0.488	_0.029
Yes	408	197	48.3%	211	51.7%	0.9	0.6-1.3	0.488			
Experienced vomiting during pregnancy											
No	303	154	50.8%	149	49.2%	1.0(ref)			3.132	0.077	0.075
Yes	254	110	43.3%	144	56.7%	1.3	0.9-1.9	0.077			
Food cravings during pregnancy											
No	246	98	39.8%	148	60.2%	1.0(ref)			10.102	0.001	0.135
Yes	309	165	53.4%	144	46.6%	0.6	0.4-0.8	0.002			
Food aversion during pregnancy											
No	302	151	50.0%	151	50.0%	1.0(ref)			1.720	0.190	0.056
Yes	250	111	44.4%	139	55.6%	1.3	0.9-1.8	0.19			

Weight gain concern*****											
Gain too MUCH weight	391	190	48.6%	201	51.4%	1.0(ref.)			0.646	0.421	0.038
Gain too LITTLE weight	67	29	43.3%	38	56.7%	1.2	0.7-2.1	0.422			
Dietary advice during pregnancy											
Yes	469	227	48.4%	242	51.6%	1.0(ref.)			1.200	0.273	0.046
No	88	37	42.0%	51	58.0%	1.3	0.8-2.1	0.274			
Dietary supplement intake											
Yes	520	246	48.5%	261	51.5%	1.0(ref.)			3.617	0.057	0.081
No	31	16	34.0%	31	66.0%	1.8	0.9-3.4	0.060			

* Estimated total time spent walking continuously, for at least 10 minutes, for recreation, exercise or to get from place to place

** Estimated total time spent doing moderate physical activity (such as gentle swimming)

*** Since the start of pregnancy did you experience “feeling depressed, low mood or sad (lasting two weeks or more)?”

**** Since the start of pregnancy did you experience “Intense anxiety (such as panic attacks)”

*****As there is no “usual” group, “gain too much weight” was chosen as the reference category as the majority of participants was in this group

Backward stepwise logistic regression was used for all multivariable analysis. Because it is an elimination method (Bursac *et al.* 2008, Zhang 2016), only the variables that were statistically significant were included in the final models presented in this thesis but all variables were included in the initial logistic regression model as listed in each table (5-28, 5-30, 5-32, 5-37 and 5-39).

For example, the third column in Table 5-28, 'Pre-pregnancy variables used in the multivariable analysis', shows all the variables that were included in the initial statistical model and were statistically significant in the univariate analysis. After performing backward stepwise logistic regression, only a few variables showed statistical significance. These statistically significant variables are described as "Variables that showed statistically significant association" in the fourth column in Table 5-28. This statistical approach includes all the variables at the start and, at each step, it progressively eliminates several variables so a final model that best explains the data/variables is presented (Bursac *et al.* 2008, Zhang 2016) as described in the paragraph below. This method has been reported to have advantages when there are multiple potential explanatory variables, which was the case in this study (Zhang 2016). Moreover, Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Goodness were conducted prior to each of the analyses and supported the quality of the logistic regression models (Salkind 2010, Archer & Lemeshow 2006). Results of Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Goodness can be found in Appendix 5-12.

One final multivariable logistic regression model was used to explore associations with the pre-pregnancy variables (Table 5-29) and two final multivariable logistic regression models were used to explore associations with the pregnancy variables (one for amount of walking time per week and amount of moderate physical activity time per week) (Table 5-31 and 5-33). Pre-pregnancy BMI as an important pre-pregnancy variable was statistically significant in the univariate analysis as well as in the multivariable analysis of pre-pregnancy predictors. Therefore, pre-pregnancy BMI was included in the model of pregnancy predictors of dietary pattern/quality during pregnancy (Tables 5-29 - 5-32).

The dependent variable was dietary pattern/quality during pregnancy with "high quality diet" as the reference category. Those were the variables that showed statistical significance in the univariate logistic regression model. Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Goodness were conducted prior to the

analyses and supported the quality of the pre-pregnancy logistic regression models (Appendix 5-12).

Table 5-28: Pre-pregnancy predictors of dietary pattern/quality during pregnancy

Group	Guiding question	Pre-pregnancy variables used in the multivariable analyses	Variables that showed statistically significant association	Variables that DID NOT show statistical significance
All significant pre-pregnancy variables	What are the pre-pregnancy predictors of a healthy diet during pregnancy?	Employment status, pre-pregnancy BMI, intense anxiety episodes (such as panic attacks) before pregnancy, history of eating disorders, body image satisfaction before pregnancy, read food labels and dietary supplement intake before pregnancy	Pre-pregnancy BMI, read food labels before pregnancy and dietary supplement intake before pregnancy	Employment status, intense anxiety episodes (such as panic attacks) before pregnancy and history of eating disorders and body image satisfaction before pregnancy

Table 5-29 shows the multivariable logistic regression model containing the pre-pregnancy variables that were statistically significant in the univariate analysis. Compared to relevant reference categories, pre-pregnancy factors significantly associated with having a diet during pregnancy that needed improvement were: being overweight before pregnancy (Adjusted (A) OR 2.1, 95% CI 1.3-3.3, $p=0.001$), reading food labels sometimes before pregnancy (AOR 2.0, 95% CI 1.3-3.1, $p=0.002$), or never reading food labels (AOR 2.3, 95% CI 1.2-4.3, $p=0.013$), and not taking dietary supplements before pregnancy (AOR 1.9, 95% CI 1.3-2.8, $p=0.001$).

Table 5-29: Pre-pregnancy predictors of dietary pattern/quality during pregnancy

Pre-pregnancy variables	Total n	High quality diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Pre-pregnancy BMI	542	258	%	284	%				
Underweight	20	10	50.0	10	50.0	0.861	1.0	0.4	2.8
Ideal	354	188	53.1	166	46.9	1.0 (ref)			
Overweight	119	40	33.6	79	66.4	0.001	2.1	1.3	3.3
Obese	49	20	40.8	29	59.2	0.206	1.5	0.8	2.8
Reads food labels	557	264	%	293	%				
Yes, always	123	75	61.0	48	39.0	1.0 (ref)			
Yes, sometimes	361	162	44.9	199	55.1	0.002	2.0	1.3	3.1
No, never	73	27	37.0	46	63.0	0.013	2.3	1.2	4.3
Dietary supplement intake before pregnancy	555	263	%	292	%				
Yes	358	191	53.4	167	46.6	1.0 (ref)			
No	197	72	36.5	125	63.5	0.001	1.9	1.3	2.8

Table 5-30: Pregnancy predictors of dietary pattern/quality during pregnancy – amount of walking time per week

Group	Guiding question	Variables used in the multivariable analyses	Variables that showed significance	Variables that DID NOT show statistical significance
All significant pregnancy variables – amount of walking time per week	What are the pregnancy predictors of a healthy diet during pregnancy?	Pre-pregnancy BMI, walking time per week and food cravings during pregnancy	Pre-pregnancy BMI and food cravings during pregnancy	Walking time per week

Table 5-31 shows the multivariable logistic regression model containing the pregnancy variables that were statistically significant in the univariate analysis. Compared to relevant reference categories, the one pregnancy factor that was significantly associated with having a diet during pregnancy that needed improvement was being

overweight before pregnancy (AOR 2.3, 95% CI 1.5-3.5, p=0.000). Participants who had food cravings during pregnancy were less likely to have a diet during pregnancy that needed improvement (AOR 0.6, 95% CI 0.4-0.8, p=0.003). Amount of walking time per week did not show any statistical significance in the multivariable analysis.

Table 5-31: Pregnancy predictors of dietary pattern/quality during pregnancy – multivariable analysis – amount of walking time per week

Pregnancy variables	Total n	High quality diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Pre-pregnancy BMI	542	258	%	284	%				
Underweight	20	10	50.0	10	50.0	0.833	1.1	0.4	2.8
Ideal	354	188	53.1	166	46.9	1.0 (ref)			
Overweight	119	40	33.6	79	66.4	0.000	2.3	1.5	3.5
Obese	49	20	40.8	29	59.2	0.096	1.7	0.9	3.2
Food cravings	555	263	%	292	%				
No	246	98	0.4	148	0.6	1.0 (ref)			
Yes	309	165	0.5	144	0.5	0.003	0.6	0.4	0.8

Table 5-32: Pregnancy predictors of dietary pattern/quality during pregnancy – amount of moderate physical activity time per week

Group	Guiding question	Variables used in the multivariable analyses	Variables that showed significance	Variables that DID NOT show statistical significance
All significant pregnancy variables – amount of walking time per week	What are the pregnancy predictors of a healthy diet during pregnancy?	Pre-pregnancy BMI, amount of moderate physical activity time per week during pregnancy and food cravings	Pre-pregnancy BMI and food cravings	Amount of moderate physical activity time per week during pregnancy

Table 5-33 shows the logistic regression model containing the pregnancy variables that were statistically significant in the univariate analysis. Compared to relevant reference categories, one pregnancy factor significantly associated with having a diet during pregnancy that needed improvement was being overweight before pregnancy (AOR 2.3, 95% CI 1.5-3.6, p=0.000). Participants who had food cravings during pregnancy were less likely to have a diet during pregnancy that needed improvement (AOR 0.6,

95% CI 0.4-0.8, $p=0.002$). Amount of moderate physical activity time per week during pregnancy did not show any statistical significance in the multivariable analysis.

Table 5-33: Pregnancy predictors of dietary pattern/quality during pregnancy – multivariable analysis – amount of moderate physical activity time per week

Pre-pregnancy variables	Total n	High quality diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Pre-pregnancy BMI	542	258	%	284	%				
Underweight	20	10	50.0	10	50.0	0.838	1.1	0.4	2.8
Ideal	354	188	53.1	166	46.9	1.0 (ref)			
Overweight	119	40	33.6	79	66.4	0.000	2.3	1.5	3.6
Obese	49	20	40.8	29	59.2	0.102	1.7	0.9	3.2
Food cravings	555	263	%	292	%				
No	246	98	0.4	148	0.6	1.0 (ref)			
Yes	309	165	0.5	144	0.5	0.002	0.6	0.4	0.8

Table 5-34 shows the results of the univariate analysis for all the pregnancy group of pregnancy, birth, neonatal and postpartum outcome variables and dietary pattern/quality during pregnancy (according to the AHEI-P (Ireland)). Mode of birth, a categorical variable and the primary outcome in this PhD study that was used to estimate the sample size, was analysed using multinomial regression analysis (Tables 5-35 and 5-36).

There was a statistically significant association between dietary pattern/quality in pregnancy and two (out of seven) pregnancy, birth, neonatal and postpartum outcomes assessed: breastfeeding initiation and breastfeeding at 3 months postpartum. Participants in the needs improvement diet group were more likely to feed their babies artificially i.e., not initiate breastfeeding (OR 2.1, CI 95% 1.4-3.2, $p=0.001$) and were not breastfeeding at 3 months postpartum (OR 1.5, CI 95% 1.1-2.2, $p=0.032$).

Table 5-34: AHEI-P (Ireland) during pregnancy and pregnancy, birth, neonatal and postpartum variables

Table 3. OR, AHEI-P (Ireland), during pregnancy and pregnancy, birth, neonatal and postpartum variables												
AHEI-P (Ireland)	Total n	Gestational length				OR	95% CI	p value	χ2	p -value	Phi	p-value
		Full-term		Preterm								
		n	%	n	%							
High quality	264	254	96.2	10	3.8	1.0(ref)						
Needs Improvement	292	280	95.9	12	4.1	1.1	0.5-2.6	0.846	0.038	0.846	0.008	0.846
AHEI-P (Ireland)	Total n	Mode of birth				OR	95% CI	p value	χ2	p -value	Phi	p-value
		Spontaneous vaginal birth		Instrumental vaginal birth and caesarean section								
		n	%	n	%							
High quality	264	103	39.0	161	61.0	1.0(ref)						
Needs Improvement	292	94	32.2	198	67.8	1.3	0.9-1.9	0.093	2.822	0.093	0.071	0.093
AHEI-P (Ireland)	Total n	Infant's weight at birth				OR	95% CI	p value	χ2	p -value	Phi	p-value
		<4kg		≥ 4								
		n	%	n	%							
High quality	261	226	86.6	35	13.4	1.0(ref)						
Needs Improvement	289	253	87.5	36	12.5	0.9	0.6-1.5	0.739	0.111	0.739	_0.014	0.739
AHEI-P (Ireland)	Total n	Postpartum depression episodes				OR	95% CI	p value	χ2	p -value	Phi	p-value
		No		Yes								
		n	%	n	%							
High quality	259	214	82.6	45	17.4	1.0(ref)						
Needs Improvement	291	231	79.4	60	20.6	1.2	0.8-1.9	0.334	0.934	0.334	0.041	0.334

AHEI-P (Ireland)	Postpartum intense anxiety episodes (such as panic attacks)						95% CI	p value	χ2	p -value	Phi	p-value
	Total	No		Yes		OR						
	n	n	%	n	%							
High quality	255	214	83.9	41	16.1	1.0(ref)						
Needs improvement	291	253	86.9	38	13.1	0.8	0.5-1.3	0.318	1.002	0.317	_0.043	0.317
AHEI-P (Ireland)	Total	Breastfeeding initiation				OR	95% CI	p value	χ2	p -value	Phi	p-value
		No		Yes								
		n	%	n	%							
High quality	263	40	15.2	223	84.8	1.0(ref)						
Needs improvement	293	80	27.3	213	72.7	2.1	1.4-3.2	0.001	11.979	0.001	_0.147	0.001
AHEI-P (Ireland)	Total	Breastfeeding at 3 months postpartum				OR	95% CI	p value	χ2	p -value	Phi	p-value
		No		Yes								
		n	%	n	%							
High quality	231	72	31.2	159	68.8	1.0(ref)						
Needs Improvement	233	95	40.8	138	59.2	1.5	1.1-2.2	0.032	4.644	0.031	_0.100	0.031

There was no statistically significant association found between dietary pattern/quality and mode of birth (Tables 5-36 and 5-37).

Table 5-35: AHEI-P (Ireland) during pregnancy and mode of birth

Table 5.50: AHEI-P (Ireland), during pregnancy, and mode of birth										
AHEI-P (Ireland)	Mode of birth						χ^2	p - value	Phi	p - value
	Spontaneous vaginal birth		Instrumental vaginal birth		Caesarean section					
	n	%	n	%	n	%				
High quality	103	39.0	74	28.0	87	33.0				
Needs Improvement	94	32.2	100	34.2	98	33.6	3.549	0.170	0.080	0.170

Table 5-36: AHEI-P (Ireland) during pregnancy and mode of birth – multinomial analysis

Mode of birth		p-value	OR	CI 95%	
				Upper	Lower
Instrumental vaginal birth	High quality	1.0(ref)			
	Needs Improvement	0.305	0.8	0.5	1.2
Caesarean section	High quality	1.0(ref)			
	Needs Improvement	0.392	1.2	0.8	1.8

One multivariable logistic regression model was performed to explore the socio-demographic/economic predictors that, together with dietary pattern/quality during pregnancy, could be associated with breastfeeding (Table 5-38). Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Goodness of fit were conducted prior to the analysis and supported the quality of this logistic regression model below (Appendix 5-12).

Table 5-37: Diet pattern/quality during pregnancy and socio-demographic/economic predictors of breastfeeding initiation

Model- group	Guiding question	Pre-pregnancy variables used in the model	Variables that showed significance	Variables that DID NOT show statistical significance
Socio-demographic/economic	What are the socio-demographic/economic predictors that together with healthy diet during pregnancy could be associated with breastfeeding initiation?	Diet, age group, country of birth and educational level	Diet, age group, country of birth and educational level	None

Participants more likely to initiate breastfeeding had MSc. or PhD level of education (AOR 2.7, 95% CI 1.3-5.4, $p=0.006$) and were non-Irish (AOR 2.7, 95% CI 1.2-4.7, $p=0.004$). Participants aged up to 29 years old (AOR 0.4, 95% CI 0.2-0.8, $p=0.003$), who were educated to Junior Certificate level or less (AOR 0.2, 95% CI 0.1-0.8, $p=0.021$), Leaving Certificate/vocational level (AOR 0.3, 95% CI 0.2-0.5, $p=0.000$), and were in the diet that needs improvement group (AOR 0.5, 95% CI 0.3-0.8, $p=0.004$) were statistically significantly less likely to initiate breastfeeding.

Table 5-38: Dietary pattern/quality during pregnancy and socio-demographic predictors of breastfeeding initiation

Variables	Total n	Breastfeeding initiation				p-value	AOR	CI 95%	
		Yes		No				Lower	Upper
		n	%	n	%				
Age group	556	436	%	120	%				
Up to 29 years	103	62	60.2	41	39.8	0.003	0.4	0.2	0.8
30 to 34 years	256	210	82.0	46	18.0	1.0 (ref)			
35 years or more	197	164	83.2	33	16.8	0.961	1.1	0.6	1.8
Education level	552	433	%	119	%				
Junior Cert or less	10	5	50.0	5	50.0	0.021	0.2	0.1	0.8
Leaving Cert/ Vocational	113	61	54.0	52	46.0	0.000	0.3	0.2	0.5
Primary degree/PG	266	217	81.6	49	18.4	1.0 (ref)			
MSc/PhD	163	150	92.0	13	8.0	0.006	2.7	1.3	5.4
Diet (AHEI-P)	556	436	%	120	%				
Healthy diet	263	223	84.8	40	15.2	1.0 (ref)			
Needs improvement	293	213	72.7	80	27.3	0.004	0.5	0.3	0.8
Country of birth	549		%		%				
Ireland	427	323	75.6	104	24.4	1.0 (ref)			
Non-Irish	122	109	89.3	13	10.7	0.004	2.7	1.4	5.2

Before conducting the final multivariable logistic regression model, a number of specific multivariable logistic regression models were explored with variables divided into sub-groups (Table 5-39) and each of those specific models can be found in Tables 5-40 - 5-46. Seven multivariable logistic regression models were performed to explore the predictors that, together with dietary pattern/quality during pregnancy, could be associated with breastfeeding at 3 months postpartum. Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Goodness of fit were conducted prior to the analysis and supported the quality of these logistic regression models below (Appendix 5-12).

Table 5-39: Dietary pattern/quality multivariable regression analysis models for exploring associations with breastfeeding at 3 months postpartum – according to the AHEI-P (in Ireland)

Model- group	Guiding question	Variables used in the model	Variables that showed significance	Variables that DID NOT show statistical significance
Socio-demographic/ economic variables (Appendix 5-13)	What are the socio-demographic/economic predictors that together with healthy diet during pregnancy could be associated with breastfeeding at 3 months postpartum?	Diet, age group, educational level, country of birth, relationship status.	Diet, age group, educational level, country of birth.	Relationship status
Socio-behaviour CHANGES variables (Appendix 5-13)	What are the changes in socio-behaviour (alcohol use and smoking) predictors that together with healthy diet during pregnancy could be associated with breastfeeding at 3 months postpartum?	Diet, smoking behaviour and alcohol use	Smoking behaviour and diet	Alcohol use
Behaviour/ attitude variables – amount of walking time per week (Appendix 5-13)	What are the behaviours/attitudes during pregnancy predictors that together with healthy diet during pregnancy could be associated with breastfeeding at 3 months postpartum?	Diet, amount of walking time per week, dietary supplement intake during pregnancy and breastfeeding advice	Amount of walking time per week	Diet, breastfeeding advice during pregnancy and dietary supplement intake during pregnancy
Behaviour/ attitude variables – amount of moderate physical activity time per week (Appendix 5-13)	What are the behaviours/attitudes during pregnancy predictors that together with healthy diet during pregnancy could be associated with breastfeeding at 3 months postpartum?	Diet, amount of moderate physical activity time per week, dietary supplement intake during pregnancy and breastfeeding advice	Amount of moderate physical activity time per week	Diet, breastfeeding advice during pregnancy and dietary supplement intake during pregnancy
Postpartum mental health – intense anxiety episodes (such as panic attacks) and depression	What are the mental health predictors (postpartum) that together with healthy diet during pregnancy could be associated with breastfeeding at 3 months postpartum	Diet, postpartum intense anxiety episodes (such as panic attacks), postpartum depression episodes and body image	Diet and body image after birth	Postpartum depression episodes and postpartum intense anxiety episodes (such as panic attacks)

episodes (Appendix 5-13)		after birth		
Final model – amount of walking time per week (Table 5-40)	All that were significant in this group	Diet, age group, educational level, country of birth, smoking behaviour, amount of walking time per week and body image after birth	Age group, diet during pregnancy, educational level and body image after birth	Country of birth, amount of walking time per week and smoking during pregnancy
Final model – amount of moderate physical activity time per week (Table 5-41)	All that were significant in this group	Diet, age group, educational level, country of birth, smoking behaviour, amount of moderate physical activity time per week and body image after birth	Age group, diet, educational level and body image after birth	Country of birth, smoking behaviour during pregnancy and amount of moderate physical activity time per week

Two final models were created: one with all the variables that were statistically significantly associated with breastfeeding at 3 months postpartum and amount of time spent walking per week (Table 5-40), and a similar model but with moderate physical activity instead (Table 5-41).

Participants more likely to be breastfeeding at 3 months postpartum were those who were sometimes satisfied with their body image (AOR 5.2, 95% CI 1.9-14.5, $p=0.002$), and participants less likely to be breastfeeding at 3 months postpartum were aged 35 years or more (AOR 0.5, 95% CI 0.2-0.9, $p=0.015$), educated to Leaving Certificate/vocational level of education (AOR 0.4, 95% CI 0.2-0.8, $p=0.004$), or had a diet during pregnancy that needed improvement (AOR 0.6, 95% CI 0.4-0.9, $p=0.039$).

There was no association between breastfeeding at 3 months postpartum and country of birth, amount of walking time per week and smoking behaviour; all of which were significant in the specific previous multivariable analysis.

Table 5-40: Dietary pattern/quality during pregnancy and final predictors for exploring breastfeeding at 3 months postpartum – amount of walking time per week

Variables	Total n	Breastfeeding 3 months postpartum				p-value	AOR	CI 95%	
		Yes		No				Lower	Upper
		n	%	n	%				
Age group	464	297	%	167	%				
Up to 29 years	79	34	43.0	45	57.0	0.101	0.9	0.7	1.5
30 to 34 years	216	152	70.4	64	29.6	1.0 (ref)			
35 years or more	169	111	65.7	58	34.3	0.015	0.5	0.2	0.9
Education level	460	294	%	166	%				
Junior Cert or less	9	3	33.3	6	66.7	0.110	0.3	0.1	1.3
Leaving Cert/Vocational	79	32	40.5	47	59.5	0.004	0.4	0.2	0.8
Primary degree/PG	221	147	66.5	74	33.5	1.0 (ref)			
MSc/PhD	151	112	74.2	39	25.8	0.225	1.4	0.8	2.2
Diet (AHEI-P)	464	297	%	167	%				
High quality	231	159	68.8	72	31.2	1.0 (ref)			
Needs improvement	233	138	59.2	95	40.8	0.039	0.6	0.4	0.9
Body image satisfaction after pregnancy	459	293	%	166	%				
Yes, always	56	50	89.3	6	10.7	1.0 (ref)			
Yes, sometimes	274	169	61.7	105	38.3	0.002	5.2	1.9	14.5
No, never	129	74	57.4	55	42.6	0.600	0.9	0.5	1.4

Participants more likely to be breastfeeding at 3 months postpartum were those who were sometimes satisfied with their body image (AOR 5.0, 95% CI 1.8-14.1, p=0.002). Participants less likely to be breastfeeding at 3 months postpartum were aged 35 years or more (AOR 0.5, 95% CI 0.2-0.9, p=0.015), educated to Leaving Certificate/vocational level of education (AOR 0.4, 95% CI 0.2-0.7, p=0.003) and those who had a diet that needed improvement during pregnancy (AOR 0.6, 95% CI 0.4-0.9, p=0.036).

There was no association between breastfeeding at 3 months postpartum and country of birth, smoking behaviour and amount of moderate physical activity time per week; all of which were significant in the specific previous multivariable analysis.

Table 5-41: Dietary pattern/quality during pregnancy and final predictors for exploring breastfeeding at 3 months postpartum – amount of moderate physical activity time per week.

Variables	Total n	Breastfeeding 3 months postpartum				p-value	AOR	CI 95%	
		Yes		No				Lower	Upper
		n	%	n	%				
Age group	464	297	%	167	%				
Up to 29 years	79	34	43.0	45	57.0	0.101	0.9	0.7	1.5
30 to 34 years	216	152	70.4	64	29.6	1.0 (ref)			
35 years or more	169	111	65.7	58	34.3	0.015	0.5	0.2	0.9
Education level	460	294	%	166	%				
Junior Cert or less	9	3	33.3	6	66.7	0.104	0.3	0.1	1.3
Leaving cert/Vocational	79	32	40.5	47	59.5	0.003	0.4	0.2	0.7
Primary degree/PG	221	147	66.5	74	33.5	1.0 (ref)			
MSc/PhD	151	112	74.2	39	25.8	0.300	1.3	0.8	2.1
Diet (AHEI-P)	464	297	%	167	%				
High quality	231	159	68.8	72	31.2	1.0 (ref)			
Needs improvement	233	138	59.2	95	40.8	0.036	0.6	0.4	0.9
Body image satisfaction after pregnancy	459	293	%	166	%				
Yes, always	56	50	89.3	6	10.7	1.0 (ref)			
Yes, sometimes	274	169	61.7	105	38.3	0.002	5.0	1.8	14.1
No, never	129	74	57.4	55	42.6	0.659	0.9	0.6	1.4

5.7.2 Dietary pattern/quality, pre-pregnancy and during pregnancy, as defined by cluster analysis

Univariate logistic regression analysis was performed to explore the pre-pregnancy and pregnancy predictors of dietary pattern/quality during pregnancy as defined by cluster analysis (Table 5-42).

Compared to relevant reference categories, the pre-pregnancy factors statistically significantly associated with having a diet in need of improvement were: being aged <29 years (OR 4.4, CI 95% 2.7-7.1, $p=0.000$), in a relationship but not living with one's partner (OR 3.1, CI 95% 1.6-5.8, $p=0.000$), having Leaving Certificate/vocational level

of education (OR 3.1, CI 95% 1.9-4.9, $p=0.000$), being in casual paid work (OR 2.1, CI 95% 1.1-3.9, $p=0.022$), and being overweight (OR 2.5, CI 95% 1.6-3.9, $p=0.000$) or obese (OR 2.8, CI 95% 1.5-5.3, $p=0.001$). Moreover, other factors that were statistically significantly associated with being in a 'needs improvement diet' group were: not exercising before pregnancy (OR 3.2, CI 95% 1.9-5.4, $p=0.000$), being "sometimes" (OR 1.9, CI 95% 1.2-2.9, $p=0.003$) and "never" satisfied (OR 2.5, CI 95% 1.1-5.6, $p=0.021$) with body image, sometimes (OR 2.1, CI 95% 1.2-3.6, $p=0.006$) and never reading food labels (OR 5.9, CI 95% 5.9-11.4, $p=0.000$), and not taking any type of dietary supplements before pregnancy (OR 1.8, CI 95% 1.2-2.6, $p=0.002$). On the contrary, participants who had a 'private health insurance' (even if they did not use private care, they were labelled as 'private health insurance') were statistically significantly less likely to be in the diet group that needed improvement (OR 0.6, CI 95% 0.4-0.8, $p=0.002$).

Table 5-42: Dietary pattern/quality (cluster analysis) during pregnancy and pre-pregnancy variables

	Total	Health conscious diet		Needs improvement diet							
	n	n	%	n	%	OR	95% CI	p –value	χ ²	p – value	Phi
Age group											
Up to 29 years	103	47	45.6	56	54.4	4.4	2.7-7.1	0.000			
30 to 34 years	257	202	78.6	55	21.4	1.0(ref)			39.417	0.000	0.266
35 years or more	197	144	73.1	53	26.9	1.3	0.9-2.1	0.173			
Relationship status											
Married or living with partner	500	364	72.8	136	27.2	1.0(ref)			14.484	0.001	0.162
In a relationship – not living with partner	43	20	46.5	23	53.5	3.1	1.6-5.8	0.000			
Single	11	6	54.5	5	45.5	2.2	0.7-7.4	0.191			
Education level											
Junior Cert or less	10	6	60	4	40	1.9	0.5-7.1	0.312			
Leaving Cert/Vocational	113	55	48.7	58	51.3	3.1	1.9-4.9	0.000	35.233	0.000	0.252
Primary degree/PG cert	267	199	74.5	68	25.5	1.0(ref)					
MSc/PHD	163	130	79.8	33	20.2	0.7	0.5-1.2	0.216			
Employment status											
Full time paid work	481	349	72.6	132	27.4	1.0(ref)			6.437	0.040	0.108
Part time paid work	32	20	62.5	12	37.5	1.6	0.7-3.3	0.224			
Casual paid work	43	24	55.8	19	44.2	2.1	1.1-3.9	0.022			

Country of birth											
Ireland	428	296	69.2	132	30.8	1.0(ref)			2.292	0.130	0.065
Non-Irish	122	93	76.2	29	23.8	0.7	0.4-1.5	0.367			
Pre-pregnancy BMI											
Underweight	20	14	70	6	30	1.5	0.6-4.1	0.409			
Ideal	354	276	78	78	22	1.0(ref)			23.085	0.000	0.206
Overweight	119	70	58.8	49	41.2	2.5	1.6-3.9	0.000			
Obese	49	27	55.1	22	44.9	2.8	1.5-5.3	0.001			
Type of care*											
Public care	215	135	62.8	80	37.2	1.0(ref)			9.423	0.002	0.132
Private health insurance	322	242	75.2	80	24.8	0.6	0.4-0.8	0.002			
Exercise										0.000	
Yes	488	360	73.8	128	26.2	1.0(ref)			19.739		_0.189
No	64	30	46.9	34	53.1	3.2	1.9-5.4	0.000			
Depression episodes before pregnancy											
No	473	337	71.2	136	28.8	1.0(ref)			0.843	0.359	_0.039
Yes	83	55	66.3	28	33.7	1.3	0.7-2.1	0.359			
Intense anxiety episodes (such as panic attacks) before pregnancy											
No	495	352	71.1	143	28.9	1.0(ref)			0.801	0.371	_0.038
Yes	61	40	65.6	21	34.4	1.3	0.7-2.2	0.372			
Difficulties in putting on weight											
No	537	381	70.9	156	29.1	1.0(ref)			1.504	0.22	_0.052
Yes	19	11	57.9	8	42.1	1.8	0.7-4.5	0.22			

Difficulties in losing weight											
No	476	337	70.8	139	29.2	1.0(ref)			0.138	0.71	_0.016
Yes	80	55	68.8	25	31.3	1.1	0.6-1.8	0.71			
History of eating disorders before pregnancy											
No	530	371	70	159	30	1.0(ref)			1.418	0.234	_0.051
Yes	22	18	81.8	4	18.2	0.5	0.2-1.6	0.242			
Body image before pregnancy											
Always	167	133	79.6	34	20.4	1.0(ref)			10.385	0.006	0.137
Sometimes	354	237	66.9	117	33.1	1.9	1.2-2.9	0.003			
Never	33	20	60.6	13	39.4	2.5	1.1-5.6	0.021			
Reads food labels											
Yes, always	123	103	83.7	20	16.3	1.0(ref)					
Yes, sometimes	361	256	70.9	105	29.1	2.1	1.2-3.6	0.006	30.521	0.000	0.234
No, never	73	34	46.6	39	53.4	5.9	5.9-11.4	0.000			
Dietary supplement intake											
Yes	358	275	76.8	83	23.2	1.0(ref)			10.083	0.001	_0.135
No	197	116	58.9	81	41.1	1.8	1.2-2.6	0.002			

*As previously reported in the methodology chapter, participants who had or had not private health insurance but not necessarily had private (or semi-private) antenatal care

Table 5-43 shows the results for pregnancy variables as potential predictors of dietary pattern/quality during pregnancy according to cluster analysis. Compared to the relevant reference categories, participants more likely to have a diet in need of improvement were those who stopped smoking during pregnancy (OR 1.9, CI 95% 1.1-3.6, $p=0.021$) and were still smoking during pregnancy (OR 8.9, CI 95% 3.2-25, $p=0.000$); those who stopped alcohol use during pregnancy (OR 1.9, CI 95% 1.2-3.2, $p=0.005$); those who had no moderate physical activity (OR 8.3, CI 95% 3.8-17.9, $p=0.000$) or less than 150 minutes per week (OR 2.8, CI 95% 1.3-6.2, $p=0.011$), were never satisfied with their body image (OR 2.7, CI 95% 1.3-5.6, $p=0.007$), did not take any dietary supplement during pregnancy (OR 3.6, CI 95% 1.7-7.6, $p=0.001$), and who experienced nausea (OR 1.7, CI 95% 1.1-2.7, $p=0.013$) or vomiting during pregnancy (OR 2.3, CI 95% 1.5-3.3, $p=0.000$). Similarly, the other variable used to measure physical activity during pregnancy (amount of time walking per week) showed a statistically significant association: participants who did not walk or who were walking less than 150 minutes per week at the time of completing the survey also had higher odds of being in the needs improvement diet group (OR 4.0, CI 95% 2.2-7.4, $p=0.000$) and (OR 1.6, CI 95% 1.1-2.4, $p=0.028$) respectively.

Table 5-43: Dietary pattern/quality (cluster analysis) during pregnancy and pregnancy variables

	Cluster groups						OR	95% CI	p –value	χ2	p –value	Phi
	Total n	Health conscious diet		Needs improvement diet								
		n	%	n	%							
Smoking behaviour												
Never/stopped	476	351	73.7	125	26.3	1.0(ref)			28.01	0.000	0.226	
Stopped smoking during pregnancy	53	31	58.5	22	41.5	1.9	1.1-3.6	0.021				
Still smoking	21	5	23.8	16	76.2	8.9	3.2-25	0.000				
Alcohol use (drinking behaviour)												
Never/stopped before pregnancy	126	101	80.2	25	19.8	1.0(ref)			8.662	0.013	0.125	
Stopped drinking alcohol during pregnancy	387	259	66.9	128	33.1	1.9	1.2-3.2	0.005				
Still drinking alcohol	38	29	76.3	9	23.7	1.3	0.5-2.9	0.609				
Walking												
None	59	28	47.5	31	52.5	4	2.2-7.4	0.000	21.382	0.000	0.197	
<150 minutes	285	198	69.5	87	30.5	1.6	1.1-2.4	0.028				
≥150 minutes	208	163	78.4	45	21.6	1.0(ref)						
Moderate physical activity												
None	237	133	56.1	104	43.9	8.3	3.8-17.9	0.000	51.278	0.000	0.307	
<150 minutes	215	170	79.1	45	20.9	2.8	1.3-6.2	0.011				
≥150 minutes	93	85	91.4	8	8.6	1.0(ref)						
Depression episodes during pregnancy												
No	522	373	250.3	149	28.5	1.0(ref)			3.723	0.054	_0.082	
Yes	34	19	55.9	15	44.1	1.9	0.9-3.9	0.058				

Intense anxiety episodes (such as panic attacks) during pregnancy									2.531	0.112	_0.067
No	528	376	71.2	152	28.8	1.0(ref)					
Yes	28	16	57.1	12	42.9	1.8	0.8-4.0	0.117			
Relationship problems during pregnancy									2.119	0.145	_0.062
No	535	382	71.4	153	28.6						
Yes	18	10	55.6	8	44.4	1.9	0.7-5.1	0.153			
Body image during pregnancy									10.279	0.006	0.137
Always	172	122	70.9	50	29.1	1.0(ref)					
Sometimes	342	249	72.8	93	27.2	0.9	0.6-1.4	0.645			
Never	36	17	47.2	19	52.8	2.7	1.3-5.6	0.007			
Experienced nausea during pregnancy									6.215	0.013	_0.106
No	149	117	78.5	32	21.5	1.0(ref)					
Yes	408	276	67.6	132	32.4	1.7	1.1-2.7	0.013			
Experienced vomiting during pregnancy									18.773	0.000	_0.184
No	303	237	78.2	66	21.8	1.0(ref)					
Yes	254	156	61.4	98	38.6	2.3	1.5-3.3	0.000			
Food cravings during pregnancy									0.478	0.479	_0.019
No	246	177	72	69	28	1.0(ref)					
Yes	309	214	69.3	95	30.7	1.1	0.7-1.6	0.478			

Food aversion during pregnancy

No	302	215	71.2	87	28.8	1.0(ref)			0.167	0.683	_0.017
Yes	250	174	69.6	76	30.4	0.9	0.6-1.3	0.683			

Weight gain concern

Gain too MUCH weight	391	282	79.1	109	27.9	1.0(ref)				0.186	_0.062
Gain too LITTLE weight	67	43	64.2	24	35.8	1.4	0.8-1.5	0.187	1.752		

Dietary advice during pregnancy

Yes	469	336	71.6	133	28.4	1.0(ref)					
No	88	57	64.8	31	35.2	1.4	0.8-2.5	0.196	1.683	0.195	_0.055

Dietary supplement intake

Yes	520	377	72.5	143	27.5	1.0(ref)					
No	31	13	41.9	18	58.1	3.6	1.7-7.6	0.001	13.215	0.000	_0.155

Before conducting the final multivariable logistic regression model, a number of specific multivariable logistic regression models were explored with the pre-pregnancy variables divided into sub-groups (Table 5-44). The final model can be found in Table 5-45 and the three previous sub-group models can be found in Appendix 5-14. The dependent variable was dietary pattern/quality during pregnancy with the “needs improvement diet” as reference category. Those were the variables that showed statistical significance either in the univariate logistic regression model or were statistically significant in previous studies. Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Goodness were conducted prior to all analysis and all supported the quality of the logistic regression models (Appendix 5-12).

As previously explained, backward stepwise logistic regression was used on all multivariable analysis and since it is an elimination methods only, the variables that were statistically significant were included in the models but all variables were included in the initial logistic regression model, as shown in Table 5-44 below.

Table 5-44: Pre-pregnancy and dietary pattern/quality multivariable regression analysis models

Group	Guiding question	Variables used in the multivariable analyses	Variables that showed significance	Variables that DID NOT show statistical significance
Socio-demographic/economic (Appendix 5-14)	What are the socio-demographic/economic pre-pregnancy predictors of a health conscious diet during pregnancy?	Age group, relationship status, level of education, employment status, health insurance and pre-pregnancy BMI	Age group, level of education, relationship status and pre-pregnancy BMI	Employment status Type of care
Behaviour (Appendix 5-14)	What are the behaviour pre-pregnancy predictors of a health conscious diet during pregnancy	Exercise, body image, read food labels and dietary supplement intake	Exercise, body image, read food labels and dietary supplement intake	None
Mental health – Depression episodes and intense anxiety episodes (such as panic attacks) (Appendix 5-14)	What are the mental health (altogether) pre-pregnancy predictors of a health conscious diet during pregnancy	Depression episodes, intense anxiety episodes (such as panic attacks) and body image satisfaction	Body image satisfaction	Depression episodes, intense anxiety episodes (such as panic attacks)
All significant variables (final model) (Table 5-45)	What are the pre-pregnancy predictors of a health conscious diet during pregnancy – altogether	Age, level of education, employment status, pre-pregnancy BMI, exercise, body image, read food labels and dietary supplement intake	Age, level of education, exercise, body image, read food labels	Employment, dietary supplement intake and pre-pregnancy BMI

Table 5-45 shows the final logistic regression model containing the variables that were statistically significant. Compared to relevant reference categories, pre-pregnancy factors significantly associated with having a diet during pregnancy that needed improvement were: being aged up to 29 years (AOR 3.3, 95% CI 1.9-5.9, $p=0.000$), being educated to Leaving Certificate/vocational level (AOR 2.5, 95% CI 1.5-4.2, $p=0.001$), not exercising before pregnancy (AOR 2.5, 95% CI 1.4-4.5, $p=0.003$), being

never satisfied with body image (AOR 2.0, 95% CI 1.2-3.3, $p=0.005$), and sometimes (AOR 2.4, 95% CI 1.3-4.4, $p=0.003$) or never reading food labels (AOR 4.9, 95% CI 2.3-10.5, $p=0.000$).

There was no significant association between employment status, the intake of dietary supplements during pregnancy, pre-pregnancy BMI and being in the 'diet needs improvement' group during pregnancy, all of which were statistically significant in the univariate regression analysis.

Table 5-45: Final pre-pregnancy predictors of dietary pattern/quality during pregnancy

Pre-pregnancy variables	Total n	Health conscious diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Age group	557	393	%	164	%				
Up to 29 years	103	47	45.6	56	54.4	0.000	3.3	1.9	5.9
30 to 34 years	257	202	78.6	55	21.4	1.0 (ref)			
35 years or more	197	144	73.1	53	26.9	0.076	1.6	0.9	2.5
Education level	553	390	%	163	%				
Junior Cert or less	10	6	60	4	40.0	1	1	0.2	4.2
Leaving Cert/Vocational	113	55	48.7	58	51.3	0.001	2.5	1.5	4.2
Primary degree/PG	267	199	74.5	68	25.5	1.0 (ref)			
MSc/PhD	163	130	79.8	33	20.2	0.506	0.8	0.5	1.4
Exercise before pregnancy	552	390	%	162	%				
Yes	488	360	73.8	128	26.2	1.0 (ref)			
No	64	30	46.9	34	53.1	0.003	2.5	1.4	4.5
Body image satisfaction	554	390	%	164	%				
Yes, always	167	133	79.6	34	20.4	1.0 (ref)			
Yes, sometimes	354	237	66.9	117	33.1	0.233	1.8	0.7	4.4
No, never	33	20	60.6	13	39.4	0.005	2	1.2	3.3
Reads food labels	557	393	%	164	%				
Yes, always	123	103	83.7	20	16.3	1.0 (ref)			
Yes, sometimes	361	256	70.9	105	29.1	0.003	2.4	1.3	4.4
No, never	73	34	46.6	39	53.4	0.000	4.9	2.3	10.5

The next analysis explored the pregnancy predictors of having a diet that needs improvement during pregnancy. As with the pre-pregnancy predictor variables, a number of specific multivariable logistic regression models were explored before performing a final logistic regression model for the pregnancy predictor variables (Appendix 5-15). All the pregnancy variables were divided into sub-groups as shown in Table 5-46. Two different variables were used to measure the level of exercise during pregnancy (walking and moderate physical activity) and subsequently, two separate final models were created (Tables 5-47 and 5-48).

None of the mental health variables were included in the final model as they had not shown any statistical significance at any time (neither in univariate regression analysis nor in those specific multivariable regression models).

Those were the variables that showed statistical significance, either in the univariate logistic regression model or are usually statistically significant according to the literature. Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Goodness of fit were conducted prior to all analysis and all supported the quality of the logistic regression models below (Appendix 5-12).

Age group, level of education and pre-pregnancy BMI as important pre-pregnancy variables (all were statistically significant in the univariate analysis as well as in the multivariable analysis of pre-pregnancy predictors) were brought to the two final models of pregnancy predictors of dietary pattern/quality during pregnancy.

Table 5-46: Pregnancy and dietary pattern/quality multivariable regression analysis models

Model- group	Guiding question	Variables used in the multivariable analysis	Variables that showed significance	Variables that DID NOT show statistical significance
Socio-behaviour changes – Amount of walking time per week (Appendix 5-15)	What are the socio- behaviour predictors during pregnancy of a health conscious diet during pregnancy?	Smoking behaviour, alcohol use, amount of walking time per week	All variables were significant	None
Socio-behaviour changes – Amount of	What are the socio behaviour predictors during	Smoking behaviour, alcohol use, amount of	All variables were significant	None

moderate physical activity time per week (Appendix 5-15)	pregnancy of a health conscious diet during pregnancy?	moderate physical activity time per week		
Behaviour/attitude (Appendix 5-15)	What are the behaviour/attitude predictors during pregnancy of a health conscious diet during pregnancy	Nausea, experienced vomiting, dietary advice received, dietary supplement intake	Experienced vomiting and dietary supplement intake during pregnancy	Nausea and dietary advice
Mental health – (Appendix 5-15)	What are the mental health (altogether) pregnancy predictors of a health conscious diet during pregnancy	Body image during pregnancy, depression episodes during pregnancy and intense anxiety episodes (such as panic attacks) during pregnancy	Body image satisfaction during pregnancy	Depression episodes during pregnancy and intense anxiety episodes (such as panic attacks) during pregnancy
All variables – with amount of walking time per week (Table 5-47)	What are the pregnancy predictors of a health conscious diet during pregnancy - altogether	Age, level of education, pre-pregnancy BMI, smoking behaviour, alcohol use, amount of walking time per week, body image, dietary supplement intake during pregnancy and experienced vomiting	Age, level of education, Smoking behaviour, alcohol use, amount of walking time per week and experienced vomiting	Pre-pregnancy BMI, body image during pregnancy and dietary supplement intake during pregnancy
All variables – with amount of moderate physical activity per week (Table 5-48)	What are the pregnancy predictors of a health conscious diet during pregnancy - altogether	Age, level of education, pre-pregnancy BMI, smoking behaviour, alcohol use, amount of moderate physical activity time per week, body image, dietary supplement intake during pregnancy and experienced vomiting	Age, level of education, smoking behaviour, alcohol use, amount of moderate physical activity time per week and experienced vomiting	Pre-pregnancy BMI, body image during pregnancy and dietary supplement intake during pregnancy

Table 5-59 shows the final logistic regression model containing the variables that were statistically significant. Pregnancy factors that were significantly associated with having a diet during pregnancy that needed improvement were: being aged up to 29 years

(AOR 3.3, 95% CI 1.9-5.9, $p=0.000$), leaving certificate/vocational level of education (AOR 2.6, 95% CI 1.5-4.5, $p=0.001$), smoking during pregnancy (AOR 5.1, 95% CI 1.5-17.2, $p=0.008$), stopped drinking alcohol during pregnancy (AOR 1.9, 95% CI 1.1-3.4, $p=0.024$), walking for less <150 minutes (AOR 1.6, 95% CI 1.1-2.7, $p=0.043$) and not walking (AOR 4.2, 95% CI 2.1-8.6, $p=0.000$) and vomiting during pregnancy (AOR 2.5, 95% CI 1.6-3.8, $p=0.000$).

There was no association between being in the diet that needs improvement during pregnancy group and pre-pregnancy BMI, satisfaction with body image during pregnancy and dietary supplement intake during pregnancy, all of which were significant in the univariate analysis.

Table 5-47: Final pregnancy predictors of dietary pattern/quality during pregnancy – amount of walking time per week

Variables	Total n	Health conscious diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Age group	557	393	%	164	%				
Up to 29 years	103	47	45.6	56	54.4	0.000	3.3	1.9	5.9
30 to 34 years	257	202	78.6	55	21.4	1.0 (ref)			
35 years or more	197	144	73.1	53	26.9	0.274	1.3	0.8	2.2
Education level	553	390	%	163	%				
Junior Cert or less	10	6	60	4	40.0	0.591	1.5	0.3	6.9
Leaving Cert/Vocational	113	55	48.7	58	51.3	0.001	2.6	1.5	4.5
Primary degree/PG	267	199	74.5	68	25.5	1.0 (ref)			
MSc/PhD	163	130	79.8	33	20.2	0.749	0.9	0.5	1.6
Smoking behaviour	550	387	%	163	%				
Never/stopped	476	351	73.7	125	26.3	1.0 (ref)			
Stopped smoking during pregnancy	53	31	58.5	22	41.5	0.268	1.5	0.7	3.1
Still smoking	21	5	23.8	16	76.2	0.008	5.1	1.5	17.2
Alcohol use (drinking behaviour)	551	389	%	162	%				
Never/stopped	126	101	80.2	25	19.8	1.0 (ref)			
Stopped drinking alcohol during pregnancy	387	259	66.9	128	33.1	0.024	1.9	1.1	3.4
Still drinking alcohol	38	29	76.3	9	23.7	0.902	0.9	0.3	2.7
Walking	552	389	%	163	%				
≥150 minutes	208	163	78.4	45	21.6	1.0 (ref)			
<150 minutes	285	198	69.5	87	30.5	0.043	1.6	1.1	2.7
None	59	28	47.5	31	52.5	0.000	4.2	2.1	8.6
Vomiting during pregnancy	557	393	%	164	%				
No	303	237	78.2	66	21.8	1.0 (ref)			
Yes	254	156	61.4	98	38.6	0.000	2.5	1.6	3.8

For the second multivariable model, the variable walking during pregnancy was replaced by moderate physical activity during pregnancy. Pregnancy factors that were significantly associated with having a diet during pregnancy that needed improvement were: being aged up to 29 years (AOR 3.4, 95% CI 1.9-6.2, p=0.000), Leaving

Certificate/vocational level of education (AOR 2.6, 95% CI 1.5-4.5, $p=0.001$), smoking during pregnancy (AOR 4.8, 95% CI 1.3-17.2, $p=0.017$), drinking alcohol during pregnancy (AOR 2.0, 95% CI 1.1-3.6, $p=0.017$), moderate physical activity for <150 minutes (AOR 2.8, 95% CI 1.1-7.1, $p=0.033$) and no moderate physical activity (AOR 6.9, 95% CI 2.8-17.3, $p=0.000$) and vomiting during pregnancy (AOR 2.3, 95% CI 1.5-3.6, $p=0.000$).

There was no association between being in the 'diet that needs improvement' group and pre-pregnancy BMI, body image during pregnancy and dietary supplement intake during pregnancy; all of which were significant in the univariate analysis.

Table 5-48: Pregnancy predictors of dietary pattern/quality during pregnancy – amount of moderate physical activity time per week

Variables	Total n	Health conscious diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Age group	557	393	%	164	%				
Up to 29 years	103	47	45.6	56	54.4	0.000	3.4	1.9	6.2
30 to 34 years	257	202	78.6	55	21.4	1.0 (ref)			
35 years or more	197	144	73.1	53	26.9	0.243	1.4	0.8	2.3
Education level	553	390	%	163	%				
Junior Cert or less	10	6	60	4	40.0	0.615	1.5	0.3	7
Leaving Cert/Vocational	113	55	48.7	58	51.3	0.001	2.6	1.5	4.5
Primary degree/PG	267	199	74.5	68	25.5	1.0 (ref)			
MSc/PhD	163	130	79.8	33	20.2	0.963	1.0	0.6	1.8
Smoking behaviour	550	387	%	163	%				
Never/stopped	476	351	73.7	125	26.3	1.0 (ref)			
Stopped smoking during pregnancy	53	31	58.5	22	41.5	0.517	1.3	0.6	2.7
Still smoking	21	5	23.8	16	76.2	0.017	4.8	1.3	17.2
Drinking behaviour	551	389	%	162	%				
Never/stopped	126	101	80.2	25	19.8	1.0 (ref)			
Stopped drinking during pregnancy	387	259	66.9	128	33.1	0.017	2.0	1.1	3.6
Still drinking	38	29	76.3	9	23.7	0.888	0.9	0.3	2.9
Moderate PA	545	388	%	157	%				
≥150 minutes	93	85	91.4	8	8.6	1.0 (ref)			
<150 minutes	215	170	79.1	45	20.9	0.033	2.8	1.1	7.1
None	237	133	56.1	104	43.9	0.000	6.9	2.8	17.3
Vomiting during pregnancy	557	393	%	164	%				
No	303	237	78.2	66	21.8	1.0 (ref)			
Yes	254	156	61.4	98	38.6	0.000	2.3	1.5	3.6

5.8 Pregnancy, birth, neonatal and postpartum outcomes of dietary pattern/quality during pregnancy

There was no statistically significant association between diet pattern/quality in pregnancy and mode of birth (primary outcome). There was a statistically significant association between diet pattern/quality in pregnancy and breastfeeding initiation and breastfeeding at 3 months postpartum. Participants in the diet needs improvement group were more likely to feed their babies artificially, i.e., not initiate breastfeeding (OR 4.1, CI 95% 2.6-6.2, $p=0.000$) and have stopped breastfeeding at 3 months postpartum (OR 3.0, CI 95% 1.9-4.6, $p=0.000$) (Table 5-49).

Table 5-49: Dietary pattern/quality (cluster analysis) during pregnancy and pregnancy, birth, neonatal and postpartum outcome variables

Variables	Gestational length														
	Full-term				Preterm				OR	95% CI	p-value	χ2	p -value	Phi	p -value
	n	%	n	%											
Health conscious diet	379	96.7	13	3.3											
Needs improvement diet	155	94.5	9	5.5	1.7	0.7-4.0	0.236	1.435	0.231	0.051	0.231				
Cluster analysis	Mode of birth				OR	95% CI	p value	χ2	p -value	Phi	P-value				
	Spontaneous vaginal birth		Instrumental vaginal birth and caesarean section												
	n	%	n	%											
Health conscious	144	36.7	248	63.3	1.0(ref)										
Needs Improvement	53	32.3	111	67.7	1.2	0.8-1.8	0.321	0.986	0.321	0.042	0.321				
Cluster analysis	Infant's weight at birth				OR	95% CI	p-value	χ2	p -value	Phi	p -value				
	< 4		≥4kg												
	n	%	n	%											
Health conscious diet	340	86.7	52	13.3											
Needs improvement diet	145	88.4	19	11.6	0.9	0.5-1.5	0.588	0.293	0.588	0.023	0.588				
Cluster analysis	Postpartum depression episodes				OR	95% CI	p-value	χ2	p -value	Phi	p -value				
	No		Yes												
	n	%	n	%											
Health conscious diet	318	81.7	71	18.3											
Needs improvement diet	127	78.9	34	21.1	1.2	0.8-1.9	0.437	0.606	0.436	0.033	0.436				

Cluster analysis	Postpartum intense anxiety episodes (such as panic attacks)				OR	95% CI	p-value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Health conscious diet	331	85.5	56	14.5							
Needs improvement diet	136	85.5	23	14.5	1.0	0.6-1.7	0.999	0.000	0.999	0.000	0.999
Cluster analysis	Breastfeeding initiation				OR	95% CI	p-value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Health conscious diet	55	14	338	86							
Needs improvement diet	65	39.9	98	60.1	4.1	2.6-6.2	0.000	45.603	0.000	0.286	0.000
Cluster analysis	Breastfeeding at 3 months postpartum				OR	95% CI	p-value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Health conscious diet	103	29.5	246	70.5							
Needs improvement diet	64	55.7	51	44.3	3.0	1.9-4.6	0.000	25.654	0.000	0.235	0.000

Multinomial regression analyses was also performed to assess dietary pattern/quality during pregnancy and mode of birth and no statistically significant association was found (Tables 5-50 and 5-51).

Table 5-50: Dietary pattern/quality (cluster analysis) during pregnancy and mode of birth

Cluster	Mode of birth						χ ²	p - value	Phi	p - value
	Spontaneous vaginal birth		Instrumental vaginal birth		Caesarean section					
	n	%	n	%	n	%				
Health conscious diet group	144	36.7	127	32.4	121	30.9				
Needs Improvement diet group	53	32.3	47	28.7	64	39	3.466	0.177	0.079	0.177

Table 5-51: Dietary pattern/quality during pregnancy and mode of birth multinomial analysis

Multinomial analysis					
Mode of birth		p-value	OR	CI 95%	
				Upper	Lower
Instrumental vaginal birth	Health conscious diet group				
	Needs Improvement diet group	0.981	1.0	0.6	1.6
Caesarean section	Health conscious diet group				
	Needs Improvement diet group	0.104	1.4	0.9	2.2

One multivariable logistic regression model was performed to explore the socio-demographic/economic predictors that, together with dietary pattern/quality during pregnancy, could be associated with breastfeeding Table 5-52. Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Goodness of fit were conducted prior to the analysis and supported the quality of this logistic regression model below (Appendix 5-12).

Table 5-52: Dietary pattern/quality multivariable regression analysis socio-demographic model for exploring breastfeeding initiation

Model- group	Guiding question	Variables used in the multivariable analysis	Variables that showed significance	Variables that DID NOT show statistical significance
Socio-demographic/ economic	What are the socio-demographic/economic predictors that together with health conscious diet during pregnancy could be associated with breastfeeding initiation?	Diet, age group, country of birth and educational level	Diet, country of birth and educational level	Age group

Participants more likely to initiate breastfeeding had MSc or PhD level of education (AOR 2.8, 95% CI 1.4-5.7, p=0.004) and were non-Irish (AOR 2.4, 95% CI 1.2-4.7, p=0.010). Participants who were educated to Junior Certificate level or less (AOR 0.2, 95% CI 0.1-0.9, p=0.041), Leaving Certificate/vocational level (AOR 0.3, 95% CI 0.2-0.6, p=0.000), and were in the diet during pregnancy group that needs improvement (AOR 0.3, 95% CI 0.2-0.5, p=0.000) were statistically significantly less likely to initiate breastfeeding (Table 5-53).

Table 5-53: Dietary pattern/quality during pregnancy and socio-demographic predictors for exploring breastfeeding initiation

Predictors for exploring breastfeeding initiation									
Variables	Total n	Breastfeeding initiation				p-value	AOR	CI 95%	
		Yes		No				Lower	Upper
		n	%	n	%				
Education level	552	433	%	119	%				
Junior Cert or less	10	5	50.0	5	50.0	0.041	0.2	0.1	0.9
Leaving Cert/Vocational	113	61	54.0	52	46.0	0.000	0.3	0.2	0.6
Primary degree/PG	267	217	81.6	49	18.4	1.0 (ref)			
MSc/PhD	163	150	92.0	13	8.0	0.004	2.8	1.4	5.7
Diet (cluster)	556	436	%	120	%				
Health conscious	393	338	86.0	55	14.0	1.0 (ref)			
Needs improvement	163	98	60.1	65	39.9	0.000	0.3	0.2	0.5
Country of birth	549	432	%	117	%				
Ireland	122	109	89.3	13	10.7	1.0 (ref)			
Non-Irish	427	323	75.6	104	24.4	0.010	2.4	1.2	4.7

Specific multivariable logistic regression models were also explored for breastfeeding at 3 months postpartum (Table 5-54 and Appendix 5-16). Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Goodness of fit were conducted prior to all analysis and all supported the quality of the logistic regression models below, except for the 'Behaviour/attitude variables – amount of moderate physical activity per week' (Appendix 5-12).

Table 5-54: Dietary pattern/quality multivariable regression analysis models for exploring breastfeeding at 3 months postpartum

Model- group	Guiding question	Variables used in the multivariable analysis	Variables that showed significance	Variables that DID NOT show statistical significance
Socio-demographic/ economic variables (Appendix 5-16)	What are the socio-demographic/economic predictors that, together with health conscious diet during pregnancy, could be associated with breastfeeding practice at 3 months after birth?	Diet, age group, educational level, country of birth, relationship status.	Diet, age group, educational level, country of birth.	Relationship status
Socio-behaviour CHANGES variables (Appendix 5-16)	What are the changes in socio-behaviour (drinking and smoking) predictors that, together with health conscious diet during pregnancy, could be associated with breastfeeding practice at 3 months after birth?	Diet, smoking and drinking behaviour	Diet and smoking behaviour	Drinking behaviour
Behaviour/attitude variables – amount of walking time per week (Appendix 5-16)	What are the behaviours/attitudes during pregnancy predictors that, together with health conscious diet during pregnancy, could be associated with breastfeeding practice at 3 months postpartum?	Diet, amount of walking time per week, dietary supplement intake during pregnancy and breastfeeding advice	Diet and amount of walking time per week	Breastfeeding advice during pregnancy and dietary supplement intake during pregnancy
Behaviour/attitude variables – amount of moderate physical activity per week (Appendix 5-16)	Same as above but with moderate physical activity instead of walking during pregnancy	Diet, amount of moderate physical activity time per week, dietary supplement intake during	Only diet	Amount of moderate physical activity time per week, breastfeeding advice during pregnancy

		pregnancy and breastfeeding advice		and dietary supplement intake during pregnancy
Postpartum mental health – intense anxiety episodes (such as panic attacks) and depression episodes (Appendix 5-16)	What are the mental health predictors (after birth) that, together with health conscious diet during pregnancy, could be associated with breastfeeding practice at 3 months postpartum?	Diet, postpartum intense anxiety episodes (such as panic attacks), postpartum depression episodes and body image after birth	Diet, postpartum intense anxiety episodes (such as panic attacks) and body image after birth	Postpartum depression episodes
Final model (Table 5-55)	All that were significant in this group	Diet, age group, educational level, country of birth, smoking behaviour, amount of walking time per week, postpartum intense anxiety episodes (such as panic attacks) and body image after birth	Diet, age group, educational level and body image after birth	Country of birth, smoking behaviour, amount of walking time per week, postpartum intense anxiety episodes (such as panic attacks)

Table 5-55 shows the final logistic regression model containing all the variables that were statistically significantly associated with breastfeeding at 3 months postpartum. Participants more likely to be breastfeeding at 3 months postpartum were those who have answered 'yes, sometimes' for body image satisfaction after pregnancy (AOR 5.0, 95% CI 1.8-14.0, $p=0.002$). Participants less likely to be breastfeeding at 3 months postpartum were aged 35 or more years (AOR 0.5, 95% CI 0.3-0.9, $p=0.043$), participants educated to Leaving Certificate/vocational level of education (AOR 0.5, 95% CI 0.3-0.9, $p=0.019$) and were in the diet during pregnancy group that needs improvement (AOR 0.4, 95% CI 0.3-0.7, $p=0.000$).

There was no association between breastfeeding at 3 months postpartum and country of birth, smoking behaviour, walking and postpartum intense anxiety episodes (such as

panic attacks); all of which were significant in the specific previous multivariable analysis.

Table 5-55: Dietary pattern/quality during pregnancy and final predictors for exploring breastfeeding at 3 months postpartum

Exploring breastfeeding at 6 months postpartum									
Variables	Total n	Breastfeeding 3 months postpartum				p-value	AOR	CI 95%	
		Yes		No				Lower	Upper
		n	%	n	%				
Age group	464	297	%	167	%				
Up to 29 years	79	34	43	45	57	0.208	0.7	0.5	1.2
30 to 34 years	216	152	70.4	64	29.6	1.0 (ref)			
35 years or more	169	111	65.7	58	34.3	0.043	0.5	0.3	0.9
Education level	460	294	%	166	%				
Junior Cert or less	9	3	33.3	6	66.7	0.151	0.3	0.1	1.5
Leaving Cert/Vocational	79	32	40.5	47	59.5	0.019	0.5	0.3	0.9
Primary degree/PG	221	147	66.5	74	33.5	1.0 (ref)			
MSc/PhD	151	112	74.2	39	25.8	0.268	1.3	0.9	2.2
Diet (cluster)	464	297	%	167	%				
Health conscious	349	246	70.5	103	29.5	1.0 (ref)			
Needs improvement	115	51	44.3	64	55.7	0.001	0.4	0.3	0.7
Body image satisfaction after birth	459	293	%	166	%				
Yes, always	56	50	89.3	6	10.7	1.0 (ref)			
Yes, sometimes	274	169	61.7	105	38.3	0.002	5.0	1.8	14.0
No, never	129	74	57.4	55	42.6	0.558	0.9	0.5	1.4

5.9 Pregnancy, birth, neonatal and postpartum outcomes of diet adequacy/balance

5.9.1 'Adequacy of all macronutrients' (CHOs, protein and fat)

Univariate logistic regression was used to explore the associations between diet adequacy, as determined by participants who met versus did not meet requirements for all three macronutrients, and birth and postpartum variables. There was no statistically significant association found between diet adequacy ('adequacy of all nutrients') and any of the postpartum variables (Table 5-56).

Table 5-56: Dietary ‘adequacy of all macronutrients’ during pregnancy and pregnancy, birth, neonatal and postpartum outcomes

	Full-term		Preterm		OR	95% CI	p-value	χ2	p -value	Phi	p -value
	n	%	n	%							
Yes	203	95.3	10	4.7							
No	331	96.5	12	3.5	0.7	0.3-1.7	0.483	0.495	0.482	_0.030	0.482
‘Adequacy of all macronutrients’	Mode of birth				OR	95% CI	p value	χ2	p -value	Phi	p-value
	Spontaneous vaginal birth		Instrumental vaginal birth and caesarean section								
	n	%	n	%							
Yes	74	34.7	139	65.3	1.0(ref)						
No	123	35.9	220	64.1	0.9	0.7-1.4	0.789	0.072	0.789	_0.011	0.789
‘Adequacy of all macronutrients’	Infant's weight at birth				OR	95% CI	p value	χ2	p -value	Phi	p -value
	<4kg		≥ 4								
	n	%	n	%							
Yes	183	85.9	30	14.1							
No	302	88	41	12	0.8	0.5-1.3	0.464	0.536	0.464	0.031	0.464
‘Adequacy of all macronutrients’	Postpartum depression episodes				OR	95% CI	p value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Yes	172	81.9	38	18.1							
No	273	80.3	67	19.7	1.1	0.7-1.7	0.641	0.218	0.641	0.020	0.641
‘Adequacy of all macronutrients’	Postpartum intense anxiety episodes (such as panic attacks)				OR	95% CI	p value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Yes	177	85.5	30	14.5							
No	290	85.5	49	14.5	1.0	0.6-1.6	0.990	0.000	0.990	_0.001	0.990

‘Adequacy of all macronutrients’	Breastfeeding initiation				OR	95% CI	p value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Yes	47	22.2	165	77.8							
No	73	21.2	271	78.8	0.9	0.6-1.4	0.792	0.070	0.792	_0.011	0.792
‘Adequacy of all macronutrients’	Breastfeeding at 3 months postpartum				OR	95% CI	p value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Yes	63	36	112	64							
No	104	36	185	64	1.0	0.7-1.5	0.998	0.000	0.998	0.000	0.998

Diet and mode of birth (as the primary outcome) was also assessed using multinomial regression analysis (Tables 5-57 and 5-58) and there was no statistically significant association found.

Table 5-57: ‘Adequacy of all macronutrients’ and mode of birth

‘Adequacy of all macro-nutrients’	Mode of birth						χ ²	p - value	Phi	p - value
	Spontaneous vaginal birth		Instrumental vaginal birth		Caesarean section					
	n	%	n	%	n	%				
Yes	74	34.7	67	31.5	72	33.8				
No	123	35.9	107	31.2	113	32.9	0.078	0.982	0.012	0.982

Table 5-58: Dietary ‘adequacy of all macronutrients’ and mode of birth – multinominal regression analysis

Multinomial regression analysis					
Mode of birth		p-value	OR	CI 95%	
				Upper	Lower
Instrumental vaginal birth	‘Adequacy of all macronutrients’				
	No adequacy	0.852	0.9	0.6	1.5
Caesarean section	‘Adequacy of all macronutrients’				
	No adequacy	0.785	0.9	0.6	1.4

Multivariable logistic regression analysis was not performed for diet adequacy and the birth/postpartum outcome variables since none of the univariate analysis showed statistical significance.

5.9.2 Protein to non-protein ratio (P:NP ratio)

The final analysis explored associations were between diet adequacy/balance as determined by P:NP ratio, participants who were above or below the median for P:NP ratio, and birth and postpartum variables.

Compared to participants whose P:NP ratio was above the median, those whose P:NP ratio were below the median were more likely to initiate breastfeeding (OR 1.9, CI 95% 1.3-2.9, p=0.002).

Table 5-59: Dietary ratio of P:NP during pregnancy and pregnancy, birth, neonatal and postpartum outcomes

Table 3-03: Dietary ratio of P:NP during pregnancy, birth, neonatal and postpartum outcomes											
P:NP ratio	Gestational length				OR	95% CI	p-value	χ2	p -value	Phi	p -value
	Full-term		Preterm								
	n	%	n	%							
Above the median	257	97.3	7	2.7							
Below the median	277	94.9	15	5.1	1.9	0.8-4.9	0.140	2.254	0.133	0.064	0.133
P:NP ratio	Mode of birth				OR	95% CI	p value	χ2	p -value	Phi	p- value
	Spontaneous vaginal birth	Instrumental vaginal birth and caesarean section									
		n	%	n							
Above the median	103	39.0	161	61.0	1.0(ref)						
Below the median	94	32.2	198	67.8	1.3	0.9-1.9	0.093	2.822	0.093	0.071	0.093
P:NP ratio	Infant's weight at birth				OR	95% CI	p value	χ2	p -value	Phi	p -value
	< 4		≥ 4								
	n	%	n	%							
Above the median	230	87.1	34	12.9							
Below the median	255	87.3	37	12.7	1.0	0.6-1.6	0.942	0.005	0.942	0.003	0.942
P:NP ratio	Postpartum depression episodes				OR	95% CI	p value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Above the median	216	82.8	45	17.2							
Below the median	229	79.2	60	20.8	1.3	0.8-1.9	0.295	1100	0.294	0.045	0.294

P:NP ratio	Postpartum intense anxiety episodes (such as panic attacks)				OR	95% CI	p value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Above the median	223	85.1	39	14.9							
Below the median	244	85.9	40	14.1	0.9	0.6-1.5	0.790	0.071	0.790	_0.011	0.790
P:NP ratio	Breastfeeding initiation				OR	95% CI	p value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Above the median	42	15.9	222	84.1							
Below the median	78	26.7	214	73.3	1.9	1.3-2.9	0.002	9561	0.002	0.131	0.002
P:NP ratio	Breastfeeding at 3 months postpartum				OR	95% CI	p value	χ2	p -value	Phi	p -value
	No		Yes								
	n	%	n	%							
Above the median	75	32.3	157	67.7							
Below the median	92	39.7	140	60.3	0.1	0.7-1.5	0.998	0.000	0.998	0.000	0.998

Finally, mode of birth as a possible outcome for diet balance/adequacy was explored using multinomial regression (Tables 5-60 and 5-61). Therefore, in this multinomial analysis, spontaneous vaginal birth was compared with both instrumental vaginal birth and caesarean section.

Table 5-60: Dietary ratio of P:NP during pregnancy and mode of birth

P:NP ratio	Mode of birth						χ^2	p - value	Phi	p - value
	Spontaneous vaginal birth		Instrumental vaginal birth		Caesarean section					
	n	%	n	%	n	%				
Above the median	103	39	84	31.8	77	29.2	0.414	0.110	0.089	0.110
Below the median	94	32.2	90	30.8	108	37				

Participants whose P:NP ratio were below the median were statistically less likely to birth spontaneously in comparison to giving birth by caesarean section (OR 0.7, CI 95% 0.4-0.9, $p=0.037$). There was no statistically significant association between diet (P:NP ratio) and giving birth by instrumental vaginal birth in relation to spontaneous vaginal birth.

Table 5-61: Mode of birth multinominal analysis

Mode of birth		p-value	OR	CI 95%	
				Upper	Lower
Instrumental vaginal birth	Above the median (P:NP ratio)	0.441	0.9	0.6	1.3
	Below the median (P:NP ratio)				
Caesarean section	Above the median (P:NP ratio)	0.037	0.7	0.4	0.9
	Below the median (P:NP ratio)				

In order to explore further the relationship P:NP ratio and other predictors of mode of birth, two multinomial multivariable models were performed (Tables 5-62 - 5-63) containing diet (as measured by P:NP ratio), age group, pre-pregnancy BMI and exercise during pregnancy. The first multinomial model measured the amount of walking time during pregnancy, and the second measured the amount of moderate physical activity time per week.

There was no statistically significant association found between diet as measured by P:NP ratio and giving birth by instrumental vaginal birth in comparison to spontaneous vaginal birth. Participants who were aged 35 years or more were more likely to give birth by caesarean section (OR 1.9, CI 95% 1.2-3.1, $p=0.008$) in comparison to spontaneous vaginal birth.

Table 5-62: Dietary ratio of P:NP during pregnancy and other predictors of mode of birth – amount of walking time per week

Variables	Total n	Spontaneous vaginal birth								
		Instrumental vaginal birth				Caesarean section				
		p-value	OR	CI 95%		Total n	p-value	OR	CI 95%	
				Lower	Upper				Lower	Upper
Diet as measured by P:NP ratio	174					185				
P:NP ratio above the median	84	1.0 (ref)				77	1.0 (ref)			
P:NP ratio below the median	90	0.353	1.2	0.8	1.9	108	0.072	1.5	0.9	2.3
Age group	174					185				
Up to 29 years	25	0.113	0.6	0.3	1.1	29	0.166	0.7	0.4	1.2
30 to 34	84	1.0 (ref)				77	1.0 (ref)			
35 or more	65	0.083	1.5	0.9	2.5	79	0.008	1.9	1.2	3.1
Pre-pregnancy BMI	171					179				
Underweight	7	0.992	1.0	0.3	2.9	4	0.403	0.6	0.2	2.1
Ideal	114	1.0 (ref)				112	1.0 (ref)			
Overweight	38	0.245	1.4	0.8	2.4	49	0.058	1.7	0.9	2.9
Obese	12	0.235	0.6	0.3	1.3	14	0.338	0.7	0.3	1.5
Walking	173					183				
≥150 minutes	71	1.0 (ref)				65	1.0 (ref)			
<150 minutes	87	0.259	0.8	0.5	1.2	90	0.442	0.836	0.5	1.3
None	15	0.725	0.9	0.4	1.9	28	0.432	1.4	0.6	2.9

There was no statistically significant association found between diet as measured by P:NP ratio and giving birth by instrumental vaginal birth in comparison to spontaneous vaginal birth. Participants more likely to give birth by caesarean section in comparison to spontaneous vaginal birth were aged 35 years or more (OR 1.8, CI 95% 1.1-2.9, p=0.016) and participants who did no moderate physical activity during pregnancy (OR 2.2, CI 95% 1.1-4.1, p=0.002).

Table 5-63: Dietary ratio of P:NP during pregnancy and other predictors of mode of birth – amount of moderate physical activity time per week

Variables	n total	Spontaneous vaginal birth								
		Instrumental vaginal birth				Caesarean section				
		p-value	OR	CI 95%		p-value	OR	CI 95%		
				Lower	Upper			Lower	Upper	
Diet as measured by P:NP ratio	174					185				
P:NP ratio above the median	84	1.0 (ref)				77	1.0 (ref)			
P:NP ratio below the median	90	0.444	1.1	0.8	1.8	108	0.110	1.4	0.9	2.3
Age group	174					185				
Up to 29 years	25	0.087	0.6	0.3	1.1	29	0.072	0.6	0.3	1.5
30 to 34	84	1.0 (ref)				77	1.0 (ref)			
35 or more	65	0.159	1.4	0.9	2.3	79	0.016	1.8	1.1	2.9
Pre-pregnancy BMI	171					179				
Underweight	7	0.855	1.1	0.4	3.2	4	0.477	0.6	0.2	2.2
Ideal	114	1.0 (ref)				112	1.0 (ref)			
Overweight	38	0.28	1.4	0.8	2.4	49	0.205	1.4	0.8	2.5
Obese	12	0.155	0.6	0.3	1.2	14	0.194	0.6	0.3	1.3
Moderate PA	171					180				
≥150 minutes	34	1.0 (ref)				23	1.0 (ref)			
<150 minutes	66	0.223	0.7	0.4	1.3	59	0.856	0.9	0.5	1.8
None	71	0.911	1.0	0.6	1.9	98	0.020	2.2	1.1	4.1

Chapter Six: Discussion of findings from the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study, strengths and limitations of the study

6.1 Introduction

This chapter discusses the results of the thesis in relation to the current literature and evidence, highlights results that are similar and different, and discusses the underlying plausible explanations. While the chapter is organised in parts, according to each of the study’s objectives, the discussion is integrated throughout. The study’s strengths and limitations are addressed and the chapter concludes with a discussion of the challenges faced in this PhD.

6.2 Part I: Discussion – discussion of the general/primary descriptive findings

The average age of women (32.99 years old) in the study was slightly older than the 30.4 years for first-time mothers nationally (Healthcare Pricing Office 2018). Similar to national statistics, 77.8% of women in the study were Irish, in comparison to 76.3% nationally (Healthcare Pricing Office 2018). Over three-quarters of women (77.9%, n= 433) were educated to degree/PG certificate level or above, considerably higher than the 2016 Irish census data that reported 56.2% of women aged 15-39 years old had a third level qualification (Central Statistics Office 2017a).

The proportion of women in paid employment (92.3%, n=513/556, for both full-time and part-time paid work) was also much higher than for women in Ireland of all ages (53.6% in 2016) and even for women in Europe of all ages (61.4% in 2016) (Central Statistics Office 2017a). The employment rate of women in Ireland by age group reported by the CSO in 2016 was: 63.3% (20-24 years), 77.8% (25-34 years) and 74.6% (35-44 years) (Central Statistics Office 2017b).

Healthy Ireland (2018) reports the proportion of both men and women who have private health insurance by age group in 2017 was: over 30% (18-29 years), less than 40% (30-39 years) and less than 50% (40-49 years) (Department of Health 2018). In this study, 60% of the women had a private insurance.

The women recruited to this study had a higher supplement use before and during pregnancy, lower smoking and drinking alcohol rates, higher breastfeeding intention and breastfeeding rates at 3 months postpartum, as well as greater PA levels, all of which are consistent with the behaviour of women with higher educational attainment.

6.3 Part II: Discussion – general diet adequacy

Self-reported diet quality is subjective since quality relates to nutritional adequacy and the variety of one's diet as well as how it is aligned to the national dietary guidelines (Gresham *et al.* 2016). In this study, the majority of women (67.5%, n=325) thought that their diet before pregnancy was very healthy (8.8%, n=49) or healthy (58.7%, n=326).

The Table below (Table 6-1) compares findings for energy and macronutrient intake from the 'Diet and dietary patterns during pregnancy in nulliparous women in Ireland' study, with findings from a systematic review (Blumfield *et al.* 2012a), from the SLÁN report (2007), and from another Irish study that measured the nutrient intake of pregnant women (n=402) presenting for antenatal care (mean gestational age of 12.6 weeks, ± 2.6) (Mullaney *et al.* 2017).

Table 6-1: Mean energy and macronutrient comparison between the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study and other studies*

Nutrient	‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study (2019)	Europe (2012)	UK (2012)	United States/ Canada (2012)	Australia/ New Zealand (2012)	Japan (2012)	SLÁN 2007	Mullaney et al. (2017)
Energy (calories)	2390 (+495.4)	2198 (+275) (n=27)	2030 (+210) (n=19)	2202 (+173) (n=31)	2213 (+263) (n=31)	1842 (+213) (n=31)	2278	2111
Protein	108.6 (+23.56) 18.2%	85 (+12g) (n=25)	73 (+7g) (n=18)	87 (+11g) (n=29)	87 (+12g) (n=7)	67 (+14g) (n=6)	93 (17%E)	17.3%
Total fat	92.7 (+21.37g) 35%	88 (+17g) (n=27)	85 (+8g) (n=17)	85 (+12g) (n=23)	88 (+11g) (n=7)	62 (+9g) (n=6)	86 (36%E)	36.2%
Saturated fat	35.3 (+9.46g)	34 (+11g) (n=20)	31 (+2g) (n=5)	29 (+4g) (n=12)	41 (+6g) (n=2)	18 (+2g) (n=2)	33 (13%E)	
Polyunsaturated fat	14.4 (+3.85g)	12 (+4g) (n=20)	13 (+1g) (n=3)	17 (+4g) (n=7)	11 (+1g) (n=2)	13g (n=1)	17 (7%E)	
Monounsaturated fat	31.2 (+7.42g)	31 (+7g) (n=18)	25 (+1g) (n=3)	31 (+5g) (n=6)	26g (n=1)	21 (+2g) (n=2)	30 (12%E)	
Carbohydrate	280.4 (+74.67g) 45.6%	268 (+42g) (n=25)	254 (+28g) (n=15)	285 (+31g) (n=21)	271 (+42g) (n=5)	250 (+11g) (n=3)	266	48.1%
Fibre	29.9 (+8.8g)	19 (+5g) (n=13)	17 (+3g) (n=12)	19 (+4g) (n=10)	22 (+1g) (n=3)	15 (+6g) (n=3)		

*Kilojoules (as presented in the SR) were converted to calories in the table here

*n=number of studies

*Table adapted from Blumfield *et al.* (2012a), SLÁN (2007) and Mullaney *et al.* (2007)

Compared to the studies in the systematic review (Blumfield *et al.* 2012a), the mean nutritional values (for mean energy intake and mean macronutrient intake) found in this study were higher than the mean intake found in the SR. Possible reasons for these higher values include the fact that diet was measured in the third trimester, the time in pregnancy when energy requirements are higher, and the relatively high socio-demographic and economic status of this sample. A systematic review of socio-economic differences in the consumption of fruit and vegetables in Europe revealed that a higher socio-economic status was associated with a higher intake of fruits and vegetables and that, therefore, an unhealthier dietary pattern could be related to a lower socio-economic group in Europe (as observed in this study) (De Irala-Estevez *et al.* 2000). The high number of women exceeding the recommended fat intake (especially for saturated fat) in this study is also of concern.

Mean dietary micronutrient intake was below the recommendations for Vitamin B9, Vitamin D, Vitamin E, Calcium and Fluoride (European Food Safety Authority 2017), similar to Mullaney *et al.*'s (2017) findings that pregnant women's diet failed to achieve the recommendations for Vitamin D, B9, Iron and Calcium. The median dietary intakes of Vitamin D during pregnancy was also reported in another Irish study with 64 women and ranged from 1.9–2.1 µg/day (McGowan *et al.* 2011), way below the adequate intake (AI) of 15 µg/day as recommended by the European Food and Safety Authority (EFSA 2017). Similarly, O'Keeffe *et al.* (2016) found that only 0.9% of women's dietary intake (from diet alone) reached the recommended levels for Vitamin D, 36% for Calcium, 17.6% for Iron, and that Folate levels were also low, at 26%. Blumfield *et al.*'s (2013) systematic review findings showed that Folate, Vitamin D intake, and Iron levels, in most geographic regions, were below the national recommendations. Those findings show that studies have consistently found that even women from higher socio-economic groups are not reaching the recommendations for important pregnancy-related micronutrients. For instance, an Irish study involving 897 mother–child pairs found that a higher maternal intake of Vitamin D during pregnancy was linked to a lower risk of developing asthma over a 10-year time period (OR 0.93 per µg/day, 95% CI 0.89 to 0.98) (Viljoen *et al.* 2018), similar to results from several previous studies that have also suggested this association (Litonjua *et al.* 2016, Erkkola *et al.* 2009, Litonjua 2012).

Vitamin A deficiency affects 15% of pregnant women in low-income countries (Gernard *et al.* 2016, Mousa *et al.* 2019). Due to its importance (Gernard *et al.* 2016, Parr *et al.* 2018, Bastos Maia *et al.* 2019), the deficiency of Vitamin A is a public health problem in

some parts of the world (Parr *et al.* 2018, Bastos Maia *et al.* 2019). Conversely, in this PhD study, a high mean intake of Vitamin A (1257.03 µg /day) was found in the participants' diet. The potential for excessive intakes of Vitamin A in pregnancy has raised concerns over the diet of people in developed countries, due to its characteristic high consumption of animal products, fortified foods as well as the use of dietary supplements (Parr *et al.* 2018). Therefore, the final value for Vitamin A could be higher. Similar to deficiency, an excessive intake of Vitamin A during pregnancy is a cause of concern as it might have teratogenic effects in the first 60 days of pregnancy (Bastos Maia *et al.* 2019, Mousa *et al.* 2019). Another study found an association with excess intake of Vitamin A during pregnancy with child asthma (at the age of 7 years) (Parr *et al.* 2018). Therefore, according to the current literature, an adequate intake (both avoiding deficiency and excessive intake) of Vitamin A during pregnancy is vital for both the health of pregnant women and their babies.

Iodine deficiency is still prevalent in developed countries therefore it is important to understand the dietary patterns of Iodine consumption as well as the dietary sources of Iodine so interventions can be planned (Ershow *et al.* 2018). An Irish study presenting national representative data (n=1500, 760 men and 740 women) on the dietary intake of Iodine in the general population (aged 18–90 years) found that Irish females (non-pregnant) in the childbearing age range of 18-35 years old had the lowest mean dietary Iodine intake (95 µg/day) (McNulty *et al.* 2017). It reinforces the idea that IDD still exists in developed countries such as Ireland and even more importantly, women in childbearing age are also in risk of IDD. Another Irish study has suggested that IDD is a public health concern, both in Ireland and in the UK, due to the prevalence of mild-moderate Iodine deficiency among women of childbearing age (O'Kane *et al.* 2016). Nutritional education and health campaigns to increase the knowledge around Iodine among women of childbearing age are needed as an attempt to eradicate Iodine deficiency (O'Kane *et al.* 2016).

The mean intake of dietary Iodine (212.35 µg/day) was found to be above the recommendations (140-200 µg/day) for pregnancy. O'Kane *et al.* (2016) suggests that there is a statistically significant association between Iodine nutritional knowledge and a higher dietary intake of Iodine. Just like Iodine deficiency, the excessive intake of Iodine can cause transient inhibition of thyroid hormone synthesis (Pearce *et al.* 2016). However, this effect is linked to a very high Iodine exposure associated with medical or diagnostic doses (Pearce *et al.* 2016). According to the Institute of Medicine, the upper safe limit of Iodine during pregnancy is 1100 µg/d but is 500 µg/d according to the

WHO (Pearce *et al.* 2016). The European Food and Safety Authority reports 600 µg as safe for pregnant and lactating women, taking into consideration the lack of evidence of adverse effects of this level (Scientific Committee on Food - Scientific Panel on Dietetic Products, Nutrition and Allergies 2006). Having said that, it is clear that the mean intake of Iodine in this study was considerably lower than any of the above safe upper limits for this micronutrient.

6.4 Part III: Discussion – dietary changes and social behaviour changes during pregnancy

Research has shown that regardless of the deleterious effects of alcohol intake during pregnancy to the offspring (Dejong *et al.* 2019, Kelly *et al.* 2009, Patra *et al.* 2011, Andersen *et al.* 2012, Murphy *et al.* 2014, O'Keeffe *et al.* 2016, Popova *et al.* 2017), pregnant women are still drinking alcohol in the peri-conception time period (Dejong *et al.* 2019, Patra *et al.* 2011, McCarthy *et al.* 2013, Murphy *et al.* 2014, O'Keeffe *et al.* 2016, Popova *et al.* 2017). The proportion of women in this PhD study who consumed alcohol, at 6.9%, is even lower than the global prevalence of alcohol use during pregnancy of 9.8% (Dejong *et al.* 2019, Popova *et al.* 2017). Other studies have suggested that pregnant women with higher educational levels are more likely to follow the guidelines about limiting alcohol during pregnancy (Crozier *et al.* 2009a). Complete abstinence from alcohol has been strongly recommended, as no safe threshold has been established so far (Dejong *et al.* 2019, Ceccanti *et al.* 2016, Kahila *et al.* 2016, Fiorentino *et al.* 2017).

The majority of women in this study never smoked cigarettes (57.5%, n=317/550) and only 3.8% (n=21/550) reported continued smoking during their pregnancy. A systematic review and meta-analysis (Lange *et al.* 2018) estimated the prevalence of pregnant women who smoke during pregnancy throughout different regions of the world (Appendix 6-1). In contrast to my study, Ireland came up as the country with the highest prevalence of women smoking during pregnancy (Lange *et al.* 2018); however, these data were based on meta-analyses of five studies conducted over the past 30 years, so may not reflect recent changing trends in smoking. As a response to that study, the Council of the Irish Heart Foundation (ASH Ireland) published a note of caution in November 2018 regarding those figures published in Lange *et al.*'s (2018) systematic review (Doorley & Hanafin 2018). ASH Ireland have stated that more recent Irish studies about smoking during pregnancy have a significantly lower prevalence

than that published in the systematic review (38%) (Doorley & Hanafin 2018). As an example, in a study with more than 42,500 pregnant women in a large hospital site in Dublin, the prevalence of smoking during pregnancy was not only lower (at 10.9%) but also recorded annual decreases in prevalence (Reynolds *et al.* 2017).

Another systematic literature review (17 original papers published between 1997 and 2006 with population-representative samples of pregnant women in high-income countries) reported that women who are younger, have a lower economic level, have many children, do not have a partner or have a partner who smokes, or do not attend the routine antenatal visits are much more likely to smoke during pregnancy (Schneider & Schütz 2008). That could explain why the prevalence of smoking in this sample of nulliparous women, all attending a maternity hospital for antenatal care, was so low. Also another important factor that could have contributed positively to the lower smoking rate found in this study is that a majority of the women had at least a third degree level of education. It has also been reported that the lower the level of education, the greater the probability of smoking (Kandel *et al.* 2009, Riaz *et al.* 2018) and even an increased risk for offspring smoking (Biederman *et al.* 2017, Kandel *et al.* 2009).

Changes in the practice of exercise before and during pregnancy, as an important measure of lifestyle behaviour, were also taken into consideration in this study due to the growing body of literature showing the positive association between regular exercise during pregnancy and improved maternal and fetal outcomes (Barakat *et al.* 2019, Clarke & Gross 2004, Pereira *et al.* 2007, Fell *et al.* 2009, Gaston & Cramp 2011, Nascimento *et al.* 2012, Leppanen *et al.* 2014, Hinman *et al.* 2015, Nascimento *et al.* 2015). However, despite these positive associations, research has been, at the same time, reporting a decrease in physical activity levels during pregnancy (Hamilton *et al.* 2019, Clarke & Gross 2004, Pereira *et al.* 2007, Fell *et al.* 2009, Gaston & Cramp 2011, Leppanen *et al.* 2014, Nascimento *et al.* 2015).

A high proportion of women in the study stated that they were exercising prior to pregnancy (88.4%, n=488/552), and a high proportion of women were walking during pregnancy (89.3%, n=493/552). Just over half of the women were doing at least some moderate physical activity (56.5%, n=308/445). It should be noted though that exercise before pregnancy was measured by “at least 10 minutes” which is very easy to achieve.

Predictors of physical activity during pregnancy according to the literature include higher income and education level (Gaston & Cramp 2011, Leppanen *et al.* 2014), and not having another child at home (Domingues & Barros 2007, Gaston & Cramp 2011, Leppanen *et al.* 2014), both factors present in this study. Other predictors that have been reported in the literature include exercise before pregnancy (Haakstad *et al.* 2009, Owe *et al.* 2009, Gaston & Cramp 2011, Leppanen *et al.* 2014), so women who already exercised before pregnancy were more likely to exercise during pregnancy. In this cohort, 88.4% (n=488/552) of women exercised for at least 10 minutes at a time, at least once per week before pregnancy. According to the literature, women who have a higher pre-pregnancy BMI and/or higher gestational weight gain (Domingues & Barros 2007, Haakstad *et al.* 2009, Owe *et al.* 2009), as well as women who have or develop health problems during pregnancy (such as nausea and vomiting during pregnancy), are less likely to exercise during pregnancy (Owe *et al.* 2009, Leppanen *et al.* 2014).

Measuring possible dietary changes that women could be making to their diet when becoming pregnant was one of the aims of this thesis. Because of that, there were some questions about changes in the intake of certain food items/groups from before to during pregnancy, about changes in the number of meals per day/week, as well as whether they were following any specific diets before and during pregnancy.

6.5 Part IV: Discussion – the use of four different methods of assessing diet

6.5.1 The construct and use of the Alternate Healthy Eating Index for pregnancy in Ireland (AHEI-P (Ireland))

The AHEI-P has been previously used in four studies to measure the overall diet quality/dietary patterns during pregnancy (Rifas-Shiman *et al.* 2009, Rodríguez-Bernal *et al.* 2010, Melere *et al.* 2013, Han *et al.* 2015). A recent American study, from 2019, used the AHEI-P but in the different context of couples planning their first pregnancy (Hsiao *et al.* 2019).

Rifas-Shiman *et al.* (2009), who adapted the healthy eating index for pregnancy (AHEI-P) based on the Alternate Healthy Eating Index (AHEI), reported that a poorer-quality diet was found in women who were younger, less educated, had more children, and had higher pre-pregnancy BMI. Similarly, Han *et al.* (2015) also found that pregnant women who scored higher (highest tertile) were older, had a lower pre-pregnancy BMI,

were more likely to be better educated, have a higher income, were more likely to be married and living with their husbands, were nulliparous and did not smoke regularly before or during pregnancy.

Similar to Melere *et al.* (2013) and Han *et al.* (2015), in this PhD study, the original AHEI-P (from Rifas-Shiman *et al.* 2009) was adapted, and validated, to a diet quality index, AHEI-P (Ireland), based on the Irish and European guidelines, and that would suit the Irish context.

According to the AHEI-P (Ireland), the sample in this PhD study had a relatively high mean score (70.8) and lower index (minimum 47.4, maximum 87.0, SD 5.6), compared to other studies that have also used the AHEI-P: a mean score of 61 (minimum 33, maximum 89, SD 10) (Rifas-Shiman *et al.* 2009); a mean score of 52.4 (minimum 12.6, maximum 94.3, SD 13.8) (Han *et al.* 2015) and a mean AHEI (adapted) score of 54.3 (minimum 35, maximum 75 – on a scale of 100) (Rodríguez-Bernal *et al.* 2010).

The analysis was based on the final total score of the AHEI-P (Ireland), and women were split into two groups: 'diet needs improvement' and 'high quality' diet. Meanwhile, Rifas-Shiman *et al.* (2009) used the AHEI-P score and multivariate-adjusted linear regression models; Han *et al.* (2015) compared maternal characteristics among the mean score of three groups (tertiles), and Rodríguez-Bernal *et al.* (2010) assessed diet quality in a similar adaption of the AHEI in quintiles to adjusted birth weight, birth length, and head circumference as continuous outcomes.

Since there were few studies using the AHEI-P, the dietary analysis found here cannot be compared to many other studies (due to different indices used, and different national dietary guidelines used in the calculation). However, the main purpose of the dietary indices should be to assess compliance to specific recommendations (Previdelli *et al.* 2016), adapted from national guidelines and to the population being investigated (Melere *et al.* 2013), which was the case in this PhD study, justifying the use of this dietary method to assess dietary pattern/quality.

A majority of women were in the 'diet needs improvement' group but that number could have been higher than the reality for two main reasons: the first reason was based on the decision to keep trans fats acids as one of the nine items, because a survey conducted by the Food Safety Authority of Ireland (FSAI) revealed a low content of trans fats acids in pre-packaged products in Ireland (80 out of 100) (Food Safety of

Authority of Ireland 2008). The second reason may be due to the inclusion of composite foods as a source of vegetables and fruits. By taking composite fruits and vegetables (instead of fruits and vegetables alone) into consideration, it helped to increase the final amount of intake and therefore, the final score for fruits and vegetables. Otherwise, not taking composite fruits and vegetables in consideration could introduce bias (O'Brien *et al.* 2003).

The AHEI-P (Ireland) score for Calcium, Folate and Iron (three out of nine components of the AHEI-P (Ireland)) was based on dietary intake alone (and not from supplements); in a cohort with high dietary supplement use during pregnancy. Perhaps by not adding micronutrients from potential dietary supplement intake resulted in women scoring lower in the AHEI-P (Ireland) for those specific micronutrients, but the main idea was to measure their intake from diet alone. Nevertheless, as an attempt to address this issue, dietary supplement use during pregnancy was used as a covariate to adjust the model, similar to Rodríguez-Bernal *et al.*'s work (2010).

A general limitation of the use of indices is that they usually consider a minimum number of portions to be consumed and do not establish limits for high intakes, which may result in a higher gestational weight gain during pregnancy from those women who have really high scores (as there is no upper limit) (Melere *et al.* 2013). That could explain why the 'high quality diet' group (as defined by the AHEI-P (Ireland)) had a non-significant trend towards a higher mean energy intake. Additionally, a trend toward a higher intake of Sodium was found in the 'high quality diet' group. That could be not only because the AHEI-P (Ireland) is grouping women based on a restricted number of items (and that does not include Sodium) but also due to the fact that composite fruits and vegetables were included, which could also be adding a higher content of Sodium (juices, canned soup, canned vegetables, broths and stocks).

6.5.2 The use of cluster analysis

There are few studies that use cluster analysis as a method of assessing dietary pattern/diet quality during pregnancy (Freitas-Vilela *et al.* 2017) and most of them explore the nutritional adequacy of the different patterns found (Okubo *et al.* 2011b, Hoffmann *et al.* 2013, McGowan & McAuliffe 2013) rather than associations with pregnancy, birth, neonatal and postpartum outcomes.

Dietary cluster analysis has been reported as a good method for grouping women based on the similarity of their dietary pattern (Hearty & Gibney 2008, Reedy *et al.* 2010, Sauvageot *et al.* 2017). Dietary cluster analysis is based on the overall diet, different from the AHEI-P (Ireland) that score women based on specific foods and nutrients. Some limitations of the use of cluster analysis include: there is still not a 'gold standard' determining the optimal number of clusters and the determination of the dietary groups created are usually as a result of subjective decisions of the researcher conducting the study (Kim *et al.* 2015, Sauvageot *et al.* 2017).

6.5.3 The construct and use of the adequacy of all macronutrients and the use of the P:NP ratio

Nutritional adequacy is the correlation of an individual's or population's dietary intake and the nutritional requirements stated by health authorities for optimal health (Castro-Quezada *et al.* 2014). Therefore, this method created a binary variable (women who had 'adequacy of all macronutrients' and those who did not) and was developed to explore associations with pregnancy, birth, neonatal and postpartum outcomes. However, there was no statistically significant association between those women who met recommendations (%E) of all macronutrients and those who did not.

The ratio of P:NP dietary intake was the second chosen method to explore the adequacy and balance of diet in relation to pregnancy, birth, neonatal and postpartum outcomes. Its use in this study was inspired by one of the studies included in the SR (Chapter 3) that reported that there is a relationship between maternal macronutrient profile during pregnancy and fetal adiposity and fat distribution (Blumfield *et al.* 2012c, Blumfield *et al.* 2012b).

Exploring the relationship of macronutrient content (after performing analysis of the adequacy of all macronutrients) and pregnancy, birth, neonatal and postpartum outcomes was conducted because there is uncertainty in relation to the optimal macronutrient (P:NP) balance required to improve the short and long-term neonatal outcomes (Blumfield *et al.* 2012c, Blumfield & Collins 2014, Mousa *et al.* 2019). It has been suggested that an imbalanced diet poor in both macro and micronutrients will have a considerable and significant negative impact on pregnancy and neonatal health (Danielewicz *et al.* 2017, Mousa *et al.* 2019). Moreover, it has been suggested that those effects may persist into adulthood and increase the risk of metabolic diseases (Blumfield *et al.* 2012c, Danielewicz *et al.* 2017, Mullaney *et al.* 2017, Mousa *et al.*

2019). A limitation of the use of the dietary method 'adequacy of all macronutrients' as well as the dietary method 'P:NP ratio' is that they do not take into account the quality of macronutrients (fat content, quality of carbohydrates and protein). Almost half of women in the study were above the recommendations for fat and almost all women were above the recommendations for saturated fat, which was possible to assess by comparing intakes to the guidelines as a measure of compliance.

6.5.4 Using different methods to assess diet during pregnancy

Based on the idea that all parts of food and diet should be taken into consideration in nutrition research (Jacobs *et al.* 2009, Jacobs & Tapsell 2013) as one's diet is composed of a diversity of different foods, the need to study dietary patterns and quality emerged.

Human nutrition is complex and the definition of a healthy diet may vary according to which dietary method is being used. In this PhD study, two different dietary methods to measure dietary patterns of more complex analysis were used; they were different from each other in their construction and methodology and perhaps because of that, each of those methods generated sometimes different findings for the same women.

Despite the lack of statistically significant associations between diet measured by P:NP ratio and adequacy of all macronutrients and pregnancy, birth, neonatal and postpartum outcomes, perhaps they could be further explored by using different types of statistical approaches. Macronutrient distribution range for adequacy has a relatively broad range (45-60% for CHOs, 12-20% for protein and, 20-35% for fat) nonetheless, after using the dietary method 'adequacy of all macronutrients' in this study, it raised awareness that despite this, it might not be so easy to reach adequacy of all, as just over one-third of women in this study were able to have a diet with an 'adequacy of all macronutrients'.

The AHEI-P (Ireland) (hypothesis-driven approach) was useful to assess dietary pattern/quality based on nine selected items (three of which were relevant micronutrients for pregnancy); it divided women into two groups: the majority of them with a diet in need of improvement, based on the compliance to national recommendations. Moreover (this will be further discussed in the coming parts of this chapter), there were statistically significant predictors of those dietary patterns (groups) as well as outcomes for women in those specific dietary groups. Perhaps the use of the

AHEI-P (Ireland) early in pregnancy (or even before pregnancy) can be a useful tool as it helps to identify women who are not in the high quality group and the need to offer these women individual dietary advice tailored for their needs.

Cluster analysis (data-driven approach) is a method that also revealed two dietary patterns by using a complex statistical combination of dietary intake. It worked well as a method of establishing different and exclusive dietary patterns with more statistically significant differences in the mean energy and micronutrient intakes between the groups. This method also revealed more variables to be statistically significantly associated with the dietary pattern/quality.

Therefore, findings from the four methods used in this study show that each one answers a different research question in a specific way and that, when used together, provide complementary information that could help to improve public health policies and programmes (Previdelli *et al.* 2016).

6.6 Part V: Discussion – predictors of dietary patterns during pregnancy

6.6.1 Predictors of dietary pattern/quality during pregnancy as determined by the Alternate Healthy Eating Index for pregnancy in Ireland (AHEI-P (Ireland)) and k-means cluster analysis

The only pre-pregnancy predictor variable that showed statistical significance according to both the AHEI-P (Ireland) and cluster analysis in the final logistic regression model was the practice of reading food labels before pregnancy. Both categories showed an association with quality of diet: women who sometimes read and women who never read food labels were both more likely to have a diet during pregnancy that needed improvement in both methods (AHEI-P (Ireland) and cluster analysis).

An Irish study also found a relationship between reading food labels and having a healthier diet in the second trimester of pregnancy (McGowan & McAuliffe 2013). Women from higher socio-demographic/economic groups are more likely to read food labels (Kim *et al.* 2014). The practice of reading food labels, for instance, is related to the level of education that not only influences one's food choices but also enhances

one's ability to interpret the information on food labels (Alkerwi *et al.* 2015). Level of education was one of the other variables included in the final logistic regression from cluster analysis and was statistically significantly associated with diet quality even in a cohort of highly educated women.

A number of other studies have reported the association between a higher educational level and better quality of diet (Wesołowska *et al.* 2019, Savard *et al.* 2019, Northstone *et al.* 2008, Rifas-Shiman *et al.* 2009, McGowan & McAuliffe 2013, Emond *et al.* 2018), as well as association with other socio-demographic, such as being of older age, and lifestyle factors (Northstone *et al.* 2008, McGowan & McAuliffe 2013, Emond *et al.* 2018), and the practice of regular exercise before pregnancy (Emond *et al.* 2018). All those factors were found to be statistically significantly associated to dietary pattern/quality in this PhD study, according to multivariable logistic regression (cluster analysis).

The final pre-pregnancy variable that showed a statistically significant association with dietary pattern/quality during pregnancy (according to cluster analysis) was pre-pregnancy body image satisfaction: women who were sometimes satisfied with their body image before pregnancy were almost twice more likely to have a diet that needed improvement during pregnancy, in comparison with women who were always satisfied with their body image before pregnancy. Body image satisfaction has been suggested to play an important role in weight regulation and gestational weight gain (Henriques *et al.* 2013). Moreover, poor body image is also associated with obesity (Henriques *et al.* 2013) and those factors could explain the association between pre-pregnancy body image and diet quality during pregnancy. However it has also been suggested that it is easier for women to accept body changes during pregnancy without affecting their body image satisfaction (Boscaglia *et al.* 2003, Henriques *et al.* 2013) and perhaps this is the reason why body image during pregnancy no longer showed any association with quality of diet during pregnancy.

According to the AHEI-P (Ireland), two other pre-pregnancy variables showed statistically significant associations with diet during pregnancy in the multivariable logistic regression model: pre-pregnancy BMI and supplement intake before pregnancy. Previous studies have shown also a relationship between pre-pregnancy BMI and quality of diet during pregnancy (Wesołowska *et al.* 2019, Savard *et al.* 2019, Laraia *et al.* 2007, Northstone *et al.* 2008, Emond *et al.* 2018).

Based on self-reported pre-pregnancy BMI, 8.9% (n=48) women were in the BMI range for obesity. There were no women in the very obese BMI range in this study. One Irish study (n=604) where weight and height were measured (pre-pregnancy BMI) in early pregnancy and mean pre-pregnancy BMI was 26.7 (5.6) kg/m² (O'Toole *et al.* 2012). O'Keeffe *et al.* (2016) found that 29% of their total sample (n=718) were overweight or obese.

Besides being a predictor of dietary pattern/quality during pregnancy, a higher pre-pregnancy BMI has been also linked to other complications and adverse pregnancy outcomes for the mother and baby, such as a higher risk of developing gestational diabetes mellitus (Baeten *et al.* 2001, Guelinckx *et al.* 2008, Torloni *et al.* 2009, Muller *et al.* 2018), pre-eclampsia (Gasse *et al.* 2019, Mohammadi *et al.* 2019, Baeten *et al.* 2001, O'Brien *et al.* 2003, Guelinckx *et al.* 2008, Dantas *et al.* 2013, Shao *et al.* 2017), caesarean section (Mohammadi *et al.* 2019, Baeten *et al.* 2001, Guelinckx *et al.* 2008, Kominiarek *et al.* 2010, Pettersen-Dahl *et al.* 2018), infant macrosomia (Mohammadi *et al.* 2019, Baeten *et al.* 2001, Guelinckx *et al.* 2008, Zhao *et al.* 2018) and many others, including long-term effects for the offspring (Mohammadi *et al.* 2019, Guelinckx *et al.* 2008, Godfrey *et al.* 2017, Lahti-Pulkkinen *et al.* 2019).

The proportion of women who took supplements was 64.5% before pregnancy, and 94.4% during pregnancy, similar to proportions reported in an Australian study with pregnant women (n=2146); 64% took supplements before pregnancy and another 88% and 91% that took supplements in the second and third trimester, respectively (Livock *et al.* 2016). In a Norwegian study, 81.4% (n=32,653) of women took at least one supplement during pregnancy (Haugen *et al.* 2008b). Other studies in Ireland have shown that 56.7% (n=228/524) of women in Ireland take dietary supplements during pregnancy (Mullaney *et al.* 2017), and 98.2% (493/502) report taking folic acid supplement during pregnancy (Cawley *et al.* 2018).

The use of supplements before and during pregnancy has also been linked to a higher socio-economic and education level (Nilsen *et al.* 2006, Pouchieu *et al.* 2013) which is in line with the findings of this study, which found that 94.4% of the women took dietary supplements during pregnancy. It has been reported that the number of women taking folic acid supplements before pregnancy is something between 19%-44%, and around 84-96% at any time during pregnancy (and not at the very start) (SafeFood 2017); the lower prevalence of folic acid as a supplement intake before pregnancy could be due to the fact that many pregnancies in Ireland are unplanned (SafeFood 2017).

Another fact that should be noted is that it is important that women start taking folic acid in the periconceptional period when it is a critical time to help decrease the number of neural tube defects (Cawley *et al.* 2018). An Irish study examining folic acid supplementation found that the majority of pregnant women, 56.1% (n=245/437) who reported the timing of when they started taking folic acid supplements (n=437) did not initiate FA supplementation until after their last menstrual period (LMP) (Cawley *et al.* 2018). This is important, as Cawley *et al.* showed that 80.4% (n=46) of women who started taking folic acid supplements 4-8 weeks before their last menstrual period, achieved the optimal level of folate in their red blood cells, while this level was achieved by only 53.6% (n=153) of the pregnant women who started taking folic acid supplements after their last menstrual period ($p<0.001$) (2018).

The use of dietary supplements (especially Folic Acid and Vitamin D) can contribute significantly to achieving the recommended values during pregnancy (Haugen *et al.* 2008b) and the number of women using supplements during pregnancy was very high in this study. On the other hand, due to the adverse health effects of excessive intake of supplements, special attention should be given to which supplements (which micronutrients) are really required for pregnancy. The Food Safety Authority of Ireland's (FSAI) Scientific Committee recommends caution regarding use of dietary supplements, as the only supplements they recommend is Folic Acid for women who are sexually active and Vitamin D3 for infants from birth to 12 months (Food Safety Authority of Ireland 2018). However, the fact that 100% of participants in this study had intakes of Vitamin D that were below recommended levels indicates the need for supplements of this vitamin in pregnancy so women can achieve the recommendations for Vitamin D for pregnancy.

Cluster analysis revealed more pregnancy variables as predictors of dietary pattern/quality during pregnancy than the AHEI-P (Ireland): smoking behaviour, alcohol intake, exercise during pregnancy (both walking during pregnancy and moderate physical activity) and vomiting during pregnancy.

The association of smoking during pregnancy and dietary pattern/quality during pregnancy has also been previously reported in the literature (McGowan & McAuliffe 2013, Emond *et al.* 2018). A systematic review of literature of cigarette smoking and unhealthy dietary patterns of nutrient intake in a non-pregnant population also

concluded that there was a statistically significant difference in dietary intake between those who smoke and those who did not (Dallongeville *et al.* 1998).

Both the American College of Obstetricians and Gynecologists (ACOG) and the Royal College of Obstetricians and Gynaecologists (RCOG) recommend at least 150 minutes of moderate-intensity PA per week during pregnancy (Royal College of Obstetricians and Gynaecologists 2017). Walsh *et al.* (2011) found that 24% (n=84) of pregnant women met the recommendations for more than 30 minutes walking (brisk and easy walking combined) on five or more occasions per week. Despite the health benefits of physical activity during pregnancy (Downs *et al.* 2012, Bisson *et al.* 2016), there are also barriers to the measurement (valid measures) and accurate estimation of PA, and therefore the benefits of PA during pregnancy for the mother and infant (Downs *et al.* 2012). For instance, a recent systematic review and meta-analysis of 54 studies examining the association between PA during pregnancy and infant birth weight (or risks of small or large birth weight) reported that only 10 studies used questionnaires that were specifically validated to assess PA (Bisson *et al.* 2016). Considering this, it is understandable why there is always caution by researchers, clinicians and policies on how to promote PA in a safe manner.

The last pregnancy variable (according to cluster analysis) that was statistically significantly associated with a dietary pattern or quality in need of improvement was vomiting during pregnancy. However, not much is known about the relationship between diet and nausea and vomiting during pregnancy (Crozier *et al.* 2017) and in the available data, there are some inconsistencies in whether women who experience vomiting during pregnancy would be more likely to follow a healthy or unhealthy pattern (Crozier *et al.* 2017).

Regarding pregnancy variables that could be statistically significantly associated with dietary pattern/quality during pregnancy, according to the AHEI-P (Ireland), the only one that showed an association in the multivariable logistic regression model was food cravings. Similarly to nausea and vomiting during pregnancy, experiencing cravings during pregnancy might also induce changes in the diet (Forbes *et al.* 2018) and trigger pregnant women to increase and/or decrease the intake of specific food items (Hill *et al.* 2016).

6.7 Part VI: Discussion – Pregnancy, birth, neonatal and postpartum outcomes of diet during pregnancy

This study aimed to explore a possible relationship between diet during pregnancy (as determined by all four different methods) and seven pregnancy, birth, neonatal and postpartum outcomes: mode of birth (primary outcome), length of gestation, infant's weight at birth, breastfeeding initiation and at 3 months postpartum, depression episodes after birth and intense anxiety or panic attacks after birth.

Mode of birth, as the primary outcome in this PhD study, was explored in relation to all four dietary methods; however, it only showed a statistically significant association with maternal diet during pregnancy according to P:NP ratio in the univariate analysis. None of the studies included in the SR (chapter 3) explored mode of birth as an outcome of diet during pregnancy so, to my knowledge, this was the first study that tried to measure this. Usually studies on diet and nutrition would suggest pre-pregnancy BMI (BMI range for obesity) (Rénes *et al.* 2018, Solmi & Morris 2018, Harvey *et al.* 2018, Shen *et al.* 2018, Marchi *et al.* 2015, Hure *et al.* 2017), gestational diabetes (Boriboonthirunsarn & Waiyanikorn 2016, Zeki *et al.* 2018) and gestational weight gain (excessive GWG) (Bianchi *et al.* 2018, Harvey *et al.* 2018) as strong predictors of mode of birth. Moreover, the four dietary patterns/quality methods used to explore diet during pregnancy in relation to mode of birth used a diet-as-a-whole approach instead of single nutrients or food-groups.

In this PhD study, mode of birth was significantly associated with ratio of P:NP in multinominal regression analysis. However, in the multinominal multivariable analysis, there was no statistically significant association found between diet (as measured by the ratio of P:NP) and mode of birth when including the variables age group, pre-pregnancy BMI, and physical activity during pregnancy as measured by two different variables (amount of walking time per week during pregnancy and amount of moderate physical activity during pregnancy) in the model. This was also an attempt to assess diet, according to the P:NP ratio, as a potential independent (and dependent) factor for mode of birth that has not been explored previously in other studies.

As the proportion of spontaneous vaginal birth were so different to the estimated proportions, the *a priori* sample size calculation was, in retrospect, perhaps not effective. An *a posteriori* estimate of sample size was thus calculated to help future

researchers know how large a sample might be needed to have a more realistic chance of detecting a difference, if it exists. Therefore, the prevalence found in this PhD study was used as an estimate: 0.32 (below the median PNP) instead of 0.5 and 0.39 (above the median PNP) instead of 0.35. A total of 729 participants should be in each group and a final total sample of $n=1458$ participants would be needed.

Two other outcomes were found to be statistically significantly associated with diet during pregnancy: breastfeeding initiation and breastfeeding at 3 months postpartum, both of which were found to be associated with dietary pattern/quality during pregnancy using the AHEI-P (Ireland) and cluster analysis, and their findings were very similar.

Ireland has one of the lowest breastfeeding rates in Europe (Desmond & Meaney 2016, Department of Health 2016, Gallagher *et al.* 2016) and the world (Tarrant *et al.* 2011). Both proportions of women who initiated breastfeeding and who were still breastfeeding at 3 months postpartum in this PhD study were above the national average (Begley *et al.* 2008, Tarrant *et al.* 2011, Theurich *et al.* 2019, Gallagher *et al.* 2016).

Educational level, country of birth and diet pattern/quality, as socio-demographic/economic predictors of breastfeeding initiation in this PhD study, showed statistically significant associations. These findings are in line with previous studies that also found that educational level was a predictor of breastfeeding initiation (Kevany *et al.* 1975, Celi *et al.* 2005, Heck *et al.* 2006, Niela-Vilén *et al.* 2016, Henninger *et al.* 2017). Age and educational level, socio-demographic/economic predictors that were also statistically significantly associated with breastfeeding at 3 months postpartum (in the final multivariable logistic regression model) are also in line with previous Irish studies (Tarrant *et al.* 2011, Ladewig *et al.* 2014, Mullaney *et al.* 2014) and international studies (Henninger *et al.* 2017).

Findings from this study have shown that women aged 35 years and older are more likely to initiate breastfeeding, and that they were more likely (in relation to the reference category) to not be breastfeeding at 3 months postpartum. Due to a number of different reasons, the age of women having their first baby is rising in Ireland and, according to the CSO in Ireland (2017c), the average age of women having their first baby is 31 years old (and 65% are aged between 30 and 39 years). Advanced maternal age has been suggested as a higher risk for pregnancy complications (Lampinen *et al.* 2009), and it has also been suggested that advanced age in

nulliparous women (among other factors) could be associated with a delayed onset of lactogenesis, all factors which could be affecting breastfeeding for those women.

Another statistically significant predictor of breastfeeding initiation in this study was being non-Irish. Another Irish study has even reported maternal nationality as one of the strongest predictors of breastfeeding initiation (Ladewig *et al.* 2014, Gallagher *et al.* 2016). Moreover, both Ladewig *et al.* (2014) and Gallagher *et al.* (2016) suggest that the increase in Irish breastfeeding rates might be due to the increase in immigration instead of as a consequence of public policies.

Findings from this study show that women who were sometimes satisfied with their body image were more likely to breastfeed their babies than those who were always satisfied with their body image 3 months after giving birth. Studies have linked poorer body image concern of women in the overweight and obese BMI range with lower breastfeeding rates (Hauff & Demerath 2012, Swanson *et al.* 2017). In this study, women who were never satisfied with their body image did not show any statistically significant association to breastfeeding at 3 months when compared to women who were always satisfied.

Dietary pattern/quality (according to the AHEI-P (Ireland) and cluster analysis) during pregnancy was also associated with breastfeeding, both initiation and at 3 months postpartum. To my knowledge, this was the first study to use dietary pattern/quality methods as a predictor of breastfeeding initiation and duration. Women who are concerned with their diet during pregnancy, based on their self-awareness of the benefits of healthy eating during pregnancy for them and their babies, are also more likely to breastfeed based on the idea that breastfeeding is the optimal form of nutrition in the first months of life.

6.8 Part VII: Challenges faced in this PhD journey

The construct of this PhD thesis was not grounded on a specific hypothesis but instead was designed to investigate diet as a whole during pregnancy and possible and relevant predictors and outcomes. Every step and decision made was based on the literature and its controversies. It was a very long journey filled with challenges and learning that evolved and developed from the very initial plan as I became more and more immersed in the literature on diet and pregnancy.

The first challenge came with the first decision to investigate diet during pregnancy as a whole (dietary patterns) instead of focusing on one or a set of single nutrients and one or some specific outcomes. The importance of this new approach has been previously discussed in the literature review and methodology chapter.

It was decided to develop and apply the 'Diet and Physical Activity survey' in the third trimester as data were already available from survey 1 when women were recruited to the MAMMI study, in the first trimester of pregnancy, and survey 1 was already a lengthy questionnaire. Then I included questions about dietary habits before pregnancy as well as the usual questions on diet during the whole pregnancy, to try to assess possible changes in the diet from before to during pregnancy. It could be said that women's diet should have been measured at least one more time in the beginning of pregnancy as well as before pregnancy, in order to measure dietary changes from before to during pregnancy, but this was felt to be too great a burden for women who were already being asked to complete two surveys throughout pregnancy and four surveys in the postnatal period, each taking 30 to 45 minutes to complete.

After performing the literature review as well as the systematic review, there was a decision needed as to which tool to use to assess diet during pregnancy. The FFQ chosen seemed to be the most appropriate one for a large cohort study to measure usual dietary intake covering the whole pregnancy and seemed best suited to the study's aim and objectives; bearing in mind that all dietary assessment tools have their strengths and limitations as described in the previous chapters.

The process of validating (face and content validity) the 'Diet and Physical Activity survey' as well as measuring its reliability (test-retest) was a very important step. The appropriateness, meaningfulness and usefulness of the survey (and questions) were analysed from the perspective of pregnant women, researchers and experts in the nutrition field.

It was not possible to find a nutrition software tool that was designed to assess the nutritional content collected directly from the FFQ used, therefore after some consideration and research, Nutritics was chosen as the data analysis tool. A codebook and conversion sheet were then developed in order to adapt the data collected to the dietary software tool developed for food diary use.

Handling the misreporting of dietary intake, often a problem in nutrition research, was another step that needed careful methodological consideration. Almost half of the dietary data inputted in Nutritics was double-checked for errors, every survey was double-checked before being excluded. As already described in the methodology chapter, cut-off limits were adopted (<500 and >3500 kcal/day) and 11.7% of women from the final sample were excluded (n=74/631). This proportion of misreporting was very similar to that found in the SLÁN 2007 survey, where the proportion of over-reporters was 12% (SLÁN 2007). However, excluding women with improbable energy intakes will not guarantee that the included women have not misreported other food items (Meltzer *et al.* 2008).

After having all the dietary data analysed by Nutritics, women's nutrient intake was checked for macronutrient according to the European Food and Safety Authority, 2017, and micronutrient adequacy according to two different guidelines, the European Food and Safety Authority, 2017, and the UK Scientific Advisory Committee on Nutrition/Committee on Medical Aspects of Food and Nutrition Policy, 2017. Another challenge encountered was when I realised how complex it would be to analyse the micronutrient contribution, from supplement intake, to achieve the micronutrient recommendations. Like previous studies, only the prevalence of supplement use was given before and during pregnancy as the calculated micronutrient contribution from supplements is rarely described (Haugen *et al.* 2008b, Livock *et al.* 2016).

The challenge was the complexity of analysing diet as a whole and from four different perspectives (each method has its own limitations). The four methods were chosen also after a meticulous search of literature to measure seven possible outcomes of diet during pregnancy. In order to explore the predictors of diet during pregnancy, only two of the four dietary methods were used: the two dietary methods that set dietary patterns/diet quality as they give a more complete picture (Chen *et al.* 2016).

To my knowledge, the AHEI-P has only been used in a few studies before (Rifas-Shiman *et al.* 2009, Melere *et al.* 2013, Dewi *et al.* 2018) and this is the first time it has been used in Ireland in a pregnant population. Therefore, it was necessary to validate it in an Irish context and the positive feedback from experts encouraged me to go forward with the decision to use it in my PhD thesis. Mullaney *et al.* (2016) had previously reported that a limitation of the AHEI-P was that its use partly depends on nutrient intake data that will require a nutrient analysis software. However, for this PhD, I had to use software anyway for the purpose of giving a very detailed analysis of the diet, and

having a composite quality score for both foods and nutrients, based on Irish and European dietary recommendations, would enable assessment of women's compliance.

The decision to use cluster analysis as a second method of dietary pattern/quality was to give the study a better sense of completeness. The use of dietary cluster analysis was very challenging as it involves advanced statistical analysis but it was very helpful to be able to model the analysis on an Irish study that had previously used this method in a population of pregnant women (McGowan & McAuliffe 2013).

In this study, using two different methods of macronutrient profile/balance and adequacy to explore possible pregnancy, birth, neonatal and postpartum outcomes was not very successful. Perhaps the way the groups were divided, as well as the way the outcome variables (such as birth weight being binary) were also categorised, resulted in not being able to capture a statistically significant association.

Data analysis and interpretation of the results was perhaps the greatest challenge encountered, as well as discussing the findings and how the statistical significance of some variables changed depending on which other variables were entered in the logistic regression model. Exploring logistic regression models with variables divided in subgroups before going directly to a final logistic regression model helped refine and select the final variables.

6.9 Part VIII: Discussion – strengths and limitations of the study

This is a longitudinal study in Ireland investigating maternal diet during pregnancy with a multiple approach to measure diet during pregnancy. In this study, the dietary data were collected using a validated instrument for pregnant women in Ireland, assessing their usual diet throughout pregnancy and diet quality using evidence-based methods. The use of dietary supplements before and during pregnancy (including folic acid intake) and the practice of physical activity was taken into account in the analysis. Other strengths of this study were: the sample size of women who were recruited early in pregnancy and followed up prospectively, the high response and retention rate, and collecting both pre-pregnancy and pregnancy variables. The data collected for specific

outcomes such as length of gestation, mode of birth and infant weight at birth were obtained directly from hospital records. Pre-pregnancy and pregnancy predictors of dietary pattern/quality during pregnancy were explored in relation to two different dietary methods (of assessing dietary pattern/quality). Pregnancy, birth, neonatal and postpartum possible outcomes of diet during pregnancy (as measured by the four different dietary methods) were also investigated. To my knowledge, this was the first study to explore pre-pregnancy and pregnancy mental health and behavioural variables as predictors of dietary pattern/quality as measured by the AHEI-P. In addition, the survey instrument used in this study was found to be both valid and reliable.

Finally, another important strength of this study, already highlighted throughout this thesis and that should be acknowledged, is the inclusion of both a literature review and systematic review. The literature review was very necessary and useful as a basic immersion in the general literature around women's diet before and during pregnancy, nutritional guidelines and the dietary recommendations for pregnancy, and maternal health and social behaviour changes. The literature review also set the scene for the reader by providing an overview of the many aspects that should be taken into consideration when undertaking a study around diet during pregnancy. Furthermore, by performing a SR on diet during pregnancy, among the many contributions, it enabled me to gain in-depth knowledge of studies of high methodological quality and guided some methodological decisions that had to be taken e.g., use of FFQ (as discussed in the previous section).

Nevertheless, there are a number of potential study limitations to note. Since this study cohort was from one maternity hospital and from a higher socio-demographic/economic background and therefore, results cannot be widely generalisable to a national sample level (external validity). Another limitation is that some of the important data used, such as pre-pregnancy weight and height, were self-reported with the limitation that women can over-estimate their heights and under-estimate their weight (Akhtar-Danesh *et al.* 2008, Burton *et al.* 2010, Olfert *et al.* 2018). Nevertheless, self-reported weight and height are often used in epidemiological studies and national surveys (Akhtar-Danesh *et al.* 2008, Gildner *et al.* 2015). Use of self-reported weight and height to calculate BMI has the advantage of being low-cost, less invasive and easier to collect when surveying a larger number of women. Some studies have shown some concordance between pre-pregnancy BMI measured and calculated based on self-reported measurements (Natamba *et al.* 2016, Araújo *et al.* 2017). Taking into consideration variables regarding

mental health and physical activity gave a sense of completeness to the data and context.

Another important limitation was that it was not possible to verify if women reached the recommendations for micronutrients, as the supplement data could not be included in the final nutrient analysis. Therefore, the supplemented micronutrients' contribution to the total micronutrients intake could not be measured, especially when a large number of women were taking supplements during pregnancy and neither were taken into account when scoring for the AHEI-P (Ireland).

Methodological limitations that usually come with any other major study include: choosing one dietary assessment tool over the other; diet in this study was assessed only at one time point but it is important to assess pre-pregnancy diet since there is growing literature linking diet before pregnancy to pregnancy and birth outcomes (Gresham *et al.* 2016). Moreover, measuring diet before pregnancy (rather than during pregnancy, as I did) would have given my study an overall picture of dietary changes. Nevertheless, the data collected were analysed and can still be better explored in different ways as dietary changes were not such an important part of my study and it was still possible to picture food items/groups that women ate more or less of, because they were now pregnant.

Finally, as part of data analysis, it should not be overlooked that the nulliparous women who took part in this study come from a more privileged background and that this will have an impact on the study results. This was a longitudinal study that required pregnant women to complete detailed surveys demanding a certain level of literacy skills and a good knowledge of written and spoken English.

Chapter Seven: Conclusion and recommendations of the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study

7.1 Introduction to the chapter

This chapter concludes the thesis, based on the work conducted as part of this PhD. Recommendations for future research on diet during pregnancy, and for clinicians and public health policy-makers, are identified.

7.2 Conclusion

This PhD study included a cohort of 557 nulliparous women, over three-quarters of whom were born in Ireland, predominantly aged 30 years and older, and had third-level degree education. Nine in ten women were married or living with their partner and could always afford to buy sufficient food for their household. Almost nine in ten were in full-time employment and six in ten had private health insurance. Moreover, the proportion of women breastfeeding at 3 months postpartum was considerably higher than the 35% reported by the HSE in 2015 (Purdy *et al.* 2017). The proportion of women who smoked cigarettes or drank alcohol during pregnancy was low when compared to national and international studies. All the above demographics should be taken into consideration when interpreting the findings of this PhD study. The data show that even these women struggled to meet the Irish and European dietary and lifestyle recommendations for pregnant women.

An accurate assessment of diet, as well as its interpretation, is crucial to determine adequacy of dietary composition and nutritional intake. Therefore, the dietary tool used to assess diet during pregnancy in this study was thoughtfully chosen and validated in a population of pregnant women. Misreporting of diet intake was carefully measured and data were excluded based on a *a priori* low and high cut-off method for dietary energy intake during pregnancy. Reports with a calculated daily energy intake of <500 and >3500 kcal/day were excluded (11.7%, n=74/631). Plausibility of reported energy intake should always be addressed in studies about diet, as misreporting diet is a well-documented problem in research.

Recent research has consistently shown the benefits of adopting a whole diet approach in nutrition research. In order to do this, four different dietary assessment methods were used to explore and assess pregnant women's diet from a whole diet approach. The use of these four approaches permitted a thorough assessment of women's diet during pregnancy.

To assess diet adequacy, measured by 'adequacy of all macronutrients' (CHOs, protein and fat), two groups were created, of which fewer than four in ten women had a diet that met 'adequacy for all macronutrients'. Moreover, macronutrient adequacy was assessed according to the recommended adequacy ranges, for each macronutrient alone: CHOs (45-60%), protein (12-20%) and fat (20-35%), as well as adequacy to the different types of fat (saturated fat, MUFA and PUFA). The vast majority of women (93.9%) were above the recommended level for saturated fat intake (0-10%), thus highlighting the need to assess all macronutrients from a perspective of quality (quality of fats, protein and carbohydrates). Each of these analyses enhanced understanding of women's overall macronutrient intake, and the quality of macronutrients, during pregnancy. The analysis of macronutrients alone identifies a need for action, especially when there is such a large number of pregnant women whose diet included a high intake of saturated fat.

In relation to the adequacy of pregnancy-related micronutrient intake (micronutrients from diet alone), just over half of the women met the recommendations for Calcium (54.4%, n=254) and Iron (53%, n=295), and almost three-quarters met the recommendation for Folate (73.4%, n=409). All of the women were below the recommendations for Vitamin D (100%, n=557). The lack of dietary compliance with specific pregnancy-related micronutrients has also been reported by other Irish and international studies. These findings clearly show that even a cohort of women from higher socio-demographic-economic backgrounds, and from a developed country, might be at risk of micronutrient deficiency during pregnancy, which can lead to adverse sequelae (such as increased risk of asthma in children of mothers with low vitamin D intake (Viljoen *et al.* 2018). Some of the reason for a quarter of the women not meeting the recommendation for Folate levels may be due the drop in the number of foods in Ireland fortified with folic acid (Kelly *et al.* 2016).

Despite the fact that it was not possible to assess the contribution that the intake of dietary supplements made to women's micronutrient intake, a high proportion of women in this study took supplements during pregnancy and this might overcome the

possible micronutrient deficiency during pregnancy. Nevertheless, an important lesson learned is that further studies assessing dietary supplement intake during pregnancy should focus on the intake of dietary supplements within a more specific time period: studies should focus on the perinatal period, before pregnancy and in the very beginning of pregnancy, due to the increased specific micronutrients requirements, especially in Folic Acid. Literature suggests that the benefits of dietary supplement use are greater at the beginning of pregnancy and, in the case of Folic Acid, before (Cawley *et al.* 2018) and up to the first 12 weeks of pregnancy.

The use of protein:non-protein ratio (P:NP) as a second method to assess diet adequacy/balance showed that just over half of the women were below the median (0.09-0.22). Due to the suggested benefits of an optimal proportion of maternal protein intake during pregnancy in order to provide for proper fetal growth, as well as to maintain metabolic homeostasis and health during pregnancy, it was decided to include the use of P:NP ratio as one of the dietary methods used in this PhD study to explore dietary effects on potential pregnancy, birth, neonatal and postpartum outcomes. However, no statistically significant associations were found. Further studies could explore this relationship between P:NP ratio and outcomes.

The use of two different assessments of dietary pattern/quality during pregnancy (AHEI-P (Ireland) and cluster analysis) yielded different results regarding women's diet during pregnancy. The AHEI-P (Ireland) was a useful tool to group pregnant women into two different diet quality groups based on the cut-off point of their overall AHEI-P (Ireland) score. The scores related to the level of compliance of specific food items and pregnancy-related micronutrients (nine items in the AHEI-P (Ireland) scale) in relation to the current nutritional recommendations for pregnancy and national dietary guidelines: $\geq 1,000\text{mg}$ (Calcium), $\geq 400\mu\text{g}$ (Folic Acid) and $\geq 16\text{mg}$ (Iron). The scores (total score as well as the individual score for each of the nine components) generated by the AHEI-P (Ireland) could be used further in clinical practice (antenatal care) to assess the overall quality of pregnant women's diet and, from there, make more specific recommendations and interventions on how they could improve their dietary intake during pregnancy.

Assessment of whole diet, pattern and quality, using cluster analysis permitted an even broader perspective on dietary intake than the other three dietary assessment methods. There is a growing body of literature supporting the idea that researching intake of specific nutrients (and foods) in isolation might not give a realistic picture of an

individual's overall diet, and its impact on health. Current national guidelines and recommendations are now coming to terms of what a diet as a whole should be consistent of, in terms of healthful dietary patterns recommendations (instead of single or specific foods).

I was motivated by trying to understand what pregnant women in Ireland were eating, its overall adequacy and pattern, and also what the potential predictors of dietary pattern/quality during pregnancy were, and how diet during pregnancy could be associated with pregnancy, birth, neonatal and postpartum outcomes. For these reasons, pre-pregnancy and pregnancy predictors of dietary pattern/quality (according to the AHEI-P (Ireland) and dietary cluster analysis) were explored, as well as the possible pregnancy, birth, neonatal and postpartum outcomes of diet during pregnancy in relation to all four dietary assessments methods. Physical activity and other important lifestyle changes (before and during pregnancy) were taken into consideration in the analysis. It is likely that the sample size achieved was not sufficient to identify whether or not diet in pregnancy affects mode of birth, although undertaking physical activity did show a decrease in caesarean section rate.

Socio-demographic, economic, and behavioural changes in lifestyle (before and during pregnancy), and mental health variables were used as potential predictors of dietary pattern/quality during pregnancy, and assessed by two different methods. A number of different pre-pregnancy and pregnancy variables were found to be statistically significantly associated with dietary pattern/quality during pregnancy. Assessing predictors (both pre-pregnancy and pregnancy) of dietary pattern/quality during pregnancy can help to identify women who are at a higher risk of not following a healthy diet during pregnancy and, therefore, are in need of dietary information and dietary advice tailored to their specific needs and circumstances.

Possible pregnancy, birth, neonatal and postpartum outcomes associated with diet during pregnancy in relation to all four methods of assessing diet were investigated. Results showed that pregnant women who had a healthier dietary pattern/quality during pregnancy were significantly more likely to breastfeed (initiation and duration), according to both AHEI-P (Ireland) and cluster analysis.

A number of other pre-pregnancy and pregnancy variables together with dietary pattern/quality during pregnancy also were predictors of breastfeeding initiation and continuation at 3 months postpartum. Those variables include socio-demographic and

economic factors for breastfeeding initiation: women who had an MSc or PhD level of education and were non-Irish were more likely to initiate breastfeeding, while women less likely to initiate breastfeeding were aged ≤ 29 years old, were educated to Junior Certificate level or less, or to Leaving Certificate/vocational level and were in the diet that needed improvement group. Similar socio-demographic and economic factors affecting breastfeeding initiation were found to be predictors of breastfeeding at 3 months postpartum: women less likely to be breastfeeding at 3 months postpartum were aged ≥ 35 years and were educated to Leaving Certificate/vocational level. Moreover, factors related to mental health also made an impact on breastfeeding rates: women more likely to be breastfeeding at 3 months postpartum were sometimes satisfied with their body image.

Two key messages can be drawn from the breastfeeding findings: the first is that breastfeeding promotion and support for all pregnant women is necessary, especially for those at higher risk of not breastfeeding. There are national efforts and a national strategy to promote and increase breastfeeding rates in Ireland. According to the latest studies, the rates of breastfeeding in Ireland are rising, however, Ireland remains with the lowest breastfeeding rate in Europe. On top of that, it has been suggested that the increase in breastfeeding rates is due to immigration.

The second message is about how women with a healthier diet during pregnancy are more likely to breastfeed their babies. Breastmilk is the best mode of infant feeding for at least the first six months of life. That, added to the fact that those babies have already been exposed to a healthier diet in the fetal period, perhaps will be more likely to follow a healthier diet during their infancy and childhood. Further studies are required to explore the impact of those food choices in the offspring's future health. It is important to focus on how to encourage pregnant women at higher risk of not breastfeeding and to understand what their reasons for not breastfeeding are, or even how the breastfeeding promotion message is reaching them.

There were no statistically significant associations between diet during pregnancy and any of the other pregnancy, birth, neonatal and postpartum outcomes. Regardless, the benefits of a healthy diet during pregnancy should be widespread. Moreover, it would benefit further investigation involving each of these four dietary methods as predictors and each of these pregnancy, birth, neonatal and postpartum outcomes by using a different methodological approach, such as using the ratio of P:NP or the AHEI-P (Ireland) in tertiles and infants weight at birth as a linear regression model.

This PhD study also considered important lifestyle behaviours and changes, such as smoking and alcohol consumption, from before to during pregnancy. Despite evidence of the negative effect that smoking and drinking alcohol during pregnancy might have for both the woman and baby, many women continue to do so. Although the prevalence of smoking and alcohol use found in this study were below the national and international rates, 3.8% (n=21/550) and 6.9% (n=38/551) of our respondents smoked and drank alcohol during pregnancy. This may be because of many different reasons, such as the perceived deleterious effects of smoking and drinking (and even the conflicting messages about whether it is safe to do so), social smoking (smoking in social situations), or that it helps them relax and cope with life circumstances. Interventions to combat the intake of alcohol and smoking during pregnancy such as smoking cessation support groups, as well as HSE's Alcohol Programme, are important as it has also been reported that there are no safe levels that can protect the developing baby.

Exercise and physical activity during pregnancy as another important lifestyle behaviour was also included in this PhD study. This PhD study included the IPAQ-SF since it was used previously in other studies in Ireland, as it was suggested as the most appropriate version of measuring physical activity (among the four different IPAQ versions that are available). Therefore, IPAQ-SF was used to measure physical activity before pregnancy and again for pregnancy, with some questions adapted for pregnancy. However, for this PhD study, exercise and physical activity during pregnancy were assessed based on the amount of walking time per week and amount of moderate physical activity time per week during pregnancy and then compared with the recommendations of a minimum of 150 minutes per week.

There was a higher proportion of women who self-reported walking rather than doing moderate physical activity for 150 minutes or more per week during pregnancy and that could be due to many different reasons. Women should be informed, during antenatal care, of the huge benefits of exercise and physical activity during pregnancy (for the woman and baby), and encouraged to exercise. More studies about diet during pregnancy should assess women's habitual level of exercise and physical activity during pregnancy by using a comparable and standardised self-report measure (such as the IPAQ) for accuracy and so comparisons with other study findings can be made.

Understanding better the role of diet before-during pregnancy and pregnancy, birth, neonatal and postpartum outcomes is essential to decreasing and avoiding the deleterious effects for the mother and baby in the short and long term (as suggested by the developmental origins of health and disease hypothesis that many health conditions affecting adults might be triggered during fetal life). Pregnant women would be more open to following dietary recommendations than those in a non-pregnant population.

It is also key to promote better health of the mother, baby and the whole of society as pregnancy presents a window of opportunity and a ‘teachable moment’, as women are more open to lifestyle changes at this time. Nutrition before and during pregnancy, could, along with other healthy lifestyle changes, be one of the most powerful tools to start ending cycles of diet and lifestyle-related diseases and in turn have a positive impact on future generations.

7.3 Recommendations from this thesis

It is recommended that:

- ✓ Midwives, obstetricians and GPs, the main providers of antenatal care, should assess each women’s diet and discuss diet during pregnancy at every antenatal opportunity. This advice should include discussion on adequate intakes of Vitamins A, D, Folic Acid and saturated fat, with referral to a dietitian when appropriate;
- ✓ Midwives, obstetricians and GPs encourage pregnant women, during their first antenatal care visit and at subsequent visits when relevant, to abstain from smoking and alcohol use during pregnancy. During the subsequent visits, it is important, and recommended, to identify women and their partners who may need additional support to stop or at least reduce smoking and alcohol use during pregnancy. These women can be offered attendance at smoking cessation clinics, or QUIT support groups, and support from smoking cessation midwives, already established in many maternity hospitals. Additional information and helpful support on alcohol use is available from information campaigns (such as the information campaign on Fetal Alcohol Spectrum Disorders (FASD) Awareness Day from HSE);

- ✓ As part of encouraging and supporting healthy lifestyle choices during pregnancy, GPs, obstetricians and midwives need to discuss the benefits and safety levels of exercise/physical activity levels during pregnancy, at all antenatal care visits. Healthy pregnant women should be encouraged to continue, or commence, some exercise/physical activity during pregnancy, ideally 150 minutes of moderate-intensity physical activity (such as swimming, cycling, brisk walk, etc.) per week. This has the potential to influence and improve women's psychological and physical well-being, and pregnancy, birth, neonatal and postpartum outcomes. Moreover, exercise/physical activity during pregnancy is known to help prevent excessive gestational weight gain and contribute to a healthy infant weight at birth;
- ✓ As part of antenatal care, midwives, obstetricians and GPs should continue to discuss infant feeding and offer information on breastfeeding-related topics e.g., the importance of breastfeeding and breastfeeding practices, as recommended by the HSE. While the Baby Friendly Hospital Initiative in Ireland started 19 years ago, and is implemented in all maternity units, Ireland still has one of the lowest breastfeeding rates in Europe and therefore continuous efforts to raise the numbers are needed.

It is recommended that policy-makers should:

- ✓ Continue to support the innovation and implementation of easier-to-read nutritional food labels, and educate and encourage the population to read food labels. As part of the work already developed, the Food Safety Authority of Ireland, Health Evidence Network in Europe and the Food and Drug Administration, the federal agency of the United States, have updated their policy for nutritional labels (by 2020/2021). This user-friendly resource may help the population, and women who are pregnant or planning a pregnancy, to make better choices;
- ✓ Create more innovative, supportive and effective strategies and campaigns to encourage and promote breastfeeding, involving partners, other family members, and the general population level. An example of an innovative scheme that could be adopted by the Health Promotion Unit in the HSE is the UK's Breastfeeding Welcome Scheme (<https://www.breastfeedingwelcomescheme.org.uk>);

- ✓ Create more innovative, supportive and effective strategies and campaigns to inspire pregnant women to keep an active lifestyle during pregnancy. The “Get Ireland Active” campaign (<https://www.getirelandactive.ie>), as a national action plan, could be modified for pregnant women, as part of the HSE Health Promotion Unit’s work.

Recommendations for future research

- ✓ Dietary patterns during pregnancy should be investigated by researchers using the whole diet approach instead of the single-nutrient approach (or a limited number of nutrients);
- ✓ Future research on diet during pregnancy should assess diet in each trimester of pregnancy. It should be acknowledged that this might be a burden to participants however it would be very beneficial. By doing so, dietary changes throughout pregnancy can be identified and compared to the trimester-specific recommendations;
- ✓ Micronutrient contribution from dietary supplement use during pregnancy should be measured by researchers, as well as the timing of dietary supplement use: dietary supplement use should focus on the period before conception and first weeks of pregnancy (around the first 12 weeks);
- ✓ Future research on diet during pregnancy should also include the assessment of women’s habitual level of exercise and physical activity during pregnancy and have a sample size large enough ($n \geq 1458$) to be adequately powered to detect any possible association with mode of birth.

7.4 Dissemination

This study developed a ‘Diet and Physical Activity survey’ to assess pregnant women’s diet during pregnancy as well as possible changes that women might be making in their diet and lifestyle from before to during pregnancy. During this PhD study, diet during pregnancy was measured as a whole approach and four dietary methods to measure diet adequacy/balance and pattern/quality were used.

Dissemination of findings from this study has commenced: to date, I have been successful in having one paper published in a peer-reviewed journal, based on preparatory work, and have presented at seven international conferences (Appendix 7-

- 1). An effort will be made to disseminate the findings from this PhD study to women, clinicians, policy-makers and researchers.

Dissemination strategies of the results of this PhD study include:

- ✓ Dissemination of summary of findings on the MAMMI website as well as in the MAMMI newsletter;
- ✓ Publication of findings in peer-reviewed journals:
 - 1) Paper titled: *Diet during pregnancy that contributes to risk factors in the mother, fetus and infant – a systematic review*. Planned submission in April 2020 to the Journal Annual Review of Nutrition.
 - 2) Paper titled: *Overall adequacy of dietary intake of pregnant women in Ireland*. Planned submission in May 2020 to the Nutrition Journal;
 - 3) Paper titled: *The Alternate healthy eating index for pregnancy: adaptation and validation for use in pregnant women in Ireland*. Planned submission in June 2020 to the European Journal of Clinical Nutrition;
 - 4) Paper titled: *Use of two different dietary methods to assess dietary patterns of nulliparous women in Ireland*. Planned submission in July 2020 to the Nutrition Reviews.
- ✓ Presentation of the findings at Nutrition and maternal conferences:
 - 1) Paper titled: Pre-pregnancy and pregnancy predictors of dietary patterns of women in Ireland during pregnancy. Planned to present at Trinity Health and Education International Research Conference (THEconf2020): 'Integrated healthcare: developing person-centred health systems', 04-05th March 2020;
 - 2) Paper titled: Pregnancy, birth, neonatal and postpartum outcomes of dietary patterns of nulliparous women in Ireland. Planned to present at the 7th International Conference on Nutrition and Growth, 26-28th March 2020;
 - 3) Paper titled: Dietary patterns of nulliparous women in Ireland and breastfeeding initiation and duration. Planned to present at the 11th European Lactation Consultants Alliance (Elacta), 15-16th May 2020.

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Appendix 2-1: BMI classification

BMI	Asia-Pacific (WHO, 1997) ¹ (kg/m ²)	WHO (kg/m ²)* ²	Institute of Medicine (IOM) (kg/m ²) ²
Underweight	<18.5	<18.5	<19.8
Normal weight	18.5 – 22.9	18.5 - 24.9	19.8 - 26
Overweight/pre-obese	23 – 24.9	25 – 29.9	>26 – 29
Obesity	>25	30 – 34.9 (I) 35 – 39.9 (II)	>29
Extreme or morbid obesity	-	>40.0	-

*For adults aged over 20 years.

References: (Siega-Riz & Gray 2013)¹, (Lim *et al.* 2017)²

Appendix 2-2: Additional energy cost of pregnancy

Recommendations	1 st trimester (Kcal/day)	2 nd trimester (Kcal/day)	3 rd trimester (Kcal/day)
FAO/WHO 1973 ^{1*}	150	350	350
HYTTEN 1980 ²	300	300	300
RDA 1989 ^{2**}	-	300	300
FAO/WHO/UN 2004 ^{3***}	85	285	475
NNR 2004 ^{5****}	Minimal	358	478
IOM 2005 ^{2,5*****}	-	340	452
JAPAN 2008 ⁶	50	250	500
NICE 2010 ^{7*****}	-	-	200
EFSA (Europe) 2013 ⁴	70	260	500

¹(FAO & WHO 1973) ²(de Freitas *et al.* 2011) ³(FAO 2004) ⁴(EFSA 2013) ⁵(Alavi *et al.* 2013)

*Food and Agriculture Organization/World Health Organization (FAO/WHO) **Recommended Dietary Allowance (RDA) *** Food and Agriculture Organization/World Health Organization/United Nations (FAO/WHO/UN) ****Nordic Nutrition Recommendation

*****Institute of Medicine (IOM) *****National Institute for Health and Care Excellence

Appendix 2-3: Additional protein recommendations for pregnancy

Recommendations	1 st trimester	2 nd trimester	3 rd Trimester
EFSA 2017 ^{1*}	+1g/day	+9g/day	+28g/day
IOM 1989 ^{2**}	0	+25g/day	+25g/day
WHO <i>et al.</i> 2007 ^{3***}	+1g/day	+9g/day	+31g/day

¹(EFSA 2017) – compared to 0.83 g/d for women 18 years old or older ²(Trumbo *et al.* 2002) – Dietary recommendations published as the DRIs (RDA) - an additional intake of +1.3 g/kg/day.

³(WHO *et al.* 2007) *European Food Safety Authority (EFSA) **Institute of Medicine (IOM)

***World Health Organization (WHO)

Appendix 2-4: American Institute of Medicine (IOM): Gestational Weight Gain (GWG) - New Recommendations for Total and Rate of Weight Gain during Pregnancy, by Pre-pregnancy BMI

Pre-pregnancy BMI	BMI* (kg/m ²) (WHO)	Total Weight Gain Range (lbs)	Rates of Weight Gain* 2nd and 3rd Trimester (Mean Range in lbs/wk)
Underweight	< 18.5	28-40	1 (1–1.3)
Normal weight	18.5-24.9	25-35	1 (0.8–1)
Overweight	25.0-29.9	15-25	0.6 (0.5–0.7)
Obese (includes all classification)	>30	11-20	0.5 (0.4–0.6)

* Calculations assume a 0.5–2 kg (1.1–4.4 lbs) weight gain in the first trimester ([Siega-Riz & Gray 2013](#))

Appendix 2-5: Commonly supplemented micronutrients during pregnancy

Some of the common micronutrients ^{1,2}	Suggested effects and side effects ^{1,2,3,4}	Typical composition in a pregnancy vitamin supplement ¹
Vitamin A	+*: fetal development -**: very high doses linked to miscarriage and birth defects (central nervous system and craniofacial, cardiovascular, and thymus development)	Provided as 4,000 IU as beta carotene, 50% of the daily value
Vitamin D3	Vitamin D deficiency more common, especially in high-risk groups such as vegetarians, women who live in cold climates ¹ +: Supplementation decreases the risk of pre-eclampsia; low birth weight and preterm birth ³	400 IU as Cholecalciferol, 100% of the daily value
Vitamin B9 (Folate)	+: Prevention of neural tube defects (NTD), reduced risk for congenital heart disease; placenta development; fetal growth; birth weight and length of pregnancy ¹⁻⁵ ; and protection effect for autism ⁶⁻⁸ -: current research has suggested a possible link between high dose and autism ⁶	800 µg, 100% of the daily value
Vitamin C	Will help absorption of iron ¹	100 mg as ascorbic acid, 167% of the daily value
Calcium	+*: fetal development, high birth weight, reduced risk of preterm delivery, and better blood pressure control (and reduces the risk for preeclampsia) ³⁻⁴ -: excess of calcium associated with an increased risk of developing HELLP (Haemolysis, Elevated Liver enzymes and Low Platelets) syndrome ³ Demand almost double during pregnancy ¹	150 mg as calcium carbonate, 12% of the daily value
Iron	+*: Supplementation associated to improve health outcomes for mother-baby: fetus growth and development; length of pregnancy; birth weight and associated to decrease post-partum hemorrhages ³⁻⁴ and recent studies have associated it to decreased risk for cardiovascular disease on the offspring ³ - oxidative stress, lipid peroxidation, impaired glucose metabolism, and gestational hypertension ³	27 mg as ferrous fumarate, 150% of the daily value

Adapted from ¹(Kominiarek & Rajan 2016) ²(Gernand *et al.* 2016) ³(Marangoni *et al.* 2016) ⁴(Gardiner *et al.* 2008) ⁵(Timmermans *et al.* 2009) ⁶(Wiens & DeSoto 2017) ⁷(Wang *et al.* 2017) ⁸(Gao *et al.* 2016) *Advantages (+) ** Disadvantages (-)

Appendix 2-6: Positive health benefits associated with breastfeeding

To the child (short and long term)	To the mother (short and long term)
Lower rates of obesity ^{1,2,4}	Lower rates of obesity ¹
Lower prevalence of diabetes ^{2,4}	Protection against breast cancer ^{2,4}
Better cognitive development ^{2,3,4}	Possible protection against ovarian cancer and diabetes ²
Protection against childhood infectious diseases ^{2,4} and mortality ^{4,5}	Possible protection against cardiovascular events ⁶
	Possible protection against postpartum depression ^{4,7,8}

¹(Binns *et al.* 2016) ²(Victora *et al.* 2016) ³(Horta *et al.* 2015) ⁴(Mosca & Gianni 2017) ⁵(Sankar *et al.* 2015) ⁶(Nguyen *et al.* 2017) ⁷(Pope & Mazmanian 2016) ⁸(Figueiredo *et al.* 2014)

Appendix 3-1: PEO final search string used on the database searches

PEO	Key words
Population: Pregnant women	(Pregnancy OR pregnant OR antenatal OR prenatal OR gestation OR gestational OR gravida)
Exposure Diet/dietary pattern/nutrition	(Diet OR nutrition OR food OR "health food" OR "health eating" OR "Polyunsaturated fatty acids" OR "Long-chain polyunsaturated fatty acids" OR "Docosahexaenoic acid" OR "Eicosapentaenoic acid" OR supplement OR "food supplements" OR "dietary supplements" OR "diet supplements") ("food frequency" OR "food frequency questionnaire" OR "food survey" OR "food questionnaire" OR "food diary" OR "food behavior" OR "food behaviour" OR "food preferences" OR "food habits" OR "food record" OR "food intake" OR "diet survey" OR "diet record" OR "dietary pattern" OR "dietary factors" OR "dietary intake" OR "dietary changes" OR "dietary quality" OR "diet quality" OR "dietary assessment" OR "diet assessment" OR "diet assessment tool" OR "24-hour recall" OR "24-hour dietary recall" OR "nutrition survey" OR "nutrition assessment" OR "maternal nutrition" OR "maternal diet" OR "eating behaviour" OR eating OR "eating behavior" OR "eating pattern" OR "eating habits" OR "health behavior" OR "health behaviour" OR "energy intake")
Outcome: maternal, fetal and infant outcomes	("pregnancy outcomes" OR "pregnancy complications" OR "maternal health" OR "fetal health" OR "foetal health" OR "Body Mass Index" OR "nutritional status" OR "body composition" OR anthropometry OR "body weight" OR morbidity OR morbidities OR "risk factors" OR "adverse effects" OR comorbidity OR malformation OR "congenital abnormality" OR "birth defects")

Appendix 3-2: Quality Assessment of all papers on diet

Reference	Newcastle Ottawa Scale (adapted) - Food behaviours during pregnancy that contribute to risk factors to the mother, fetus and neonate – a systematic review																		
	SELECTION								OUTCOMES										
	1) Representative of the exposed cohort (Representativeness of diet in pregnant women)				2) Describes adequately how diet is assessed? (Type of tool used, timing of use, way diet was assessed, validated tool)	3) Ascertainment of exposure (How were the data collected)			1) Assessment of outcome				2) Was follow up long enough for outcome to occur (Yes/No)	3) Adequacy of follow-up of cohorts					
	A	B	C	D	A or B	A	B	C	A	B	C	D	A or B	A	B	C	D	E	
	Truly representative of the population (pregnant women)	Somewhat representative	Selected group	No description	A) Yes B) No	Validated FFQ; Food Diary (>=3days); 2-times 24-hour food recall	Another diet assessment method (without any reference to duration used)	No description	Independent blind assessment	Record linkage	Self report	No description	A) Yes B) No <i>select and adequate follow up period for outcome of interest</i>	Complete follow up - all subjects accounted for	Subjects lost to follow-up (<20%) unlikely to introduce bias.	Follow up rate <80% and no description of those lost	No statement	Not applicable	
	Select one of the alternatives: A or B score 1 C or D score 0				Select one of the alternatives: A scores 1 B scores 0	Select one of the alternatives: A scores 1 B or C score 0			Select one of the alternatives: A or B score 1 C or D score 0				Select one of the alternatives: A scores 1 B scores 0	Select one of the alternatives: A or B or E score 1 C or D score 0					TOTAL SCORE
Alberti-Fidanza A, Parizkova J. & Fruttini D. (1995) Relationship between mothers' and newborns' nutritional and blood lipid variables. <i>European Journal of Clinical Nutrition</i> 49, 289-298.		1			0		0			1			1			0			3
Althuizen E., van Poppel MN., Seidell JC. & van Mechelen W. (2009) Correlates of absolute and excessive weight gain during pregnancy. <i>Journal of Women's Health</i> 18, 1559-66.		1			1	1					0		1		1				5

Alwan NA., Greenwood DC., Simpson NA., McArdle HJ. & Cade JE. (2010) The relationship between dietary supplement use in late pregnancy and birth outcomes: a cohort study in British women. <i>BJOG: An International Journal of Obstetrics & Gynaecology</i> 117, 821-829.	1				1		0			1			1		1			5
Alwan NA., Greenwood DC., Simpson NA., McArdle HJ., Godfrey KM. & Cade JE. (2011) Dietary iron intake during early pregnancy and birth outcomes in a cohort of British women. <i>Human Reproduction</i> 26, 911-919.	1				1		0			1			1		1			5
Ankegowda K. & Sumitra Devi M.S. (1976) Birth weight in relation to maternal nutrition. <i>Indian Pediatrics</i> 13, 283-286.	1				0		0			1			1	1				4
Badart-Smoock A., van Houwelingen A.C., Al M.D., Kester A.D. & Hornstra G. (1997) Fetal growth is associated positively with maternal intake of riboflavin and negatively with maternal intake of linoleic acid. <i>Journal of the American Dietetic Association</i> 97, 867-870.		1			0		0					0	1			0		2
Bawadi H.A., Al-Kuran O., Al-Bastoni L.A., Tayyem R.F., Jaradat A., Tuuri G., Al-Beitawi S.N. & Al-Mehaisen L.M (2010) Gestational nutrition improves outcomes of vaginal deliveries in Jordan: an epidemiologic screening. <i>Nutrition Research</i> 30, 110-117.		1			0		0			1			1		1			4
Bergmann M.M., Flagg E.W., Miracle-McMahill H.L. & Boeing H. (1997) Energy intake and net weight gain in pregnant women according to body mass index (BMI) status. <i>International Journal of Obesity</i> 21, 1010-1017.		1			0	1				1			1			0		4

Blumfield M.L., Hure A.J., MacDonald-Wicks L.K., Smith R., Simpson S.J., Giles W.B., Raubenheimer D. & Collins C.E. (2012) Dietary balance during pregnancy is associated with fetal adiposity and fat distribution. <i>The American Journal of Clinical Nutrition</i> 96, 1032-1041.		1			1	1			1			1		1				6
Borgen I., Aamodt G., Harsem N., Haugen M., Meltzer H.M. & Brantsæter A.L. (2012) Maternal sugar consumption and risk of preeclampsia in nulliparous Norwegian women. <i>European Journal of Clinical Nutrition</i> 66, 920-925.	1				1	1			1			1		1				6
Bouwland-Both M.I., Steegers-Theunissen R.P., Vujkovic M., Lesaffre E.M., Mook-Kanamori D.O., Hofman A., Lindemans J., Russcher H., Jaddoe V.W. & Steegers E.A. (2013) A periconceptional energy-rich dietary pattern is associated with early fetal growth: the Generation R study. <i>BJOG: An International Journal of Obstetrics and Gynaecology</i> 120, 435-445.		1			1	1			1			1		1				6
Brantsæter A.L., Haugen M., Samuelsen S.O., Torjusen H., Trogstad L., Alexander J., Magnus P. & Meltzer H.M. (2009) A dietary pattern characterized by high intake of vegetables, fruits, and vegetable oils is associated with reduced risk of preeclampsia in nulliparous pregnant Norwegian women. <i>The Journal of Nutrition</i> 139, 1162-1168.	1				1	1			1			1			0			5

Brantsaeter A.L., Myhre R., Haugen M., Myking S., Sengpiel V., Magnus P., Jacobsson B. & Meltzer H.M. (2011) Intake of Probiotic Food and Risk of Preeclampsia in Primiparous Women. <i>American Journal of Epidemiology</i> 174, 807-815.	1				1	1			1			1			0			5
Canda, M.T., Sezer O. & Demir N. (2011) An audit of seafood consumption awareness during pregnancy and its association with maternal and fetal outcomes in a Turkish population. <i>Journal of Obstetrics and Gynaecology</i> 31, 293-297.	1				0		0		1			1		1				4
Castro M.B., Kac G. & Sichieri R. (2010) Assessment of protein intake during pregnancy using a food frequency questionnaire and the effect on postpartum body weight variation. <i>Cadernos de Saúde Pública</i> 26, 2112-2120.		1			1	1			1			1			0			5
Chatzi L., Melaki V., Sarri K., Apostolaki I., Roumeliotaki T., Georgiou V., Vassilaki M., Koutis A., Bitsios P. & Kogevas M. (2011) Dietary patterns during pregnancy and the risk of postpartum depression: the mother-child 'Rhea' cohort in Crete, Greece. <i>Public Health Nutrition</i> 14, 1663-1670.		1			1	1			1			1			0			5
Chatzi L., Mendez M., Garcia R., Roumeliotaki T., Ibarluzea J., Tardón A., Amiano P., Lertxundi A., Iñiguez C., Vioque J., Kogevas M. & Sunyer J. (2012) Mediterranean diet adherence during pregnancy and fetal growth: INMA (Spain) and RHEA (Greece) mother-child cohort studies. <i>British Journal of Nutrition</i> 107, 135-145.		1			1	1			1			1			0			5

Chavarro J.E., Halldorsson T.J., Leth T., Bysted A. & Olsen S.F. (2011) A prospective study of trans fat intake and risk of preeclampsia in Denmark. <i>European Journal of Clinical Nutrition</i> 65, 944-951.	1				1	1			1				1		1				6
Chong M.F., Chia A.R., Colega M., Tint M.T., Aris I.M., Chong Y.S., Gluckman P., Godfrey K.M., Kwek K., Saw S.M., Yap F., van Dam R.M., Lee Y.S. & GUSTO Study Group. (2015). Maternal Protein Intake during Pregnancy Is Not Associated with Offspring Birth Weight in a Multiethnic Asian Population. <i>The Journal of Nutrition</i> 145, 1303-1310.	1				1	1				1			1			0			5
Clausen T., Slott M., Solvoll K., Devon C.A., Vollset S.E. & Henriksen T. (2001) High intake of energy, sucrose, and polyunsaturated fatty acids is associated with increased risk of preeclampsia. <i>American Journal of Obstetrics and Gynecology</i> 185, 451-458.		1			1	1				1			1		1				6
Cohen G.R., Curet L.B., Levine R.J., Ewell M.G., Morris C.D., Catalano P.M., Clokey D. & Klebanoff M.A. (2001) Ethnicity, nutrition, and birth outcomes in nulliparous women. <i>American Journal of Obstetrics and Gynecology</i> 185, 660-7.		1			0		0			1			1		1				4
Cohen J.F., Rifas-Shiman S.L., Rimm E.B., Oken E. & Gillman M.W. (2011) Maternal trans fatty acid intake and fetal growth. <i>The American Journal of Clinical Nutrition</i> 94, 1241-1247.	1				1	1				1			1			0			5

Conway R., Reddy S. & Davies J. (1999) Dietary restraint and weight gain during pregnancy. <i>European Journal of Clinical Nutrition</i> 53, 849-853.	1			1	1				1			1		1				6
Cosatto V. F., Else P. L. & Meyer B. J. (2010) Do pregnant women and those at risk of developing post-natal depression consume lower amounts of long chain omega-3 polyunsaturated fatty acids? <i>Nutrients</i> 2, 198-213		1		1	1				1			1				0		5
Crawford M. A., Doyle W., Drury P., Lennon A., Costeloe K. & Leighfield M. (1989) n-6 and n-3 fatty acids during early human development. <i>Journal of Internal Medicine</i> Supplement 731, 159-69.			0	0	1				1			1	1					4
Cuco G., Arija V., Iranzo R., Vila J., Prieto M. T. & Fernandez-Ballart J. (2006) Association of maternal protein intake before conception and throughout pregnancy with birth weight. <i>Acta Obstetrica et Gynecologica Scandinavica</i> 85, 413-421.		1		1	1				1			1				0		5
Da Rocha C. M. & Kac G. (2012) High dietary ratio of omega-6 to omega-3 polyunsaturated acids during pregnancy and prevalence of post-partum depression. <i>Maternal & Child Nutrition</i> 8, 36-48.			0	1	1				1			1				0		4

Deierlein A. L., Siega-Riz A. M. & Herring A. (2008) Dietary energy density but not glycemic load is associated with gestational weight gain. <i>American Journal of Clinical Nutrition</i> 88, 693-699.		1			1	1			1			1			0			5
Derbyshire E., Davies J., Costarelli V. & Dettmar P. (2006) Diet, physical inactivity and the prevalence of constipation throughout and after pregnancy. <i>Maternal & Child Nutrition</i> 2, 127-134.		1			1	1			1			1			0			5
Duarte-Salles T., von Stedingk H., Granum B., Gützkow K.B., Rydberg P., Törnqvist M., Mendez M.A., Brunborg G., Brantsæter A.L., Meltzer H.M., Alexander J. & Haugen M. (2013) Dietary Acrylamide Intake during Pregnancy and Fetal Growth-Results from the Norwegian Mother and Child Cohort Study (MoBa). <i>Environmental Health Perspectives</i> 121, 374-379.		1			1	1			1			1		1				6
Dwarkanath P., Barzilay J.R., Thomas T., Thomas A., Bhat S. & Kurpad A.V. (2013) High folate and low vitamin B-12 intakes during pregnancy are associated with small-for-gestational age infants in South Indian women: a prospective observational cohort study. <i>American Journal of Clinical Nutrition</i> 98, 1450-1458.		1			1	1			1			1			0			5
Ebrahimi F., Shariff Z.M., Tabatabaei S.Z., Fathollahi M.S., Mun C.Y. & Nazari M. (2015) Relationship between sociodemographics, dietary intake, and physical activity with gestational weight gain among pregnant women in Rafsanjan City, Iran. <i>Journal of Health, Population and Nutrition</i> 33, 168-176.		1			1	1			1			1	1					6

Englund-Ögge L., Brantsæter A.L., Haugen M., Sengpiel V., Khatibi A., Myhre R., Myking S., Meltzer H.M., Kacarovsky M., Nilsen R.M. & Jacobsson B. (2012) Association between intake of artificially sweetened and sugar-sweetened beverages and preterm delivery: a large prospective cohort study. <i>American Journal of Clinical Nutrition</i> 96, 552-559.	1				1	1			1			1	1					6
Englund-Ögge L., Brantsæter A.L., Sengpiel V., Haugen M., Birgisdottir B.E., Myhre R., Meltzer H.M. & Jacobsson B. (2014) Maternal dietary patterns and preterm delivery: results from large prospective cohort study. <i>The BMJ</i> 348, g1446.	1				1	1			1			1	1					6
Fereidooni B. & Jenabi E. (2014) The use of omega 3 on pregnancy outcomes: a single-center study. <i>Journal of Pakistan Medical Association</i> 64, 1363-1365.		1			0		0		1			1		1				4
Ferland S. & O'Brien H. T. (2003) Maternal dietary intake and pregnancy outcome. <i>The Journal of Reproductive Medicine</i> 48, 86-94.		1			1	1			1			1	1					6
Fowles E.R., Murphey C., Ruiz R.J. (2011) Exploring relationships among psychosocial status, dietary quality, and measures of placental development during the first trimester in low-income women. <i>Biological Research for Nursing</i> 13, 70-79.			0		1	1				0		1	1					4

Gesteiro E., Rodriguez Bernal B., Bastida S. & Sánchez-Muniz F.J. (2012) Maternal diets with low healthy eating index or Mediterranean diet adherence scores are associated with high cord-blood insulin levels and insulin resistance markers at birth. <i>European Journal of Clinical Nutrition</i> 66, 1008-1015.			0		1	1				1			1			0		4
Godfrey K.M., Barker D.J., Robinson S. & Osmond C. (1997) Maternal birthweight and diet in pregnancy in relation to the infant's thinness at birth. <i>BJOG: An International Journal of Obstetrics & Gynaecology</i> 104, 663-667.		1			1	1				1			1		1			6
Godfrey K., Robinson S., Barker D.J., Osmond C. & Cox V. (1996) Maternal nutrition in early and late pregnancy in relation to placental and fetal growth. <i>The BMJ</i> 312, 410-414.		1			1	1				1			1		1			6
Golding J., Steer C., Emmett P., Davis J.M. & Hibbeln J.R. (2009) High levels of depressive symptoms in pregnancy with low omega-3 fatty acid intake from fish. <i>Epidemiology</i> 20, 598-603.	1				0		0				0		1				1	3
Halldorsson T.I., Meltzer H.M., Thorsdottir I., Knudsen V. & Olsen S.F. (2007) Is high consumption of fatty fish during pregnancy a risk factor for fetal growth retardation? A study of 44,824 Danish pregnant women. <i>American Journal of Epidemiology</i> 166, 687-696.	1				1	1				1			1	1				6

Halldorsson T.I., Strøm M., Petersen S.B. & Olsen S.F. (2010) Intake of artificially sweetened soft drinks and risk of preterm delivery: a prospective cohort study in 59,334 Danish pregnant women. <i>American Journal of Clinical Nutrition</i> 92, 626-633.	1				1	1				1			1	1				6
Haugen M., Meltzer H.M., Brantsaeter A.L., Mikkelsen T., Osterdal M.L., Alexander J., Olsen S.F. & Bakketeig L. (2008) Mediterranean-type diet and risk of preterm birth among women in the Norwegian Mother and Child Cohort Study (MoBa): a prospective cohort study. <i>Acta Obstetrica et Gynecologica Scandinavica</i> 87, 319-324.	1				1	1				1			1		1			6
He J.R., Yuan M.Y., Chen N.N., Lu J.H., Hu C.Y., Mai W.B., Zhang R.F., Pan Y.H., Qiu L., Wu Y.F., Xiao W.Q., Liu Y., Xia H.M. & Qiu X. (2015) Maternal dietary patterns and gestational diabetes mellitus: a large prospective cohort study in China. <i>British Journal of Nutrition</i> 113, 1292-1300.	1				1	1				1			1				1	6
Heppe D.H., van Dam R.M., Willemsen S.P., den Breeijen H., Raat H., Hofman A., Steegers E.A. & Jaddoe V.W. (2011) Maternal milk consumption, fetal growth, and the risks of neonatal complications: the Generation R Study. <i>American Journal of Clinical Nutrition</i> 94, 501-509.	1				1	1				1			1		1			6
Johnson A.A., Knight E.M., Edwards C.H., Oyemade U.J., Cole O.J., Westney O.E., Westney L.S., Laryea H. & Jones S. (1994) Dietary intakes, anthropometric measurements and pregnancy outcomes. <i>Journal of Nutrition</i> 124, 936s-942s.			0		1	1				1			1			0		4

Karamanos B., Thanopoulou A., Anastasiou E., Assaad-Khalil S., Albache N., Bachaoui M., Slama C.B., El Ghomari H., Jotic A., Lalic N., Lapolla A., Saab C., Marre M., Vassallo J., Savona-Ventura C.; MGSD-GDM Study Group. (2014) Relation of the Mediterranean diet with the incidence of gestational diabetes. <i>European Journal of Clinical Nutrition</i> 68, 8-13.	1				1	1				1		1		1				6
Klemmensen A., Tabor A., Østerdal M.L., Knudsen V.K., Halldorsson T.I., Mikkelsen T.B. & Olsen S.F. (2009) Intake of vitamin C and E in pregnancy and risk of pre-eclampsia: prospective study among 57 346 women. <i>BJOG: An International Journal of Obstetrics & Gynaecology</i> 116, 964-974.	1				1	1				1		1	1					6
Knudsen V. K., Heitmann B. L., Halldorsson T. I., Sørensen T. I. A. & Olsen S. F. (2013) Maternal dietary glycaemic load during pregnancy and gestational weight gain, birth weight and postpartum weight retention: a study within the Danish National Birth Cohort. <i>British Journal of Nutrition</i> 109, 1471-1478.	1				1	1				1		1	1					6
Knudsen V. K., Orozova-Bekkevold I. M., Mikkelsen T. B., Wolff S. & Olsen S. F. (2008) Major dietary patterns in pregnancy and fetal growth. <i>European Journal of Clinical Nutrition</i> 62, 463-470.	1				1	1				1		1	1					6

Kubota K., Itoh H., Tasaka M., Naito H., Fukuoka Y., Muramatsu Kato K., Kohmura Y.K., Sugihara K., Kanayama N.; Hamamatsu Birth Cohort (HBC) Study Team. (2013). Changes of maternal dietary intake, bodyweight and fetal growth throughout pregnancy in pregnant Japanese women. <i>Journal of Obstetrics and Gynaecology Research</i> 39, 1383-1390.		1			1	1			1			1			0			5
Lagiou P., Mucci L., Tamimi R., Kuper H., Lagiou A., Hsieh C.C. & Trichopoulos D. (2005) Micronutrient intake during pregnancy in relation to birth size. <i>European Journal of Nutrition</i> 44, 52-59.		1			1	1			1			1	1					6
Lagiou P., Tamimi R.M., Mucci L.A., Adami H.O., Hsieh C.C. & Trichopoulos D. (2004) Diet during pregnancy in relation to maternal weight gain and birth size. <i>European Journal of Clinical Nutrition</i> 58, 231-237.		1			1	1			1			1	1					6
Langhoff-Roos J., Lindmark G., Kylberg E., Gebre-Medhin M. (1987) Energy intake and physical activity during pregnancy in relation to maternal fat accretion and infant birthweight. <i>BJOG: An International Journal of Obstetrics & Gynaecology</i> 94, 1178-1185.		1			1	1			1			1	1					6

Langley-Evans A.J. & Langley-Evans S.C. (2003) Relationship between maternal nutrient intakes in early and late pregnancy and infants weight and proportions at birth: prospective cohort study. <i>The Journal of the Royal Society for the Promotion of Health</i> 123, 210-216.			0		1	1				1			1			0			4
Loy S.L., Marhazlina M., Azwany Y.N. & Hamid Jan J.M. (2011) Higher intake of fruits and vegetables in pregnancy is associated with birth size. <i>Southeast Asian Journal of Tropical Medicine and Public Health</i> 42, 1214-1223.	1				1	1				1			1			0			5
Malhotra N., Upadhyay R.P., Bhilwar M., Choy N. & Green T. (2014) The role of maternal diet and iron-folic acid supplements in influencing birth weight: evidence from India's National Family Health Survey. <i>Journal of Tropical Pediatrics</i> 60, 454-460.	1				0		0			1			1				0		3
Maslova E., Halldorsson T.I., Astrup A. & Olsen S.F. (2015) Dietary protein-to-carbohydrate ratio and added sugar as determinants of excessive gestational weight gain: a prospective cohort study. <i>BMJ Open</i> 5(2), e005839.	1				1	1				1			1		1				6
Mathew L.K. & Ko C. (2015) Dietary fat and protein intake are not associated with incident biliary sludge and stones during pregnancy. <i>Journal of Parenteral and Enteral Nutrition</i> 39, 124-128.	1				1	1			1				1		1				6

Mathews F., Yudkin P. & Neil A. (1999) Influence of maternal nutrition on outcome of pregnancy: prospective cohort study. <i>The BMJ</i> 319, 339-343.		1			1	1				1			1	1				6
Mendez M. A., Plana E., Guxens M., Foradada Morillo C. M., Albareda R. M., Garcia-Esteban R., Goñi F., Kogevinas M. & Sunyer J. (2010) Seafood consumption in pregnancy and infant size at birth: results from a prospective Spanish cohort. <i>Journal of Epidemiology & Community Health</i> 64, 216-222.	1				1	1				1			1		1			6
Metcoff J., Costiloe J.P., Crosby W., Bentle L., Seshachalam D., Sandstead H.H., Bodwell C.E., Weaver F. & McClain P. (1981) Maternal nutrition and fetal outcome. <i>American Journal of Clinical Nutrition</i> 34, 708-721.	1				0	1				1			1			0		4
Mikkelsen T.B., Osler M., Orozova-Bekkevold I., Knudsen V.K. & Olsen S.F. (2006) Association between fruit and vegetable consumption and birth weight: a prospective study among 43,585 Danish women. <i>Scandinavian Journal of Public Health</i> 34, 616-622.	1				1	1				1			1	1				6
Mikkelsen T.B., Osterdal M.L., Knudsen V.K., Haugen M., Meltzer H.M., Bakketeig L. & Olsen S.F. (2008) Association between a Mediterranean-type diet and risk of preterm birth among Danish women: a prospective cohort study. <i>Acta Obstetrica et Gynecologica Scandinavica</i> 87, 325-330.	1				1	1				1			1	1				6

Miyake Y., Sasaki S., Yokoyama T., Tanaka K., Ohya Y., Fukushima W., Saito K., Ohfuji S., Kiyohara C., Hirota Y.; Osaka Maternal and Child Health Study Group. (2006) Risk of postpartum depression in relation to dietary fish and fat intake in Japan: the Osaka Maternal and Child Health Study. <i>Psychological Medicine</i> 36, 1727-1735.	1				1	1			1			1						6
Miyake Y., Tanaka K., Okubo H., Sasaki S. & Arakawa M. (2012) Dietary meat and fat intake and prevalence of rhinoconjunctivitis in pregnant Japanese women: baseline data from the Kyushu Okinawa Maternal and Child Health Study. <i>Nutrition Journal</i> 11, 19.	1				1	1			1			1					1	6
Miyake Y., Tanaka K., Okubo H., Sasaki S. & Arakawa M. (2013) Fish and fat intake and prevalence of depressive symptoms during pregnancy in Japan: baseline data from the Kyushu Okinawa Maternal and Child Health Study. <i>Journal of Psychiatric Research</i> 47, 572-578.	1				1	1			1			1					1	6
Miyake Y., Tanaka K., Okubo H., Sasaki S. & Arakawa M. (2015) Intake of dairy products and calcium and prevalence of depressive symptoms during pregnancy in Japan: a cross-sectional study. <i>BJOG: An International Journal of Obstetrics & Gynaecology</i> 122, 336-343.	1				1	1			1			1					1	6

Moore V.M., Davies M.J., Willson K.J., Worsley A., & Robinson J.S. (2004) Dietary composition of pregnant women is related to size of the baby at birth. <i>The Journal of Nutrition</i> 134, 1820-1826.	1				1	1				1			1		1				6
Murakami K., Miyake Y., Sasaki S., Tanaka K., Yokoyama T., Ohya Y., Fukushima W., Kiyohara C., Hirota Y.; Osaka Maternal and Child Health Study Group (2008) Dietary glycemic index and load and the risk of postpartum depression in Japan: the Osaka Maternal and Child Health Study. <i>Journal of Affective Disorders</i> 110, 174-179.	1				1	1				1			1		1				6
Muthayya S., Dwarkanath P., Thomas T., Ramprakash S., Mehra R., Mhaskar A., Mhaskar R., Thomas A., Bhat S., Vaz M. & Kurpad A.V. (2009) The effect of fish and omega-3 LCPUFA intake on low birth weight in Indian pregnant women. <i>European Journal of Clinical Nutrition</i> 63, 340-346.	1				1	1				1			1					1	6
Mwanri A.W., Kinabo J.L., Ramaiya K. & Feskens E.J. (2015) High blood pressure and associated risk factors among women attending antenatal clinics in Tanzania. <i>Journal of Hypertension</i> 33, 940-947.	1				1		0			1			1					1	5
Myhre R., Brantsæter A.L., Myking S., Gjessing H.K., Sengpiel V., Meltzer H.M., Haugen M. & Jacobsson B. (2011) Intake of probiotic food and risk of spontaneous preterm delivery. <i>American Journal of Clinical Nutrition</i> 93, 151-157.	1				1	1				1			1	1					6

Neggens Y. H., Goldenberg R. L., Tamura T., Cliver S. P. & Hoffman H. J. (1997) The relationship between maternal dietary intake and infant birthweight. <i>Acta obstetrica et gynecologica Scandinavica</i> 165, 71-75.			0		0	1			1			1				0		3
North K. & Golding J. (2000) A maternal vegetarian diet in pregnancy is associated with hypospadias. The ALSPAC Study Team. Avon Longitudinal Study of Pregnancy and Childhood. <i>BJU International</i> 85, 107-113.	1				1		0		1			1		1				5
Oken E., Kleinman K. P., Olsen S. F., Rich-Edwards J. W. & Gillman M. W. (2004) Associations of seafood and elongated n-3 fatty acid intake with fetal growth and length of gestation: results from a US pregnancy cohort. <i>American Journal of Epidemiology</i> 160, 774-783.	1				1	1			1			1		1				6
Oken E., Ning Y., Rifas-Shiman S. L., Rich-Edwards J. W., Olsen S. F. & Gillman M. W. (2007) Diet during pregnancy and risk of preeclampsia or gestational hypertension. <i>Annals of Epidemiology</i> 17, 663-8.	1				1	1			1			1		1				6
Okubo H., Miyake Y., Sasaki S., Tanaka K., Murakami K. & Hirota Y. (2011) Dietary patterns during pregnancy and the risk of postpartum depression in Japan: the Osaka Maternal and Child Health Study. <i>British Journal of Nutrition</i> 105, 1251-1257.	1				1	1			1			1		1				6

Okubo H., Miyake Y., Sasaki S., Tanaka K., Murakami K., Hirota Y., Kanzaki H., Kitada M., Horikoshi Y., Ishiko O., Nakai Y., Nishio J., Yamamasu S., Yasuda J., Kawai S., Yanagihara K., Wakuda K., Kawashima T., Narimoto K., Iwasa Y., Orino K., Tsunetoh I., Yoshida J., Ito J., Kaneko T., Kamiya T., Kuribayashi H., Taniguchi T., Takemura H., Morimoto Y., Matsunaga I., Oda H. & Ohya Y. (2012) Maternal dietary patterns in pregnancy and fetal growth in Japan: the Osaka Maternal and Child Health Study. <i>British Journal of Nutrition</i> 107, 1526-33.	1				1	1				1			1	1				6
Olafsdottir A. S., Masnúsardóttir A. R., Thorgeirsdóttir H., Hauksson A., Skuladóttir G. V. & Steinfrímsdóttir L. (2005) Relationship between dietary intake of cod liver oil in early pregnancy and birthweight. <i>BJOG: An International Journal of Obstetrics & Gynaecology</i> 112, 424-9.	1				1	1				1			1				1	6
Olafsdottir A. S., Skuladottir G. V., Thorsdottir I., Hauksson A. & Steingrimsdottir L. (2006) Combined effects of maternal smoking status and dietary intake related to weight gain and birth size parameters. <i>BJOG: An International Journal of Obstetrics & Gynaecology</i> 113, 1296-1302.	1				1	1				1			1				1	6
Olafsdottir A. S., Skuladottir G. V., Thorsdottir I., Hauksson A. & Steingrimsdottir L. 2006. Maternal diet in early and late pregnancy in relation to weight gain. <i>International Journal of Obesity</i> 30, 492-499.	1				1	1				1			1				1	6

Olafsdottir A. S., Skuladottir G. V., Thorsdottir I., Hauksson A., Thorgeirsdottir H. & Steingrimsdottir L. (2006). Relationship between high consumption of marine fatty acids in early pregnancy and hypertensive disorders in pregnancy. <i>BJOG: An International Journal of Obstetrics & Gynaecology</i> 113, 301-309.	1				1	1				1			1		1			6
Olsen S. F. & Secher N. J. (2002) Low consumption of seafood in early pregnancy as a risk factor for preterm delivery: prospective cohort study. <i>The BMJ</i> 324, 447.	1				0		0			1			1		1			4
Olsen S. F., Halldorsson T. I., Willett W. C., Knudsen V. K., Gillman M. W., Mikkelsen T. B. & Olsen J. (2007) Milk consumption during pregnancy is associated with increased infant size at birth: prospective cohort study. <i>American Journal of Clinical Nutrition</i> 86, 1104-1110.	1				1	1				1			1	1				6
Olsen S. F., Hansen H. S., Secher N. J., Jensen B. & Sandstrom B. (1995) Gestation length and birth weight in relation to intake of marine n-3 fatty acids. <i>British Journal of Nutrition</i> 73, 397-404.	1				0		0			1			1		1			4
Olsen S. F., Osterdal M. L., Salvig J. D., Kesmodel U., Henriksen T. B., Hedegaard, M. & Secher N. J. (2006) Duration of pregnancy in relation to seafood intake during early and mid pregnancy: prospective cohort. <i>European Journal of Epidemiology</i> 21, 749-758.	1				0		0			1			1				1	4

Pereira-da-Silva L., Cabo C., Moreira A. C., Papoila A. L., Virella D., Neves R., Bridges K. M. & Cordeiro-Ferreira G. (2015) The effect of long-chain polyunsaturated fatty acids intake during pregnancy on adiposity of healthy full-term offspring at birth. <i>Journal of Perinatology</i> 35, 177-180.			0		1	1			1				1				0		4
Philippis C. & Johnson N. E. (1977) The impact of quality of diet and other factors on birth weight of infants. <i>American Journal of Clinical Nutrition</i> 30, 215-225.	1				0			0		1			1					1	3
Radesky J. S., Oken E., Rifas-Shiman S. L., Kleinman K. P., Rich-Edwards J. W. & Gillman M. W. (2008) Diet during early pregnancy and development of gestational diabetes. <i>Paediatric and Perinatal Epidemiology</i> 22, 47-59.	1				1	1				1			1		1				6
Ramon R., Ballester F., Iniguez C., Rebagliato M., Murcia M., Esplugues A., MARCO, A., Garcia de la Hera M. & Vioque J. (2009) Vegetable but not fruit intake during pregnancy is associated with newborn anthropometric measures. <i>The Journal of Nutrition</i> 139, 561-567.	1				1	1				1			1		1				6
Rasmussen M. A., Maslova E., Halldorsson T. I. & Olsen, S. F. (2014) Characterization of dietary patterns in the Danish national birth cohort in relation to preterm birth. <i>PLOS One</i> 9, e93644.	1				1	1				1			1			0			5

Rodriguez-Bernal C. L., Rebagliato M., Iniguez C., Vioque J., Navarrete-Munoz E. M., Murcia M., Bolumar F., Marco A. & Ballester F. (2010) Diet quality in early pregnancy and its effects on fetal growth outcomes: the Infancia y Medio Ambiente (Childhood and Environment) Mother and Child Cohort Study in Spain. <i>American Journal of Clinical Nutrition</i> 91, 1659-1666.	1				1	1			1		1		1		1			6
Rogers I., Emmett P., Ness A. & Golding J. (2004) Maternal fish intake in late pregnancy and the frequency of low birth weight and intrauterine growth retardation in a cohort of British infants. <i>Journal of Epidemiology and Community Health</i> 58, 486-492.	1				1	1			1		1		1		1			6
Rumbold A. R., Maats F. H. & Crowther C. A. (2005) Dietary intake of vitamin C and vitamin E and the development of hypertensive disorders of pregnancy. <i>European Journal of Obstetrics & Gynecology and Reproductive Biology</i> 119, 67-71.		1			1	1			1		1		1		1			6
Sabour H., Hossein-Nezhad A., Maghbooli Z., Madani F., Mir E. & Larijani B. (2006) Relationship between pregnancy outcomes and maternal vitamin D and calcium intake: A cross-sectional study. <i>Gynecological Endocrinology</i> 22, 585-589.		1			1	1			1		1					0		5

Saldana T. M., Siega-Riz A. M. & Adair L. S. (2004) Effect of macronutrient intake on the development of glucose intolerance during pregnancy. <i>American Journal of Clinical Nutrition</i> 79, 479-486.	1				1	1				1			1	1				6
Sartorelli D. S., Barbieri P. & Perdoni G. C. (2014) Fried food intake estimated by the multiple source method is associated with gestational weight gain. <i>Nutrition Research</i> 34, 667-673.		1			1	1				1			1	1				6
Scholl T. O., Chen X., Khoo C. S. & Lenders C. (2004) The dietary glycemic index during pregnancy: influence on infant birth weight, fetal growth, and biomarkers of carbohydrate metabolism. <i>American Journal of Epidemiology</i> 159, 467-474.			0		0	1				1			1			0		3
Sengpiel V., Bacelis J., Myhre R., Myking S., Devold Pay A. S., Haugen M., Brantsaeter A. L., Meltzer H. M., Nilsen R. M., Magnus P., Vollset S. E., Nilsson S. & Jacobsson B. (2014) Folic acid supplementation, dietary folate intake during pregnancy and risk for spontaneous preterm delivery: a prospective observational cohort study. <i>BMC Pregnancy and Childbirth</i> 14, 375.	1				1	1				1			1		1			6

Siega-Riz A. M., Herrmann T. S., Savitz D. A. & Thorp J. M. (2001) Frequency of eating during pregnancy and its effect on preterm delivery. <i>American Journal of Epidemiology</i> 153, 647-652.			0		0		0				0		1	1				2
Siega-Riz A. M., Savita D. A., Zeisel S. H., Thorp J. M. & Herring A. (2004) Second trimester folate status and preterm birth. <i>American Journal of Obstetrics & Gynecology</i> 191, 1851-1857.		1			1	1				1			1			0		5
Sontrop J., Avison W. R., Evers S. E., Speechley K. N. & Campbell M. K. (2008) Depressive symptoms during pregnancy in relation to fish consumption and intake of n-3 polyunsaturated fatty acids. <i>Paediatric and Perinatal Epidemiology</i> 22, 389-399.		1			1	1				1			1			0		5
Strom M., Mortensen E. L., Halldorsson T. I., Thorsdottir I. & Olsen S. F. (2009) Fish and long-chain n-3 polyunsaturated fatty acid intakes during pregnancy and risk of postpartum depression: a prospective study based on a large national birth cohort. <i>The American Journal of Clinical Nutrition</i> 90, 149-155.	1				1	1				1			1			0		5
Szzallai M., Faist V., Veitl V., Wagenbichler P. & Elmadfa I. (1994) Nutrient intake and nutritional status in the third trimester of pregnancy. <i>Bibliotheca Nutritio et Dieta</i> 51, 52-55.		1			0	1				1			1	1				5

Timmermans S., Steegers-Theunissen R. P., Vujkovic M., Den Briel H., Russcher H., Lindemans J., Mackenbach J., Hofman A., Lesafre E. E., Jaddoe V. V. & Steegers E. A. (2012) The Mediterranean diet and fetal size parameters: the Generation R Study. <i>British Journal of Nutrition</i> 108, 1399-1409.	1				1	1			1				1			0			5
Torjusen H., Brantsaeter A. L., Haugen M. & Alexander J., Bakketeig L.S., Lieblein G., Stigum H., Næs T., Swartz J., Holmboe-Ottesen G., Roos G. & Meltzer H.K. (2014) Reduced risk of pre-eclampsia with organic vegetable consumption: results from the prospective Norwegian Mother and Child Cohort Study. <i>BMJ Open</i> 4, e006143.	1				1	1				1			1			0			5
Vazjdos S., Kac G., Emmett P., Davis J. M., Golding J. & Hibbeln J. R. (2013) Dietary patterns, n-3 fatty acids intake from seafood and high levels of anxiety symptoms during pregnancy: findings from the Avon Longitudinal Study of Parents and Children. <i>PLOS One</i> 8, e67671.	1				0	1				1			1			0			4
Watson P. E. & McDonald B. W. (2010) The association of maternal diet and dietary supplement intake in pregnant New Zealand women with infant birthweight. <i>European Journal of Clinical Nutrition</i> 64, 184-93.		1			0	1				1			1		1				5
Weigel M. M., Narvaez W. M., Lopez A., Felix C. & Lopez P. (1991) Prenatal diet, nutrient intake and pregnancy outcome in urban Ecuadorian primiparas. <i>Archivos latinoamericanos de nutrición</i> 41, 21-37.		1			1	1				1			1	1					6

Wong A. C. & Ko C. W. (2013) Carbohydrate intake as a risk factor for biliary sludge and stones during pregnancy. <i>Journal of Clinical Gastroenterology</i> 47, 700-705.		1			1	1				1			1			0			5
Yoshihiro M., Keiko T., Hitomi O., Satoshi S. & Masashi A. (2015) Dietary vitamin D intake and prevalence of depressive symptoms during pregnancy in Japan. <i>Nutrition</i> 31, 160-165.	1				1	1				1			1		1				6
Zielinsky P., Piccoli A. L., JR., Manica J. L., Nicoloso L. H., Menezes H., Busato A., Moraes M. R., Silva J., Bender L., Pizzato P., Aita L., Alievi M., Vian I. & Almeida L. (2010) Maternal consumption of polyphenol-rich foods in late pregnancy and fetal ductus arteriosus flow dynamics. <i>Journal of Perinatology</i> 30, 17-21.			0		0			0	1				1					1	3

Appendix 3-3: Characteristics of the studies included in the systematic review

#	Author, year	Study title, Source Journal	Country/ Sample size	Study aim	Study design	Population demographics/char- acteristics: age, socio-economic group, nationalities, etc.	Data collection methods (e.g. FFQ, food diary...) + Characteristics	Timing of ascertain- ment (antenatal, postpartum)	Physical Activity
Women and Their Children's Health Study - WATCH study	Blumfield et al. (2012)	Dietary balance during pregnancy is associated with fetal adiposity and fat distribution. <i>American Journal of Clinical Nutrition</i>	Australia - 179 participants	"To investigate the association between maternal nutrition during pregnancy and intrauterine development of fetal body composition"	Prospective cohort	Australian women recruited from the antenatal clinic at the John Hunter Hospital from July 2006 to December 2007, with singleton pregnancies and that were presents on at least one of the four study visits	74-item food- frequency questionnaire (FFQ), two times	Antenatal: Early pregnancy: between 18- 24 weeks (referring to diet during week 6–24) and again during late pregnancy between 36- 40 week of gestation (referring to diet during week 24-40)	No
	Conway et al. (1999)	Dietary restraint and weight gain during pregnancy. <i>European Journal of Clinical Nutrition</i>	England - 62 participants	"To explore dietary intake and weight gain during pregnancy in relation to dietary restraint"	Longitudinal prospective	Healthy Caucasian, expecting their first or second singleton baby, over 18 years.	Self- administered, 7- d weighed diet record (administered two dietary records)	Antenatal: Early and late pregnancy	No

Norwegian Mother and Child Cohort Study -MoBa Study	Duarte-Salles et al. (2013)	Dietary Acrylamide Intake during Pregnancy and Fetal Growth-Results from the Norwegian Mother and Child Cohort Study (MoBa) <i>Environmental Health Perspectives (EHP)</i>	Norway - 50651 participants	"To assess associations of prenatal exposure to dietary acrylamide with small for gestational age (SGA) and birth weight"	Prospective cohort	Pregnant women who were recorded in the Medical Birth Registry of Norway (MBRN) and had singleton births, did not birth < 28 weeks or > 42 weeks and completed questionnaires 1 and 3	Semi-quantitative and self-administered 255 item FFQ	Antenatal: At gestational week 17-22 (measuring the dietary habits and intake of supplements during the first 4-5 months of pregnancy)	No (they had PA questionnaires in the MoBa study but not taken into consideration in this one)
	Ebrahimi et al. (2015)	Relationship between socio-demographics, dietary intake, and physical activity with gestational weight gain among pregnant women in Rafsanjan City, Iran. <i>Journal of Health, Population and Nutrition (JHPN)</i>	Iran - 308 participants	"To assess the relationship between sociodemographics, dietary intake, and physical activity with GWG"	Cross-Sectional	Iranian women, aged between 18-35, with a singleton pregnancy in the third trimester, from seven healthcare centres in Rafsanjan city, Iran	Two days' 24-hour recalls, interviewed administered and portion sizes described in household measures	Antenatal: Third trimester	Yes

Norwegian Mother and Child Cohort Study - MoBa Study	Englund-Ogge et al. (2012)	Association between intake of artificially sweetened and sugar-sweetened beverages and preterm delivery: a large prospective cohort study. <i>European Journal of Clinical Nutrition</i>	Norway - 60761 participants	"To further investigate the suggested connection between intake of AS beverages and preterm delivery."	Prospective cohort	Pregnant women who were recorded in the Medical Birth Registry of Norway (MBRN) and had singleton births. <u>Exclusion criteria:</u> women with any diagnosis of pre-existing or gestational diabetes	Semi-quantitative and self-administered questionnaire with 255 items	Antenatal: At gestational week 17-22 (measuring the dietary habits and intake of supplements during the first 4-5 months of pregnancy)	No (they had PA questionnaires in the MoBa study but not taken into consideration in this one)
Norwegian Mother and Child Cohort Study - MoBa Study	Englund-Ogge et al. (2014)	Maternal dietary patterns and preterm delivery: results from large prospective cohort study. <i>British Medical Journal</i>	Norway - 66000 participants	"To examine whether an association exists between maternal dietary patterns and risk of preterm delivery"	Prospective cohort	Pregnant, non-smoking women who were recorded in the Medical Birth Registry of Norway (MBRN) and women who had a singleton birth. <u>Exclusion criteria:</u> women who pregnancy lasted less than 22+0 or more than 41+6 gestational weeks	256 semi-quantitative and self-administered questionnaire	Antenatal: At gestational week 17-22 (measuring the dietary habits and intake of supplements during the first 4-5 months of pregnancy)	No (they had PA questionnaires in the MoBa study but not taken into consideration in this one)

	Eshqiri et al. (2016)	Gestational dietary patterns are not associated with blood pressure changes during pregnancy and early postpartum in a Brazilian prospective cohort. <i>European Journal of Nutrition</i>	Brazil - 191 participants	"To identify gestational dietary patterns empirically and evaluate the association between these dietary patterns and the prospective changes in SBP and DBP during pregnancy and the early postpartum period in a Brazilian sample of healthy women"	Prospective cohort	Women with a singleton pregnancy (<13 weeks at enrolment) aged between 20-40 years old and free from any infectious or chronic diseases - except for obesity.	82-item Food Frequency Questionnaire (FFQ) -interview administered	Antenatal: third trimester with diet being measured in the first 6 months prior to interview	No
Medical Research Council Environmental Epidemiology Unit (University of Southampton)	Godfrey et al. (1996)	Maternal nutrition in early and late pregnancy in relation to placental and fetal growth. <i>British Medical Journal</i>	England - 539 participants	"To assess how nutrient intakes of mothers in early and late pregnancy influence placental and fetal growth"	Prospective observational	Caucasian women, ≥ 16 years with singleton pregnancies who attended the midwives' antenatal booking clinic (< 17 weeks)	2 times FFQ: interviewed, 100-food items (measuring diet in the three months preceding the visit)	Antenatal: Early and late pregnancy	No

Medical Research Council Environmental Epidemiology Unit (University of Southampton)	Godfrey et al. (1997)	Maternal birthweight and diet in pregnancy in relation to the infant's thinness at birth. <i>British Journal of Obstetrics and Gynaecology</i>	England - 538 participants	"To examine how maternal diet in pregnancy and parental body size and birthweight influence an infant's thinness at birth measured by a low ponderal index"	Prospective observational	Caucasian women, ≥ 16 years with singleton pregnancies who attended the midwives' antenatal booking clinic (< 17 weeks)	2 times FFQ: interviewed, 100-food items (measuring diet in the three months preceding the visit)	Antenatal: Early and late pregnancy	No
The Danish National Birth Cohort Study - DNBC Study	Halldorsson et al. (2007)	Is high consumption of fatty fish during pregnancy a risk factor for fetal growth retardation? A study of 44,824 Danish pregnant women. <i>American Journal of Epidemiology</i>	Denmark - 44824 participants	"To examine the association between fish consumption and fetal growth among singleton full-term infants and to determine the importance of type of fish in this association by distinguishing between fatty fish and lean fish"	Longitudinal cohort	Women with singleton full term infants throughout Denmark at the first pre-natal visit, fluent in Danish (around gestational week 6-10)	Self-administered FFQ	Antenatal: Mid-pregnancy - week 25 of gestation	No

The Danish National Birth Cohort Study - DNBC Study	Halldorsson et al. (2010)	Intake of artificially sweetened soft drinks and risk of preterm delivery: a prospective cohort study in 59,334 Danish pregnant women. <i>American Journal of Clinical Nutrition</i>	Denmark - 59334 participants	"To examine the association between intakes of sugar sweetened and artificially sweetened soft drinks and preterm deliver"	Longitudinal cohort	All pregnant women living in Denmark and who spoke fluent Danish, enrolled at their first ante-natal consultation (6-10 weeks)	Validated FFQ with some questions about beverages intake (4 beverage items used on the study analyses: carbonated soft drinks/cola and noncarbonated soft drinks (sugar sweetened), carbonated soft drinks/cola and noncarbonated (sugar-free, light).	Antenatal: Mid-pregnancy - week 25 of gestation - covering intake in the previous 4 weeks	No

Norwegian Mother and Child Cohort Study - MoBa Study	Haugen et al. (2008)	Mediterranean-type diet and risk of preterm birth among women in the Norwegian Mother and Child Cohort Study (MoBa): a prospective cohort study. <i>Acta Obstetrica et Gynecologica Scandinavica</i>	Norway - 26563 participants	"To investigate whether a Mediterranean-type diet (MD) could be associated with a lower risk of preterm birth in the Norwegian Mother and Child Cohort Study (MoBa)"	Prospective cohort	Different inclusion/exclusion criteria was applied to meet the same characteristics as Khoury et al. study: non-smoking women with a singleton pregnancy only, BMI between 19-32, age at birth: 21-38 years. <u>Exclusion criteria:</u> history of more than 3 spontaneous abortions prior to this pregnancy, and women who had energy intake in the interval of 4,200- and 16,700 kJ	FFQ	Antenatal: At gestational week 17-24 (measuring the dietary habits since becoming pregnant)	No (they had Physical activity questionnaires in the MoBa study but not taken into consideration in this one)

Born in Guangzhou Cohort Study - BIGCS study	He et al. (2015)	Maternal dietary patterns and gestational diabetes mellitus: a large prospective cohort study in China. <i>British Journal of Nutrition</i>	China - 3063 participants	"To examine the associations between dietary patterns and the risk of GDM"	Prospective cohort	Women on their first routine antenatal examinations (around week 16) at two campuses of the Guangzhou Women and Children's Medical Center (GWCMC), that lived within Guangzhou and intended to stay there with their child for 3 years or more	64-items, self-administered FFQ	Antenatal: at gestational week of 24–27	No
	Karamanos et al. (2014)	Relation of the Mediterranean diet with the incidence of gestational diabetes. <i>European Journal of Clinical Nutrition</i>	10 Mediterranean countries, 10 centres (Algeria, France, Greece, Italy, Lebanon, Malta, Morocco, Serbia, Syria and Tunisia) - 1076 participants	"To explore a possible relationship between the incidence of GDM and the Mediterranean diet (Med Diet) pattern of eating"	Prospective, observational, non-interventional, multicentre	Pregnant women from the 10 different centres. Exclusion criteria: a known history of diabetes (type 1, type 2 or MODY) in the non-pregnant state - a history of previous GDM was not an exclusion criterion.	78 questions dietary history method/dietary questionnaire, interview administered	Antenatal: Before the OGTT was performed	No

The Danish National Birth Cohort Study - DNBC Study	Knudsen et al. (2008)	Major dietary patterns in pregnancy and fetal growth. <i>European Journal of Clinical Nutrition</i>	Denmark - 44612 participants	"To investigate possible associations between maternal diet during pregnancy and fetal growth"	Prospective cohort	Danish nationwide survey with pregnant women living in the country	360 food and drink items, validated, self-administered	Antenatal: gestational week 25 (regarding the previous 4 weeks)	No (it was measured as part of the DNBC study but not included in the analysis)
The Danish National Birth Cohort Study - DNBC Study	Knudsen et al. (2013)	Maternal dietary glycaemic load during pregnancy and gestational weight gain, birth weight and postpartum weight retention: a study within the Danish National Birth Cohort. <i>British Journal of Nutrition</i>	Denmark - 47003 participants	"To examine the associations between maternal dietary GL and gestational weight gain, birth weight, the risk of giving birth to a child large-for-gestational age (LGA) or small-for-gestational age and postpartum weight retention (PPWR)"	Prospective cohort	Danish nationwide survey with pregnant women living in the country	360 food and drink items, validated, self-administered	Antenatal: gestational week 25 (regarding the previous 4 weeks)	Yes (used to adjust for potential confounder)

	Langhoff-Ross et al. (1987)	Energy intake and physical activity during pregnancy in relation to maternal fat accretion and infant birthweight. <i>British Journal of Obstetrics and Gynaecology</i>	Sweden - 56 participants	"To elucidate the relation between dietary intake, physical activity and maternal fat accretion during pregnancy on the one hand, and infant birthweight on the other"	Prospective cohort	Healthy Swedish women, in their second pregnancy leading to a term birth	Three day food record (two times)	Antenatal: gestational week 17 and 33	Yes
The Danish National Birth Cohort Study - DNBC Study	Maslova et al. (2015)	Dietary protein-to-carbohydrate ratio and added sugar as determinants of excessive gestational weight gain: a prospective cohort study. <i>BMJ</i>	Denmark - 46262 participants	"To examine the relation between the protein:carbohydrate (P/C) ratio and added sugar intake in pregnancy and gestational weight gain (GWG)"	Prospective cohort	All women in Denmark who spoke Danish with live born singletons and complete data on dietary intake and GWG	Self-administered FFQ	Antenatal: gestational week 25 (regarding the previous 4 weeks)	Yes (it was measured as part of the DNDC study and used to adjust for potential confounder)

The Danish National Birth Cohort Study - DNBC Study	Mikkelsen et al. (2006)	Association between fruit and vegetable consumption and birth weight: a prospective study among 43,585 Danish women. <i>Scandinavian Journal of Public Health</i>	Denmark - 43585 participants	"To examine whether fruit and vegetable consumption in pregnancy is associated with birth weight in a Western population"	Prospective cohort	Women who became pregnant during the recruitment (January 1997 - October 2002), who were able to fill in questionnaires and to take part in interviews in Danish	360-item self-administered FFQ	Antenatal: gestational week 25 (regarding the previous 4 weeks)	No (it was measured as part of the DNDC study but not included in the analysis)
The Danish National Birth Cohort Study - DNBC Study	Mikkelsen et al. (2008)	Association between a Mediterranean-type diet and risk of preterm birth among Danish women: a prospective cohort study. <i>Acta Obstetrica et Gynecologica Scandinavica</i>	Denmark - 35530 participants	"To investigate if maternal intake of a Mediterranean-type diet (MD) is associated with reduced risk of preterm birth."	Prospective cohort	Pregnant Danish women, recruited between 1996 and 2002. <u>Exclusion criteria:</u> smokers, BMI <19 and >32 kg/m ² , women who were expecting a twin pregnancy, a history of chronic hypertension and more than 3 abortions and women who had a reported calculated energy intake <4,200 kJ and >16,700 kJ.	360-item self-administered FFQ	Antenatal: gestational week 25 (regarding the previous 4 weeks)	No (it was measured as part of the DNDC study but not included in the analysis)

Osaka Maternal and Child Health Study - OMCHS study	Miyake et al. (2006)	Risk of postpartum depression in relation to dietary fish and fat intake in Japan: the Osaka Maternal and Child Health Study. <i>Psychological Medicine</i>	Japan - 865 participants	"To investigate the relationship of consumption of selected high-fat foods and specific types of fatty acids with the risk of postpartum depression"	Prospective cohort	Women who became pregnant in Osaka during the period from November 2001 to March 2003	147 food-item, self-administered Diet history questionnaire (DHQ)	Antenatal: Baseline survey - around week 20 (assessing diet 1 month prior to complete)	No
	Moore et al. (2004)	Dietary composition of pregnant women is related to size of the baby at birth. <i>The Journal of Nutrition</i>	Australia - 557 participants	"To assess relations between a woman's macronutrient intakes in early and late pregnancy and the weight of the placenta as well as weight and thinness of the baby at birth"	Prospective observational	<u>Inclusion criteria:</u> "1) Caucasian and aged at least 18 y old; 2) in the first 16 weeks of a singleton pregnancy in which conception occurred without treatment for infertility; 3) planning to give birth in 1 of the 5 hospitals cooperating in the study; 4) not diabetic; 5) sufficiently fluent in English for completion of study questionnaires and able to give	Face-to-face interview, 200 food-items semi quantitative FFQ (two times)	Antenatal: First one before 16 weeks of pregnancy and second one between 30-34 weeks	No

						informed consent."			
Osaka Maternal and Child Health Study - OMCHS study	Murakami et al. (2008)	Dietary glycemic index and load and the risk of postpartum depression in Japan: the Osaka Maternal and Child Health Study. <i>Journal of Affective Disorders</i>	Japan - 865 participants	"To examine the association between dietary GI and glycemic load (GL) and postpartum depression"	Prospective cohort	Japanese pregnant women	150 food-item, self-administered Diet history questionnaire (DHQ)	Antenatal: Baseline survey (assessing diet 1 month prior to complete)	No
Osaka Maternal and Child Health Study - OMCHS study	Okubo et al. (2011)	Dietary patterns during pregnancy and the risk of postpartum depression in Japan: the Osaka Maternal and Child Health Study. <i>British Journal of Nutrition</i>	Japan - 865 participants	"To examine the association between dietary patterns during pregnancy and the risk of postpartum depression"	Prospective cohort	Japanese pregnant women	150 food-item, self-administered Diet history questionnaire (DHQ)	Antenatal: Baseline survey (assessing diet 1 month prior to complete)	No

Osaka Maternal and Child Health Study - OMCHS study	Okubo et al. (2012)	Maternal dietary patterns in pregnancy and fetal growth in Japan: the Osaka Maternal and Child Health Study. <i>British Journal of Nutrition</i>	Japan - 803 participants	"To examine the relationship of maternal dietary patterns in pregnancy to neonatal anthropometric measurements at birth"	Prospective cohort	Japanese women with live-born, singleton, term deliveries	Self-administered 151 food-item Diet history questionnaire (DHQ)	Antenatal: Baseline survey (assessing diet 1 month prior to complete)	No
The Danish National Birth Cohort Study - DNBC Study	Olsen et al. (2007)	Milk consumption during pregnancy is associated with increased infant size at birth: prospective cohort study. <i>American Journal of Clinical Nutrition</i>	Denmark - 50117 participants	"To examine whether milk consumption during pregnancy is associated with greater infant size at birth"	Prospective cohort	Women with singleton full term infants as part of the Danish study	360-item self-administered FFQ	Antenatal: gestational week 25 (regarding the previous 4 weeks)	No
Project VIVA	Radesky et al. (2008)	Diet during early pregnancy and development of gestational diabetes. <i>Paediatric and Perinatal Epidemiology</i>	US - 1733 participants	"To investigate associations of these and other nutrients and foods, including n-3 fatty acids, trans fats, whole grains and dietary patterns, with risk of GDM"	Prospective cohort	Healthy pregnant women recruited before 8 weeks of pregnancy in eight clinics in Massachusetts	140 items, semi-quantitative and self-administered FFQ	Antenatal: beginning of pregnancy up to first antenatal visit (average 11.8 weeks)	No

Infancia y Medio Ambiente Study - INMA study	Ramon et al. (2009)	Vegetable but not fruit intake during pregnancy is associated with newborn anthropometric measures. <i>Journal of Nutrition</i>	Spain - 787 participants	"To assess the association between fruit and vegetable consumption during pregnancy and anthropometric measures at birth in a general population mother-infant cohort"	Mother-Infant Prospective Cohort	Healthy pregnant women from Valencian Community who attended the first trimester prenatal at Hospital La Fe de Valencia	2 FFQs interviewed administered at two different time points in pregnancy: 100-food items, semi quantitative	Antenatal: first trimester (10–13 weeks) and third trimester (28–32 weeks)	No
Infancia y Medio Ambiente Study - INMA study	Rodriguez-Bernal et al. (2010)	Diet quality in early pregnancy and its effects on fetal growth outcomes: the Infancia y Medio Ambiente (Childhood and Environment) Mother and Child Cohort Study in Spain. <i>American Journal of Clinical Nutrition</i>	Spain - 787 participants	"To assess the effect of diet quality during the first trimester of pregnancy, as measured by the Alternate Healthy Eating Index (AHEI) adapted for pregnancy, on fetal growth"	Mother-Infant Prospective Cohort	Healthy pregnant women from Valencian Community who attended the first trimester prenatal at Hospital La Fe de Valencia	2 FFQs interviewed administered at two different time points in pregnancy: 100-food items, semi quantitative	Antenatal: first trimester (10–13 weeks)	No

Pregnancy, Infection, and Nutrition Study - PIN study	Saldana et al. (2004)	Effect of macronutrient intake on the development of glucose intolerance during pregnancy. <i>American Journal of Clinical Nutrition</i>	US - 1698 participants	"To examine the relation between macronutrient intake early in pregnancy and the development of glucose intolerance"	Prospective cohort	Singleton pregnant women (around 24-29 weeks) who spoke English, were >16years, had access to a phone, and had no plans to change their care from the research sites.	FFQ	Antenatal: Applied during second trimester (but food intake related to first trimester of pregnancy)	No
	Sartorelli et al. (2014)	Fried food intake estimated by the multiple source method is associated with gestational weight gain. <i>Nutrition Research</i>	Brazil - 88 participants	"To test the association between fried food intake estimated by a semi-quantitative food frequency questionnaire (FFQ), multiple 24-hour dietary recalls (24hRs), and the application of the multiple source method (MSM) in relation to gestational weight gain at the second and third trimesters and weight gain ratio (observed weight gain/expected weight gain)"	Prospective cohort	Healthy pregnant women, recruited on their first trimester of pregnancy (< 14 weeks) and with a pre-gravid BMI of 18.5 to 24.9 kg/m ² at 4 different health clinics in the municipality.	Two 85-semi-quantitative FFQ (two face-to-face interview) and three 24hrs dietary recalls	Antenatal: FFQ (at the second and third trimester) and 24hr diet recall (face-to-face interview or over the phone, usually at each trimester)	Yes

Healthy Start Study	Starling et al. (2017)	Maternal Dietary Patterns during Pregnancy Are Associated with Newborn Body Composition. <i>The Journal of Nutrition</i>	US - 764 participants	"To identify patterns of maternal dietary intake associated with gestational weight gain (GWG) and fasting glucose during pregnancy and to evaluate whether adherence to these patterns is associated with newborn adiposity"	Prospective cohort	Eligible participants: ≥ 16 y old with a singleton pregnancy, had <24 weeks of gestation at the time of enrolment, had no previous history of stillbirth or preterm birth at <25 weeks of gestation, and had no pre-existing diabetes, cancer, psychiatric illness, or asthma treated with steroid medications	Self-Administered, monthly web-based 24-h Recall - participants received instruction from trained study staff on how to complete.	Antenatal: at the first study visit (week 17, average 10-24)	Yes

Appendix 3-4: Outcomes of the studies included in the systematic review

#	Author, year	Study title, Source Journal	Outcomes - maternal	Outcomes - fetal	Outcomes - infant	Key findings	Comments	Potential mechanisms	Strengths/ Limitations of the study	Recommendations made by authors
Women and Their Children's Health Study - WATCH study	Blumfield et al. (2012)	Dietary balance during pregnancy is associated with fetal adiposity and fat distribution. <i>American Journal of Clinical Nutrition</i> 96 (5), 1032-1041.	No	Fetal body composition - Measured by ultrasound conducted at weeks 19, 25, 30, and 36 of pregnancy.	No	Percentage of abdominal fat was related to the intake of protein, starch and protein: carbohydrate ratio - the less protein in the diet, the more abdominal fat. The percentage of midhigh fat was associated to saturated fatty acids and polyunsaturated fatty acids - related to a diet higher in fat in	First prospective study to investigate this type of relationship. It seems that maternal diet with a high content in fat combined with a low content in protein may be related to the development of fetal midhigh fat.	The mechanisms related to the findings in the study are still very little understood. Not all low-birth-weight babies will have a greater risk of adult metabolic disorders	Limitations: The use of self-reported FFQ data to assess diet; the use of ultrasound to estimate fetal body composition (does not give accurate measurements); exploratory nature of the study and missing data: source of bias; neonatal adiposity at birth was not measured.	Further studies are needed.

						comparison to other macronutrients. And not even about the total content of fat but the quality of fat consumed. The P:C ratio and percentage of energy as PUFA caused the biggest differences in fetal abdominal and midthigh body composition, respectively.				

	Conway <i>et al.</i> (1999)	Dietary restraint and weight gain during pregnancy. <i>European Journal of Clinical Nutrition</i> 53(11), 849-853.	GWG	No	No	Restrained eaters (prior to pregnancy) were less likely to follow GWG recommendation according to their pre-pregnancy body mass index (BMI): they were more likely to either gain more or less than the recommended.	Diet restraint seems to have negative impact on overall diet and GWG which require further attention.			Counselling to pregnant women regarding GWG, dieting, stopping smoking might be beneficial. Future studies with larger and more representative population groups, including heterogenic groups.

Norwegian Mother and Child Cohort Study - MoBa Study	Duarte-Salles <i>et al.</i> (2013)	Dietary Acrylamide Intake during Pregnancy and Fetal Growth-Results from the Norwegian Mother and Child Cohort Study (MoBa) <i>Environmental Health Perspectives (EHP)</i> 121 (3), 374-379.	No	Fetal growth	No	Fetal growth was negatively associated with acrylamide intake during gestation: highest vs lowest quartile of acrylamide intake, the multivariable-adjusted odds ratio (OR) for SGA was 1.11 (95% CI 1.02, 1.21) and the coefficient for birth weight was -25.7 g (95% CI -35.9, -15.4) - produced similar results to mothers who smoked during pregnancy.	Fetal growth might be enhanced by reducing dietary intake of acrylamide during pregnancy. Results from the study support other studies regarding the decrease in birth weight associated with the exposure.			To decrease the dietary intake of acrylamide during pregnancy.

	Ebrahimi et al. (2015)	Relationship between sociodemographics, dietary intake, and physical activity with gestational weight gain among pregnant women in Rafsanjan City, Iran. <i>Journal of Health, Population and Nutrition (JHPN)</i> 33 (1), 168-176.	GWG	No	No	46% of the women gained weight within the limits recommended by the Institute of Medicine (IOM). Average GWG was 12.87±3.57 kg and it was related to age, pre-pregnancy body mass index (BMI), energy intake, and sitting time. Mean total GWG for underweight and obese women was 14.74±3.77 kg and 11.76±3.28 kg respectively 71.4% of the women did not meet the Dietary	Findings showed to be consistent with previous studies. The study was the first one to be conducted among pregnant women in the province.		Limitations: the fact that pre-pregnancy weight was based on weights in the prenatal records could produce incorrect estimation of GWG. Additionally, purposive sampling technique was used and sample-size of underweight and obese women in the study was small and sample included women from a small and urban part of Iran. Finally, the instruments used in the study, IPAQ and 24-hour	Important to educate pregnant women about the importance of following the recommended GWG. Identify women at risk of inadequate or excessive GWG.

						Reference Intake (DRI) for energy intake during the last trimester of pregnancy			dietary recall, rely on the individual's ability to remember their food intake and physical activity and also their comprehensio n.	

Norwegian Mother and Child Cohort Study - MoBa Study	Englund-Ogge et al. (2012)	Association between intake of artificially sweetened and sugar-sweetened beverages and preterm delivery: a large prospective cohort study. <i>European Journal of Clinical Nutrition</i> 96(3), 552-559.	No	No	Preterm birth (Birth before gestational week 37+0)	There was a positive relation between BMI and energy intake with the consumption of AS and SS - higher in smokers, single and less educated women. Positive relation was also found between risk of pre-term birth and increased intake of AS and SS. The relationship was stronger for SS beverages than for AS beverages (Frequent SS drinkers adjusted OR: 1.37; (95% CI		It could be that the elevated glucose concentrations after consumption of SS beverages may be related to preterm birth - it is believed that during pregnancy the sensitivity to insulin in peripheral tissues is decreased.	Strengths: Size of the study (largest so far to study this relationship); assessment of dietary intake was pre-birth; and also having access to information about previous preterm birth. Limitations: Just like any other dietary assessment method, the risk of misreporting; the participation rate was 38.5% - demographic differences between the cohort and the remaining pregnant population should be mentioned as the ones who	Further studies

						1.08, 1.74], frequent AS drinkers adjusted OR: 1.08 (95% CI 0.89, 1.32)).			decide to join the study are healthier and better educated. Moreover, the possibility of residual and unmeasured confounding factors still have an influence over the results.	

Norwegian Mother and Child Cohort Study - MoBa Study	Englund-Ogge et al. (2014)	Maternal dietary patterns and preterm delivery: results from large prospective cohort study. <i>The BMJ</i> 348, g1446.	No	No	Preterm delivery (delivery between gestational week 22+0 and 36+6.)	Preterm delivery occurred in 5.3% (3503) [late preterm in 3.9% (2558) + moderately preterm 0.7% (478) + early preterm 0.7% (469)]. The "prudent" dietary pattern was associated with significantly reduced risk of preterm delivery and lower risk of late and spontaneous preterm delivery. The "traditional" dietary pattern was also related with a lower risk of preterm delivery	Diet was divided in three patterns: "prudent" (vegetables, fruits, oils, water as beverage, whole grain cereals, fibre rich bread), "Western" (salty and sweet snacks, white bread, desserts, processed meat products), and "traditional" (potatoes, fish) As an advice to the women it is more important to increase the intake foods associated with a prudent dietary pattern than totally excluding processed food, fast food,	1) The fact that first time mothers had a higher score for a more prudent dietary pattern could be explained by the fact that first time mothers being more conscious as overall the risk of preterm delivery is significantly lower in women 2) Only a significantly reduced risk of late preterm was found after stratifying to time of delivery. This could be caused either because the low number of cases in this subgroup or	Strengths: Size of the study (participants from all over Norway, also very representative), the prospective design, and the detailed information on a wide range of potential confounding factors; assessment of dietary intake was before delivery so women were still unaware of the outcome of pregnancy. Moreover, the FFQ cover the period from the beginning of pregnancy up to the 22 week of gestation so it included the	More attention to diet counselling should be given.

						First time mothers had a significantly higher scores on the prudent dietary pattern.	junk food, and snacks.	amniotic infections that cannot be prevented by diet. Or even that the prudent dietary pattern can only prevent preterm delivery in a few days 3) Foods understood as unhealthy tend to be underreported to more than foods regarded as healthy.	important period of embryogenesis (epigenetic mechanisms and for possible later preterm delivery) Limitations: No casual inference is possible due to the study design. Also the fact that there are some residual confounding factors cannot be completely eliminated. The low participation rate - demographic differences between the cohort and the remaining pregnant population should be mentioned as	

									the ones who decide to join the study are healthier and better educated.	

	Eshquiri <i>et al.</i> (2016)	Gestational dietary patterns are not associated with blood pressure changes during pregnancy and early postpartum in a Brazilian prospective cohort. <i>European Journal of Nutrition</i> 55 (1), 21-32.	Blood Pressure (BP): Systolic BP (SBP) and diastolic BP (DBP) - obtained and comprised four waves of follow-up: first trimester (5th–13th week), second trimester (20th–26th week), third trimester (30th–36th week) and 30–45 days postpartum (38th–51th weeks after conception)	No	No	Three dietary patterns were identified: healthy, common-Brazilian and processed. No association was found between any of the dietary patterns during pregnancy and changes in the BP during pregnancy and early postpartum.			Strengths: employment of the LME (statistical procedure to account for the prospective nature of the data); adequate instruments and procedures used to assess the dietary intake (previously validated in other study); the wide range of social and behavioural data available, (controlling the effects of important confounding factors). Limitations: the losses of follow-up (common drawback in cohort	Further research should be conducted on pregnant women to clarify this understudied topic however they theorize that variations are not expected in BP throughout the studied period in a healthy pregnant women sample.

									studies), the measurement of casual ambulatory BP (it is the standard and most common procedure for diagnosing hypertension though) and finally the study data regarding the dietary pattern cannot capture potential changes on the food intake during postpartum as the time frame was 6 months prior to it is application.	

Medical Research Council Environmental Epidemiology Unit (University of Southampton)	Godfrey <i>et al.</i> (1996)	Maternal nutrition in early and late pregnancy in relation to placental and fetal growth. <i>British Medical Journal</i> 104 (6), 663-667.	No	No	Placental and birth weights adjusted for the infant's sex and duration of gestation.	Women who had a higher intake of carbohydrate in early pregnancy followed by a lower intake of dairy and meat protein in late pregnancy were more likely to have lower placental and birth weights (unrelated the mother's height and BMI). Birth and placental weight were also found to be linked to a high supplementation intake of iron and folate late in pregnancy.	Despite the fact that these findings may be of long term importance for the development of disease, they are not yet a reason for altering dietary recommendations to pregnant women.	The findings show that a high consumption of carbohydrate during early pregnancy restrains the growth of the placenta, particularly if followed by a low dairy protein intake late in pregnancy.	Further studies are needed.

Medical Research Council Environmental Epidemiology Unit (University of Southampton)	Godfrey <i>et al.</i> (1997)	Maternal birthweight and diet in pregnancy in relation to the infant's thinness at birth. <i>British Journal of Obstetrics and Gynaecology</i> 312 (7028), 410-414.	No	No	Thinness at birth (measured by a low ponderal index)	Women who had a higher intake of carbohydrate in early pregnancy followed by a lower intake of dairy protein in late pregnancy were more likely to have infants that were thin at birth (P = 0.01 and P = 0.03). Women who had low birthweight themselves also tended to have infants with lower birthweight (unrelated to fathers birthweight). Taller fathers tended to have infants with lower birthweight (and	Thinness at birth is related to insulin resistance, development of non-insulin dependent diabetes and coronary heart disease in the offspring adult life. Study results demonstrate that low ponderal index could be caused by impaired placental growth as a result of either woman's low growth rate in utero or imbalanced diet (intake of carbohydrate and protein during pregnancy) Paternal genes could also play a role at			In order to promote a proper ponderal index of infants, it is important that the intra-uterine growth of the current generation of infants is improved so that the next generation can be rewarded.

						unrelated to the mothers). Simultaneous regression also showed that gestational age, gender, parity, parental social class and smoking were independently associated with ponderal index at birth.	controlling skeletal growth.			

The Danish National Birth Cohort Study - DNBC Study	Halldorsson <i>et al.</i> (2007)	Is high consumption of fatty fish during pregnancy a risk factor for fetal growth retardation? A study of 44,824 Danish pregnant women. <i>American Journal of Epidemiology</i> 166(6), 687-696.	No	No	Fetal growth - measured by birth weight, birth length, and head circumference	The intake of fatty fish 4x or more per month was associated with a higher risk for small for gestational age (birth weight, length, and head circumference) - and an increased intake inversely associated to birth weight and length, and head circumference.	Fish intake contributed on average to: 1.7% of their total energy intake, 5.7% of their total protein intake, and 2.7% of their total fat intake 2.6% of the respondents did not consume any at all and 8% had an intake 5 g/day or less. During pregnancy, the type of fish that is being consumed matters. Women with a higher intake of fish tended to be: higher socio-economic status, with a lower pre-pregnancy BMI, older and	Fatty fish intake could be inhibiting fetal growth due to a known route of exposure to persistent organic pollutants. Authors stated there is evidence from this and other studies to show high amounts of marine fats, consumed through either intake of fish oil consumption of marine mammals or intake of fatty fish (as in this study), might have an inverse association with fetal growth. However, it is not clear	Strengths: Prospective study with large sample size Limitations: Due to the nature of an observational study, the findings could be a result of remaining or unmeasured confounders. It was also found that fish consumption was strongly related to other predictors of fetal growth such as: maternal factors (parity and BMI), lifestyle (smoking) and socioeconomic status.	It is believed that study findings are less likely to the influence of residual confounding due to the consistency between adjusted and unadjusted results for fatty fish. A moderate intake of fatty fish should be encouraged during pregnancy. More studies examining the differences between fatty and lean fish in relation to fetal growth are needed.

							less likely to be smokers.	whether this inverse association is due to industrial contaminants, fatty acid composition, or some other constituent in the fish fat.		

The Danish National Birth Cohort Study - DNBC Study	Halldorsson <i>et al.</i> (2010)	Intake of artificially sweetened soft drinks and risk of preterm delivery: a prospective cohort study in 59,334 Danish pregnant women. <i>American Journal of Clinical Nutrition</i> 92 (3), 626-633.	No	No	Preterm delivery (<37 weeks) (primary outcome)	It was found that the intake of artificially sweetened carbonated soft drinks/d is associated with an increased risk for preterm birth: adjusted OR for women who had 1 serving of artificially sweetened carbonated soft drinks/d was 1.38 (95% CI 1.15, 1.65) and 1.78 (95% CI 1.19, 2.66) for women who consumed 4 servings (for normal-weight and overweight women; and higher risk for early preterm	Since most artificially sweetened contains a combination of different types of sweeteners, It is difficult to tell which ones might be at fault. It is believed that not many studies have investigated, in humans, the potential toxicity of artificial sweeteners and is still hard to draw conclusions from studies in animals.	It could be that the content of artificial sweeteners in carbonated and noncarbonated drinks be linked to the increased risk of preterm delivery	Strengths: Study's prospective design with a large sample Limitations: Due to the nature of an observational study, the findings could be a result of remaining or unmeasured confounders.	Further studies are needed to investigate better this association

						and moderately preterm birth than with late-preterm delivery) No association was found for sugar-sweetened soft drinks.				

Norwegian Mother and Child Cohort Study - MoBa Study	Haugen <i>et al.</i> (2008)	Mediterranean-type diet and risk of preterm birth among women in the Norwegian Mother and Child Cohort Study (MoBa): a prospective cohort study. <i>Acta Obstetrica et Gynecologica Scandinavica</i> 87 (3), 319-324.	No	No	Preterm delivery: Late (born in week 35-36) and early (born before week 35 of gestation)	Neither crude OR nor adjusted OR proved any significant relation between MD and preterm births (<37 weeks), even when applied to early and late preterm birth.	It might be that a proper measurement of MD was not made. The findings that the intake of fish 2 or more times a week could have a protective effect on preterm birth is still a controversial 2.2% (569) of the women met all MD criteria, 0.6% (159) met none of the MD criteria and the rest 97.2% (25,397) women met 1-4 criteria. Women who met MD criteria had higher education level.	The findings for preterm birth (4.5%) from this sub-cohort of the MoBa study show a lower prevalence of preterm birth than the general pregnant population of Norway (6.6%) and it may be because of the exclusion of smokers and women with low BMI in the present study (so it could be compared to the Khoury one.	Strengths: Study's prospective design with a large sample Limitations: Due to the nature of an observational study, the findings could be a result of remaining or unmeasured confounders.	The impact of a cholesterol lowering diet in the prevention of preterm births requires further investigation
						"It was found that when the 5 MD criteria were analysed separately with respect to preterm birth, a reduced risk was associated with intake of fish twice or more a week, OR: 0.81 (95% CI 0.72, 0.92) for crude analysis and OR: 0.84 (CI				

						0.74, 0.95) for adjusted analysis"				

Born in Guangzhou Cohort Study - BIGCS study	He <i>et al.</i> (2015)	Maternal dietary patterns and gestational diabetes mellitus: a large prospective cohort study in China. <i>British Journal of Nutrition</i> 113 (08), 1292-1300.	Gestational Diabetes Mellitus (GDM): diagnosis by using a 75 g, 2 h oral glucose tolerance test and based on the International Association of Diabetes and Pregnancy Study Groups: fasting, 5.1 mmol/l; 1 h, 10.0 mmol/l; 2 h, 8.5 mmol/l.	No	No	Four dietary patterns were identified: vegetable pattern; protein-rich pattern; prudent pattern; sweets and seafood pattern. Around 17.8% (544) of women received a diagnosis for GDM. After adjustment for confounders, it was found that the highest tertile (tertile 3) of the vegetable pattern was associated with a decreased risk of GDM (RR 0.79, 95% CI 0.64, 0.97)	Women who had a higher education and income level tended to have a high vegetable pattern score. Women with a high protein-rich pattern score tended to be younger, parous and have less education level. First study to identify the outcomes of diet on the risk of GDM in a Chinese population. Despite the finding that protein-rich pattern was not associated with the risk of GDM some epidemiological studies have shown that a	It was speculated that a pattern of high consumption of vegetables could attenuate the harmful effects of other risk factors of GDM, along with family history of diabetes. The finding that sweets and seafood pattern increase the risk of GDM could be explained by the fact that a high-sugar diet can reduce insulin sensitivity and insulin secretion	Strengths: Study's prospective design with a large sample. Also, the analysis of diet as a whole enables have a more comprehensive analysis and even capture synergistic effects among various nutrients and food Limitations: Data on portion sizes of food items were not collected, thus it was not possible to calculate the amount of food consumption; since food intake was assessed 'in the past week'	Importance to recommend pregnant women in the Chinese population to eat a balanced diet. Further studies are needed to investigate better this association in other Asian populations

						compared to the lowest tertile (tertile 1) while the third highest tertile of the sweets and seafood pattern was associated with an increased risk of GDM ((RR 1.23, 95% CI 1.02, 1.49) compared with those for lowest tertile. No association was found for the other patterns.	high consumption of dairy products could be protective for type 2 diabetes and other components of the metabolic syndrome, as well as, a higher intake of nuts.		hence it might not be representative of dietary patterns throughout early pregnancy; since information on portion size was not collected in the present study, dietary consumption was based only on the frequency of food intake (neither was possible to adjust for total energy intake); lastly due to the nature of observational studies, although statistical analysis was adjusted for several factors, it was not	

									possible to exclude residual confounding factors.	

	Karamanos et al. (2014)	Relation of the Mediterranean diet with the incidence of gestational diabetes. <i>European Journal of Clinical Nutrition</i> 68 (1), 8-13.	Gestational Diabetes Mellitus (GDM): 75-g OGTT at the 24th–32nd week of gestation (interpreted both by the ADA_2010 and the International Association of the Diabetes and Pregnancy Study Groups (IADPSG)_2012 criteria)	No	No	GDM: 9.5% (ADA 2010 criteria) and 29% (new IADPSG criteria). Total fat contribution to the energy intake was higher in both GDM groups: ADA-positive (34.6% vs 33.0%, $P<0.05$) and IADPSG-positive (34.8% vs 32.5%, $P<0.001$). GDM prevalence was lower in women who had a better adherence to the Med Diet (higher tertile of MDI distribution), 8.0% vs 12.3%, OR=0.618,	So, having a Med Diet during pregnancy can improve glucose tolerance and reduce to some extent the incidence of GDM. In line with previous findings regarding an association of high total fat intake with the risk of both DM2 and GDM. There are no other studies in the literature examining the relation of dietary patterns and especially Med Diet with GDM. However it should be mentioned	According to the study, a Med Diet is the only eating pattern that is associated with lower incidence of CHD, DM2 and as documented in the present study, lower incidence of GDM. Yet, it is still unclear the mechanisms involved in the protective effects of the Med Diet. A possible assumption could be a decrease in circulating inflammatory biomarkers in those ones with this type of diet. Or even that the Med Diet composition may be	Strengths: 1) Since all participants were submitted to an OGTT - more accurate diagnosis of GDM; 2) The use of the 75-g OGTT and also use of the most recent, more rigorous criteria (both the ADA 2010 and the IADSPG 2012); 3) the questionnaire used for diet assessment was validated (3-Day Diet Diary) and interviewer-administered by specially trained personnel. Limitations: 1) Mixed populations having in	More interventional studies are needed

						P=0.030 by ADA_2010 and 24.3% vs 32.8%, OR=0.655, P=0.004 by IADPSG_2012 criteria.	that the methods used for the calculation of the MDI vary significantly between the studies as well as the diagnosis of GDM may vary	associated to its anti-inflammatory properties	common only the 'Mediterranean Basin' while very diverse in: ethnicity, socio-economic status, religious practices and everyday habits; 2) Population sample from each of the countries was relatively small - do not allow analysis of the data by centre and multiple comparisons.	

The Danish National Birth Cohort Study - DNBC Study	Knudsen et al. (2008)	Major dietary patterns in pregnancy and fetal growth. <i>European Journal of Clinical Nutrition</i> 62(4), 463-470.	No	No	Fetal growth: small for gestational age (SGA) Birth outcomes: birth weight and length, head and abdominal circumference s, gestational age and sex of the infant (extracted from the National Patient Registry)	Women's diet were grouped into three categories: 'Western diet' (characterized by red and processed meat, high-fat dairy), 'Health conscious' (characterized by intake of vegetables, fruits, poultry and fish); and the 'Intermediate' (a mix from the two previous ones). The OR of having a SGA baby (birth weight <2.5th percentile for gestational age and gender) for women in the Health Conscious class	Women from the first group had the highest energy intake, and also the highest number of smokers showing that those mothers were more inclined to (and so healthier lifestyle) Women from the Health Conscious group had the lowest number of smokers, as well as the lowest energy intake (healthier lifestyle). Statistical analysis revealed that low birth weight is associated to: smoking in	It was found a significant association between fetal growth, in pregnant Danish women, and diet in pregnancy unveiling that intrauterine growth conditions could be improved during pregnancy by adopting certain dietary patterns.	Strengths: The large sample size and the FFQ that was used has been validated (and the recorded data in the FFQ are applicable to analyses on food group level - providing the basis for the construction of the dietary patterns) Limitations: Since a FFQ was used, it could have introduced some bias since calculations rely on assumptions of average portions, sizes and standard recipes for complex dishes);	More studies are needed to identify determined macro- or micronutrients that may be masking these associations

						compared with women in 'the Western Diet' class was 0.74 (95% CI 0.64–0.86)	pregnancy, pre-pregnancy weight below 60 kg, low stature of the mother (<160 cm), young age of the mother (<20 years) and parity (i.e. primiparous).		moreover, quantification of potential confounders (such as exposure to smoking and drinking) have some inherent imprecision, and residual confounding cannot be completely eliminated. Finally, the sample might not represent all Danish pregnant women in their behaviour, as participants in surveys like tend to have a healthier lifestyle.	

The Danish National Birth Cohort Study - DNBC Study	Knudsen <i>et al.</i> (2013)	Maternal dietary glycaemic load during pregnancy and gestational weight gain, birth weight and postpartum weight retention: a study within the Danish National Birth Cohort. <i>British Journal of Nutrition</i> 109 (8), 1471-1478.	Gestational weight gain (GWG) (assessed between gestational week 12-30) Postpartum weight retention (PPWR) (calculated by subtracting the pre-pregnancy body weight from the postpartum weight reported 18 months after delivery)		Birth weight, risk of giving birth to a child large-for-gestational age (LGA) (infants born with birth weight above the 90th percentile for a given gestational age) or small-for-gestational age (SGA) (infants born with birth weight below the 10th percentile for a given gestational age)	Birth weight: "increased by 36 g from the lowest to highest GL quintile (95% CI 19, 53 g), and an increased risk of LGA of 14% was detected in the highest GL quintile compared with the lowest GL quintile"	The initial study hypothesis that the relation between dietary GL and gestational and birth outcomes vary in groups of maternal pre-pregnancy BMI and that those relationships are more pronounced among women who were overweight prior to pregnancy was tested and found to be positive but no statistically significant interactions were found in the analyses of SGA and LGA. Having a high GL diet during pregnancy	"The GL may play a role for excessive gestational weight gain and PPWR, which may be more pronounced among overweight and obese women." The results are based on the principle that a change on source of maternal carbohydrate could be useful as glucose is a prime substrate for the growth of the fetus.	Strengths: The large sample size, good diversity of variables different. Also, the fact that diet was assessed before birth weight and PPWR, which narrows the risk of recall bias. Limitations: Study (dietary assessment) is subject to underreporting	
						LGA: "The risk of being born LGA was higher in the group with the highest GL; the risk was increased by 14% (OR 1.14; 95% CI 1.03, 1.25) - before adjusting for pregnancy BMI. SGA: "Among women with				

						pre-pregnancy BMI below 18.5 kg/m², the risk of having a SGA baby was lowest in the group with the lowest dietary GL, which is opposite of the overall results" GWG: "Among normal-weight and overweight women, higher gestational weight gain rates were detected in the highest GL quintile (26 g/week (95% CI 19, 34) and 30 g/week (95% CI 13, 46), respectively)." PPWR: "The	increases the risk of excessive GWG and PPWR. Increasing GL was associated with a minor decrease in total energy intake, however the absolute difference between the highest and lowest groups was small (Spearman's correlation coefficient 20.01, P=0.002). "Dietary fibre intake and intake of carbohydrate increased with increasing GI (Spearman's correlation coefficient 0.24 (P, 0.001) and 0.34 (P, 0.001),			

						association between the GL and PPWR was most pronounced among pre-pregnant obese women, with an increase in weight retention of 1·3 (95% CI 0·2, 2·8) kg from the lowest to highest GL quintile."	respectively), while intakes of fat and protein decreased (Spearman's correlation coefficient 20·38 (P, 0·001) and 20·18 (P, 0·001), respectively)."			

	Langhoff-Ross et al. (1987)	Energy intake and physical activity during pregnancy in relation to maternal fat accretion and infant birthweight. <i>British Journal of Obstetrics and Gynaecology</i> 94(12), 1178-1185.	Maternal fat accretion (the difference between fat mass in early pregnancy and at week 37)	No	Infant birth weight	There were 15 smokers at week 17th and since the two groups were compared and there were no statistically significant among them, they were merged. Energy intake (crude and adjusted for physical activity) increased 3% from week 17 to 33 but when adjusted for physical activity (PA) and lean body mass, energy intake decreased an 11% in the same period. A 6% reduce in PA from week 17 to	In a healthy population of Swedish women, energy intake is positively associated to maternal fat accretion but not to birthweight.	The study suggests two possible mechanisms where PA might affect maternal fat accretion and fetal growth: by energy restriction or redistribution of blood flow.		More studies are needed.

						33. Infant birthweight was not associated to energy intake (not even considering PA and lean body mass).				
The Danish National Birth Cohort Study - DNBC Study	Maslova et al. (2015)	Dietary protein-to-carbohydrate ratio and added sugar as determinants of excessive gestational weight gain: a prospective cohort study. <i>The BMJ</i> 5(2), e005839.	GWG (self-reported weight in gestational weeks 12 and 30 and defined as gain in g/week)	No	No	Mean GWG was 471 (224) g/week. Adjusted weight gain was 16 g/week lower (95% CI 9 to 22, p for trend <0.001) in the highest (Q5) versus lowest (Q1) quintile	Low-carbohydrate diets have been successful in promoting weight loss in non-pregnant populations however this is the first study to demonstrate	"The present results could be explained by physiological responses to increased protein and reduced carbohydrate intake. Higher consumption of protein has	Strengths: large cohort, detailed dietary assessment and extensive data on covariates Limitations: The possibility of misreporting (on the FFQ)	Controlled trials are needed to differentiate between the effects of the P/C ratio or added sugar on GWG Also some further studies to specifically examine the dietary

						of the P/C ratio (~3% average reduction throughout pregnancy) GWG for women who had >20%E vs <12%E from protein was 36 g/week less (95% CI 20 to 53, p for trend <0.0001; ~8% average reduction). The intake of food with added sugar was strongly linked to GWG (Q5 vs Q1: 34, 95% CI 28 to 40 g/week, p for trend <0.0001) An association found to be only for normal weight women was: Glycaemic	that these types of diets could be also considered in pregnant populations so excessive GWG can be reduced particularly in high-risk women who already start their pregnancy overweight or obese. The study also demonstrate that just fair reductions in carbohydrates and a slight increase in protein may be beneficial to reduce GWG to a clinically relevant degree. Women in the highest quintile of the P/C ratio were usually	been shown to increase satiety, possibly by increasing satiety-inducing hormones such as peptide YY (PYY) and glucagon-like peptide-143 and repressing hunger hormones. Conversely, sugar has been shown to reduce PYY, and to increase hyperphagia and hyperinsulinaemia in animal studies." "One proposed explanation for increased food intake could be the activation of the 'reward system' by	and GWG, especially in obese women.	predictors of GWG in this subgroup S19:X19

						Index (GI) was found to be directly but weakly linked to GWG (Q4 vs Q1: 6 g/week, 95% CI -1 to 13). GWG was directly linked to the intake of sweets (mainly chocolate and mixed candy) - regardless of pre-pregnancy BMI	multiparous (49% vs 44%), had a BMI ≥ 25 kg/m² (32% vs 25%) and were smokers (15% vs 12%).	foods high in sugar and fat and mediated by endogenous opioids, dopamine and serotonin. Stimulating the reward system results in a sense of gratification that drives overeating. This, coupled with disrupted hunger-satiety signals, may cause an imbalance in energy homeostasis by which energy intake exceeds energy expenditure."		

The Danish National Birth Cohort Study - DNBC Study	Mikkelsen et al. (2006)	Association between fruit and vegetable consumption and birth weight: a prospective study among 43,585 Danish women. <i>Scandinavian Journal of Public Health</i> 34(6), 616-622.	No	No	Birth weight	An increasing quintile of fruit intake (test for trend $p < 0.0001$) as associated to also an increase in energy intake. The lowest quintile had significantly fewer dietary supplement users (test for trend $p < 0.0001$). As quintiles increase, the percentage of smokers decrease (test for trend $p < 0.0001$) and percentage of first time mothers increase (test for trend $p < 0.0001$) Fruit intake had the strongest association	A positive relation was found between fruit and vegetable consumption during pregnancy and birthweight in well-nourished Danish women, particularly among lean women.	No	Strengths: large cohort, prospective design and validated FFQ	

						with birth weight: increased by 10.7 g (95% CI 7.3–14.2) per quintile.				
The Danish National Birth Cohort Study - DNBC Study	Mikkelsen et al. (2008)	Association between a Mediterranean-type diet and risk of preterm birth among Danish women: a prospective cohort study. <i>Acta Obstetrica et Gynecologica Scandinavica</i> 87 (3), 325-330.	No	No	Preterm birth (<37 weeks) and early preterm delivery (<35 weeks)	OR for preterm was 0.61 (95% Confidence Interval (CI): 0.35 1.05) and early preterm birth 0.28 (0.11 0.76) in MD group compared to women who did not fulfil any of the MD criteria. Preterm risk was found to be 29% lower in the MD group and 72% lower for early preterm	Since the Mediterranean area includes many different countries, there are different ways to define a MD diet. There was a MD group of women who met all the study's criteria for a MD diet. Two control groups were defined as: control group 1 consisted of women that fulfilled 1-4	.	Strengths: Exposure group definitions were made a priori (MD diet), sample size and prospective design. Limitations: Although dietary intake tends to be constant in pregnancy, dietary intake was measured during 4 weeks only. Another limitation was the	Future studies are needed

						birth.	criteria (CG1) and control group 2 consisted of women that fulfilled none of the criteria (CG2). 3.2% (1,137) of participants in the present study fulfilled all the MD diet criteria while 1.5% (540) fulfilled none		observational design and the possibility that a MD may be a marker for a healthier lifestyle cannot be ruled out	

Osaka Maternal and Child Health Study - OMCHS study	Miyake <i>et al.</i> (2006)	Risk of postpartum depression in relation to dietary fish and fat intake in Japan: the Osaka Maternal and Child Health Study. <i>Psychological Medicine</i> 36 (12), 1727-1735.	Postpartum depression (Edinburgh Postnatal Depression Scale (EPDS)) - around 2–9 months postpartum	No	No	Out of the 865 surveys, 616 women reported slight or substantial changes in diet in the previous month: 509 due to nausea gravidarum, 98 due to maternal and foetal health and 9 for other reasons. Energy-adjusted intake of fish and n-3 polyunsaturated fatty acids was 48.1 and 2.3 g respectively and mean daily total energy was 6826 kJ. 6% of the babies were born with <2500 g.	First prospective study to examine the relationship between risk of postpartum depression and fish and n-3 polyunsaturated fatty acid intake		Strengths: The prospective design and relatively high rate of follow-up (86.3%) Limitations: The use EPDS for diagnosis rather than a clinician-administered structured diagnostic interview. Also dietary data was collected by using a self-administered tool and tool assessed only dietary intake for 1 month only. Moreover, subjects did not represent Japanese females in the general population so the findings should not be generalized.	Larger studies are needed (with more precise and detailed exposure and outcome measurements)

						While 816 babies (94.3%) were born at 37-41 weeks, 24 were premature deliveries (24–36 weeks of gestation). 14% (121) of the women were revealed by the second survey to have developed postpartum depression in the period from 2 to 9 months postpartum			Finally, the study could not verify an inverse relationship between fish intake and the subsequent risk of postpartum depression	
	Moore et al. (2004)	Dietary composition of pregnant women is related to size of the baby at birth. <i>The Journal of Nutrition</i> 134 (7), 1820-1826.	No	No	Birth weight	The percentage of energy derived from protein was positively associated both with birth weight (P= 0.02) and placental	Maternal dietary composition has an impact on fetal growth hence may be important for the long-term health of the child. Pregnancy	No		More studies regarding supplementation during pregnancy and diet before pregnancy are needed.

						weight ($P=0.07$) in early pregnancy (and independently of energy intake and weight gain during pregnancy). The percentage of energy from carbohydrate was negatively associated with ponderal index of the baby, both in early and late pregnancy. Dietary composition in late pregnancy was substantially unrelated to birth size.	might not be an appropriate time to change a pregnant women's nutritional plane as it could negatively affect the fetus. Study results do not sustain the idea of some sort of dietary supplementation in pregnancy.			
Osaka Maternal and Child	Murakami <i>et al.</i> (2008)	Dietary glycaemic index and load and	Postpartum depression (Japanese)	No	No	14% (121) of the women in the study	First study to examine the relationship of	It is believed that since the levels of insulin	Limitations: Diet was assessed by	Further well-designed studies about

Health Study - OMCHS study		the risk of postpartum depression in Japan: the Osaka Maternal and Child Health Study. <i>Journal of Affective Disorders</i> 110 (1), 174-179.	version of the Edinburgh Postnatal Depression Scale (EPDS) - positive if score of 9 or more) - around at 2–9 months postpartum			were classified as having postpartum depression No evident dose–response relationship between dietary GI and postpartum depression was found, after adjusting for potential confounding factors. A significant decreased risk of postpartum depression was associated with dietary GI in the first quartile and in the third quartile (multivariate odds ratio: 0.56, 95% confidence interval: 0.32–	dietary GI and GL with postpartum depression.	have an abrupt decrease after delivery, a mechanism supposed to cause postpartum depression affecting serotonergic function. Therefore, in order to reduce this symptom, a diet high in GI could be easy the symptoms - by triggering secretion of insulin - and tryptophan (the precursor of serotonin in the brain).	using a self-administered semi-quantitative DHQ (misclassification and bias). Also diet was assessed antenatal rather than postpartum; Diagnosis of postpartum depression was set with a self-report rating scale rather than a clinician-administered structured diagnostic interview; residual confounding effects could not be eliminated; women in the study were an unrepresentative sample of Japanese	dietary GI and GL and postpartum depression is needed

						0.995). For GL, there was no evident independent association (P for trend=0.13).			women in the general population; and modest sample size	
Osaka Maternal and Child Health Study - OMCHS study	Okubo et al. (2011)	Dietary patterns during pregnancy and the risk of postpartum depression in Japan: the Osaka Maternal and Child Health Study. <i>British Journal of Nutrition</i> 105 (08), 1251-1257.	Postpartum depression (Japanese version of the Edinburgh Postnatal Depression Scale (EPDS) - positive if score of 9 or more) - around at 2–9 months postpartum	No	No	Three dietary patterns were identified ('Healthy', 'Western' and 'Japanese') and postpartum depression was found to be present in 14% of the women (121). No association was found between any of the dietary patterns and the risk of postpartum depression. It was only the second quartile, compared	First study to investigate the association between the risk of postpartum depression and dietary patterns		Limitations: the first limitation of the study regarded the diagnosis of postpartum depression that was based on a self-report rating scale. Furthermore, the fact that dietary data were obtained using a self-administered diet history questionnaire and that could bring bias and also the fact that diet was being	More studies with more accurate measurements are needed to confirm this relationship rather than a clinician-administered structured diagnostic interview;

						with the first quartile of the 'Western' dietary pattern, that was found to be independently related to a decreased risk of postpartum depression (multivariate OR 0.52, 95% CI 0.30, 0.93) - although no evident exposure-response associations were observed			measured only the month before it assessment. Moreover, some remaining potential confounders cannot be ruled out. Another limitation was that the sample was not really representative of Japanese women in the general population. Lastly, since it was a small sample, it could have affected statistical power.	

Osaka Maternal and Child Health Study - OMCHS study	Okubo et al. (2012)	Maternal dietary patterns in pregnancy and fetal growth in Japan: the Osaka Maternal and Child Health Study. <i>British Journal of Nutrition</i> 107 (10), 1526-1533.	No	No	Anthropometric measurements at birth (self-reported by mothers on survey 2 according to medical records) and gestational age at birth (estimated on the basis of the first day of the last menstrual period, and confirmed by ultrasound at the first routine health check-up in each hospital)	Three dietary patterns were identified: 'meat and eggs', 'wheat products', and 'rice, fish and vegetables' patterns. Women in the 'wheat products' pattern had infants with the significantly lowest birth weight (P=0.045) and head circumference (P=0.036) among those in the three dietary patterns, after adjustment for potential confounders. The same group of women in the 'wheat products'	SGA: infants with birth anthropometric measurements below the 10th percentile (of the Japanese gestational age- and sex-specific reference growth curves). Results of the study indicate that diet high in bread, confectioneries, and soft drinks and low in fish and vegetables during pregnancy might be associated with a small birth weight and an increased risk of having a SGA infant. The current	There was a small proportion of SGA infants in the reference group of women in the 'rice, fish and vegetables' pattern, the risk of having a SGA infant for weight showed a higher OR and wide 95% CI among women in the 'wheat products' pattern (multivariate OR 5.24, 95% CI 1.13, 24.4), and the results should accordingly be interpreted with caution.	Limitations: not a representative sample of Japanese women in the general population; the dietary assessment method could bring some misreporting; pregnant women self-reported their diet at different stages of pregnancy and diet (in relation to the previous month). Moreover, maternal body weight before pregnancy was not available; and the study could not adjust for all confounding factors.	More large-scale prospective studies are needed to support the association between maternal dietary patterns and fetal growth.

						pattern had higher odds of having a SGA infant for weight (multivariate OR 5.2, 95% CI 1.1, 24.4) if compared to the group of women in the 'rice, fish and vegetables' pattern. But no association was found for birth length or head circumference	finding may reinforce previous observations that maternal diet quality is related to fetal growth			

The Danish National Birth Cohort Study - DNBC Study	Olsen <i>et al.</i> (2007)	Milk consumption during pregnancy is associated with increased infant size at birth: prospective cohort study. <i>American Journal of Clinical Nutrition</i> 86 (4), 1104-1110.	No	No	Size at birth	The intake of milk was inversely associated with the risk of small-for-gestational age (SGA) birth and directly with both large-for-gestational age (LGA) birth and mean birth weight (P for trend <0.001) No association was found between the intake of fat and protein from dairy products (excluding cheese and ice cream), and birth weight.	So, the intake of milk during pregnancy was found to be linked to a reduced risk of SGA, an increased risk of LGA, and an increased mean birth weight, abdominal circumference, placental weight, birth length, and head circumference adjusted for gestational age at birth. "The mean (SD) reported consumption of milk was 3.1 ± 2.0 glasses/d, birth weight was 3596 ± 488 g, birth length was 52.0 ± 2.2 cm, head circumference	There are several components in milk that could be linked to fetal growth. Moreover, the way modern cow milk is processed, it may have a high content of steroids and oestrogen (linked to fetal growth). Another potential mechanism mentioned is the IGF-I (peptide hormone) linked to velocity of growth in children.	Strengths: The prospective observational design. Also the fact that milk intake was assessed in mid-pregnancy. Limitations: milk intake was measured during a short time during pregnancy (1 month only). Also the nonparticipation of women who were eligible to participate.	Further studies

							was 35.0 ± 1.6 cm, abdominal circumference was 32.4 ± 6.6 cm, and placental weight was 662 ± 141 g."			
Project VIVA	Radesky et al. (2008)	Diet during early pregnancy and development of gestational diabetes. <i>Paediatric and Perinatal Epidemiology</i> 22(1), 47-59.	GDM (Non fasting oral glucose test at 26–28 weeks of gestation)	No	No	12% (206) and 5% (91) developed IGT and DDM respectively	A pre-pregnancy BMI may be a stronger predictor of abnormal glucose tolerance than any other dietary effect in early	Pre-pregnancy BMI, age, race/ethnicity, history of GDM and family history of DM, are more likely to be predictors of glucose tolerance and	Limitations: Population on the study could be a bias as they tend to be more well-educated, white and have a higher income; Misclassification	In order to reduce GDM, priority should be given to reduce obesity in women of childbearing age.

							pregnancy; What might influence more DM and GDM is the quality of the diet over the long term as diet only might not have enough time to affect the risk for GDM due to the relatively short duration of a single pregnancy.	GDM other than diet quality in early pregnancy.	n of the dietary assessment used. Strengths: Study design (prospective nature), large sample and the FFQ used was validated.	
Infancia y Medio Ambiente Study - INMA study	Ramon <i>et al.</i> (2009)	Vegetable but not fruit intake during pregnancy is associated with newborn anthropometric measures. <i>Journal of Nutrition</i> 139 (3), 561-567.	No	No	Adjusted birth weight and length	No association was found between fruit intake and birth outcomes however, it was found a linear relationship between the consumption of vegetables and weight and length of the baby as	Still limited data on the association between the consumption of vegetables and fruits and birth size (weight and length)		Limitations: Low participation rate (54%); the use of an FFQ, although appropriate for studies with large sample size could open for a misclassification of intake. Strengths: Data were collected by	Increase both pre-conception and prenatal nutrition counselling in order to promote healthier eating habits

						well as decreased the risk for SGA.			trained interviewers prospectively and accurately at two different times during pregnancy and little participants lost on follow up. Also, potential confounding factors were considered in the analysis.	
Infancia y Medio Ambiente Study - INMA study	Rodriguez-Bernal et al. (2010)	Diet quality in early pregnancy and its effects on fetal growth outcomes: the Infancia y Medio Ambiente (Childhood and Environment) Mother and Child Cohort Study in Spain. <i>American Journal of Clinical Nutrition</i> 91 (6), 1659-	No	No	Anthropometric measures at birth: birth size, birth length and head circumference (adjusted for gestational age)	A positive relation was found between improved diet during pregnancy and fetal growth, birth size and length; also found a lower risk of FGR (especially for weight) for women with a	The assessment of diet quality during pregnancy as a more broad perspective could be a very useful tool for Nutrition in public health care	A higher diet quality index could be reflecting higher intakes of important nutrients important for fetal growth	Limitations: Low participation rate (54%); the use of an FFQ, although appropriate for studies with large sample size could open for a misclassification of intake. Strengths: Data were collected by	More research around the use of AHEI during pregnancy for a more broad use is needed

		1666.				high diet quality index (AHEI)			trained interviewers prospectively and accurately; little participants lost on follow up.	
Pregnancy, Infection, and Nutrition Study - PIN study	Saldana et al. (2004)	Effect of macronutrient intake on the development of glucose intolerance during pregnancy. <i>American Journal of Clinical Nutrition</i> 79 (3), 479-486.	Glucose Intolerance (plasma glucose concentration 1 h after a 50-g glucose challenge test of 140 mg/dL at the University of North Carolina sites and a value 130 mg/dL at the Wake Medical Center) and Gestational Diabetes	No	No	Prevalence of IGT (2.6%) and GDM (5.2%) in the cohort; Women whose diet had a lower percentage of CHOs and higher in fat was more likely to develop IGT and GDM	The present study support the hypothesis that a low-carb and high-fat diet increases the risk of developing IGT during pregnancy. The results are also in accordance with previous studies however contrast with a few others but it could be due to the quality of fat as in the current study		Limitations: Dietary assessment used in the study, like any other, allows misclassification; and also, bias could be introduced by the sample is underrepresented by black women.	Further studies are needed to not only distinguish how to better distribute the increased calories on the different macronutrients but also studies that will separate out the quality of CHOs and fats of the diet.

			Mellitus (GDM)				the population's intake of polyunsaturated fat was low.			
	Sartorelli <i>et al.</i> (2014)	Fried food intake estimated by the multiple source method is associated with gestational weight gain. <i>Nutrition Research</i> 34 (8), 667-673.	Gestational Weight Gain (GWG)	No	No	18 (20.5%) and 36 (40.9%) of the 88 pregnant women gained suboptimal and excessive weight, respectively. No differences were found between women in the 3 categories of weight gain during pregnancy and intake of fried food.	The results unveil that the intake of fried food determined by MSM, but not by the FFQ and 24hRs, is related with excessive GWG. The study seems to be the first to demonstrate that the MSM can be a useful approach for assessing food intake and health outcomes.		Limitations: Small sample size, the different number of 24hRs replicates among women. Furthermore, the covariate data that was collected on the first trimester of pregnancy was subject to change over the period of pregnancy.	Further studies are needed and MSM approach as useful in epidemiological studies with short-term dietary data

						However a positive relationship was found between the intake of fried food and GWG and weight gain ration after the application of the MSM approach.	during pregnancy			

Healthy Start Study	Starling <i>et al.</i> (2017)	Maternal Dietary Patterns during Pregnancy Are Associated with Newborn Body Composition. <i>The Journal of Nutrition</i> 147 (7), 1334-1339.	No	No	Newborn adiposity: newborn body composition was measured within 3 d of birth by using air displacement plethysmography via the PEA POD device (COSMED)	Dietary pattern 1 was correlated with greater GWG ($r = 0.22$, $P < 0.01$) but lower fasting glucose at mid-pregnancy ($r = 0.16$, $P < 0.01$). Dietary pattern 2 was correlated with greater fasting glucose ($r = 0.09$, $P = 0.02$). In covariate-adjusted analyses, adherence to dietary pattern 1 was associated with greater	Two dietary patterns were identified and study findings suggest that maternal dietary patterns during pregnancy may be an important determinant of newborn body composition, independent of maternal obesity, total energy intake, and physical activity	The study findings indicate that certain gestational dietary patterns consumed by the mother during pregnancy may play a role to newborn size and body composition, potentially through effects on maternal fasting glucose.	Strengths: To our knowledge, there have been no previous studies describing data-driven maternal dietary patterns associated with newborn body composition, sample size, prospective study. Limitation: study design averaged intakes across the multiple ASA24s which unable to evaluate changes in the dietary composition	Longer term follow-up (as planned within the study)

						newborn fat-free mass but not fat mass. Women in the highest tertile of adherence to dietary pattern 1 had newborns with 61 g higher fat-free mass at birth (95% CI 12, 110 g) compared with women in the lowest tertile. By contrast, adherence to dietary pattern 2 was associated with greater newborn fat mass, birth weight, and adiposity. Women in the highest tertile of adherence to dietary pattern 2 had offspring with				

						33 g higher fat mass (95% CI 8, 59 g), 80 g higher birth weight (95% CI 15, 145 g), and 0.9% higher adiposity at birth (95% CI 0.3%, 1.6%) compared with women in the lowest tertile.				

Appendix 3-5: List of excluded studies

Excluded studies on full text (by reasons):

Abstracts, commentaries, errata, evidence summaries, protocols, RCTs, review, recommendations

Study	Reason for exclusion
Child Health Alert (2008) Diet and nutrition. Eating fish in pregnancy--is it a good or bad idea? <i>Child Health Alert</i> 26 , 3.	Commentary
Brent R.L. (1985) Maternal nutrition and congenital malformations. <i>Birth Defects Original Article Series</i> 21 (5), 1-8.	Review
Doyle W., Crawford M.A., Wynn A.H.A. & Wynn S.W. (1989) Maternal nutrient intake and birthweight. <i>Journal of Human Nutrition and Dietetics</i> 2 , 415-422.	Letter
Enoch J. (2004) Antioxidants and preeclampsia. <i>Midwifery Today with International Midwife</i> 72 , 20-23.	Review
Morris C.D., Jacobson S.L., Anand R., Ewell M.G., Hauth J.C., Curet L.B., Catalano P.M., Sibai B.M. & Levine R.J. (2001) Nutrient intake and hypertensive disorders of pregnancy: Evidence from a large prospective cohort. <i>American Journal of Obstetrics and Gynecology</i> 184 (4), 643-651.	RCT
Nishimura R.Y., Barbieri P., Castro G.S., Jordao A.A., Jr., Perdoni G.S. & Sartorelli D.S. (2014) Dietary polyunsaturated fatty acid intake during late pregnancy affects fatty acid composition of mature breast milk. <i>Nutrition</i> 30 (6), 685-689.	Validation study
Nunes M.A., Ferri C.P., Manzolli P., Soares R.M., Drehmer M., Buss C., Giacomello A., Hoffmann J.F., Ozcariz S., Melere C., Manenti C.N., Camey S., Duncan B.B. & Schmidt M.I. (2010) Nutrition, mental health and violence: from pregnancy to postpartum Cohort of women attending primary care units in Southern Brazil--ECCAGE study. <i>BMC Psychiatry</i> 10 , 66.	Study protocol
Sengpiel V., Bachelis J., Myhre R., Myking S., Devold Pay A.S., Haugen M., Brantsaeter A.L., Meltzer H.M., Nilsen R.M., Magnus P., Vollset S.E., Nilsson S. & Jacobsson B. (2014) Folic acid supplementation, dietary folate intake during pregnancy and risk for spontaneous preterm delivery: a prospective observational cohort study. <i>BMC Pregnancy and Childbirth</i> 14 , 375.	Retracted article
Shanholtz M.I. (1971) Maternal nutrition and the course of pregnancy. <i>Virginia Medical Monthly</i> (1918) 98 (7), 381-383.	Book report
Kizirian N.V., Markovic T.P., Muirhead R., Brodie S., Garnett S.P., Louie J.C., Petocz P., Ross G.P. & Brand-Miller J.C. (2016) Macronutrient Balance and Dietary Glycemic Index in Pregnancy Predict Neonatal Body Composition. <i>Nutrients</i> 8 (5), 270.	RCT

Martin C.L., Siega-Riz A.M., Sotres-Alvarez D., Robinson W.R., Daniels J.L., Perrin E.M. & Stuebe A.M. (2016) Maternal Dietary Patterns are Associated with Lower Levels of Cardiometabolic Markers during Pregnancy. <i>Paediatric and Perinatal Epidemiology</i> 30 (3), 246-255.	Not a primary study
Shin D., Lee K.W. & Song W.O. (2015) Dietary Patterns during Pregnancy Are Associated with Risk of Gestational Diabetes Mellitus. <i>Nutrients</i> 7 (11), 9369-9382.	Not a primary study

No proper data on diet during pregnancy

Study	Reason for exclusion
Ademowore A.S., Courey N.G. & Kime J.S. (1972) Relationships of maternal nutrition and weight gain to newborn birthweight. <i>Obstetrics & Gynecology</i> 39 (3), 460-464.	Diet was not measured in all the population. Gestational weight gain was the main focus of the study.
Ali F., Thaver I. & Khan S.A. (2014) Assessment of dietary diversity and nutritional status of pregnant women in Islamabad, Pakistan. <i>Journal of Ayub Medical College Abbottabad</i> 26 (4), 506-509.	Dietary diversity is being measured
Bille C., Olsen J., Vach W., Knudsen V.K., Olsen S.F., Rasmussen K., Murray J.C., Andersen A.M. & Christensen K. (2007) Oral clefts and life style factors--a case-cohort study based on prospective Danish data. <i>European Journal of Epidemiology</i> 22 (3), 173-181.	Diet was not assessed, only supplements
Golding J., Steer C.D., Hibbeln J.R., Emmett P.M., Lowery T. & Jones R. (2013) Dietary predictors of maternal prenatal blood mercury levels in the ALSPAC birth cohort study. <i>Environmental Health Perspectives</i> 121 (10), 1214-1218.	Diet was not properly assessed – focus was on GWG and not on diet
Horan M.K., McGowan C.A., Gibney E.R., Donnelly J.M. & McAuliffe F.M. (2014) Maternal low glycaemic index diet, fat intake and postprandial glucose influences neonatal adiposity--secondary analysis from the ROLO study. <i>Nutrition Journal</i> 13 , 78.	Abstract data on intervention group
Jednak M.A., Shadigian E.M., Kim M.S., Woods M.L., Hooper F.G., Owyang C. & Hasler W.L. (1999) Protein meals reduce nausea and gastric slow wave dysrhythmic activity in first trimester pregnancy. <i>American Journal of Physiology</i> 277 (4 Pt 1), G855-861.	Assessing nausea and vomiting rather than diet
Jia Z.L., Shi B., Chen C.H., Shi J.Y., Wu J. & Xu X. (2011) Maternal malnutrition, environmental exposure during pregnancy and the risk of non-syndromic orofacial clefts. <i>Oral Diseases</i> 17 (6), 584-589.	Focus more on environmental factors and smoking
Mathew L.K. & Ko C. (2015) Dietary fat and protein intake are not associated with incident biliary sludge and stones during pregnancy. <i>Journal of Parenteral and Enteral Nutrition</i> 39 (1), 124-128.	Data on assessment of diet is unclear
Saftlas A.F., Triche E.W., Beydoun H. & Bracken M.B. (2010) Does chocolate	Chocolate intake only

intake during pregnancy reduce the risks of preeclampsia and gestational hypertension? <i>Annals of Epidemiology</i> 20 (8), 584-591.	
Shin D., Bianchi L., Chung H., Weatherspoon L. & Song W.O. (2014) Is gestational weight gain associated with diet quality during pregnancy? <i>Maternal and Child Health Journal</i> 18 (6), 1433-1443.	Dietary data collected at one time point only
Shiraishi M., Haruna M., Matsuzaki M., Ota E., Murayama R., Sasaki S., Yeo S. & Murashima S. (2014) Relationship between plasma total homocysteine level and dietary caffeine and vitamin B ₆ intakes in pregnant women. <i>Nursing & Health Sciences</i> 16 (2), 164-170.	Focusing on specific nutrients in relation to plasma total homocysteine level
Tarrant R.C., Younger K.M., Sheridan-Pereira M. & Kearney J.M. (2011) Maternal health behaviours during pregnancy in an Irish obstetric population and their associations with socio-demographic and infant characteristics. <i>European Journal of Clinical Nutrition</i> 65 (4), 470-479.	No diet, only supplement use
Tovar A., Must A., Bermudez O.I., Hyatt R.R. & Chasan-Taber L. (2009) The impact of gestational weight gain and diet on abnormal glucose tolerance during pregnancy in Hispanic women. <i>Maternal and Child Health Journal</i> 13 (4), 520-530.	
Vahratian A., Siega-Riz A.M., Savitz D.A. & Thorp J.M. Jr. (2004) Multivitamin use and the risk of preterm birth. <i>American Journal of Epidemiology</i> 160 (9), 886-892.	No diet, only supplement use
Wen L.M., Simpson J.M., Rissel C. & Baur L.A. (2013) Maternal "junk food" diet during pregnancy as a predictor of high birthweight: findings from the healthy beginnings trial. <i>Birth</i> 40 (1), 46-51.	Selected dietary behaviours were measured
Wolff C.B. & Wolff H.K. (1995) Maternal eating patterns and birth weight of Mexican American infants. <i>Nutrition and Health</i> 10 (2), 121-134.	Data collected 5 years after birth
Meher A., Randhir K., Mehendale S., Wagh G. & Joshi S. (2016) Maternal Fatty Acids and Their Association with Birth Outcome: A Prospective Study. <i>PLOS One</i> 11 (1), e0147359.	Diet not being assessed here but rather blood levels of LC PUFA

Case control study

Study	Reason for exclusion
Atkinson J.O., Mahomed K., Williams M.A., Woelk G.B., Mudzamiri S. & Weiss N.S. (1998) Dietary risk factors for pre-eclampsia among women attending Harare Maternity Hospital, Zimbabwe. <i>Central African Journal of Medicine</i> 44 (4), 86-92.	Case control study
Carmichael S.L., Shaw G.M., Schaffer D.M., Laurent C. & Selvin S. (2003) Dieting behaviors and risk of neural tube defects. <i>American Journal of Epidemiology</i> 158 (12), 1127-1131.	Case control study
Carmichael S.L., Shaw G.M., Selvin S. & Schaffer D.M. (2003) Diet quality and	Case control study

risk of neural tube defects. <i>Medical Hypotheses</i> 60 (3), 351-355.	
Carmichael S.L., Yang W., Correa A., Olney R.S. & Shaw G.M. (2009) Hypospadias and intake of nutrients related to one-carbon metabolism. <i>The Journal of Urology</i> 181 (1), 315-321.	Case control study
Christensen J.S., Asklund C., Skakkebaek N.E., Jorgensen N., Andersen H.R., Jorgensen T.M., Olsen L.H., Hoyer A.P., Moesgaard J., Thorup J. & Jensen T.K. (2013) Association between organic dietary choice during pregnancy and hypospadias in offspring: a study of mothers of 306 boys operated on for hypospadias. <i>The Journal of Urology</i> 189 (3), 1077-1082.	Case control study
de Kort C.A., Nieuwenhuijsen M.J. & Mendez M.A. (2011) Relationship between maternal dietary patterns and hypospadias. <i>Paediatric and Perinatal Epidemiology</i> 25 (3), 255-264.	Case control study
Di Cintio E., Parazzini F., Chatenoud L., Surace M., Benzi G., Zanconato G. & La Vecchia C. (2001) Dietary factors and risk of spontaneous abortion. <i>European Journal of Obstetrics & Gynecology and Reproductive Biology</i> 95 (1), 132-136.	Case control study
Frederick I.O., Williams M.A., Dashow E. & et al. (2005) Dietary fiber, potassium, magnesium and calcium in relation to the risk of preeclampsia. <i>Journal of Reproductive Medicine</i> 50 , 332-344.	Case control study
Giordano F., Carbone P., Nori F., Mantovani A., Taruscio D. & Figa-Talamanca I. (2008) Maternal diet and the risk of hypospadias and cryptorchidism in the offspring. <i>Paediatric and Perinatal Epidemiology</i> 22 (3), 249-260.	Case control study
Huber J.C., Jr., Brender J.D., Zheng Q., Sharkey J.R., Vuong A.M., Shinde M.U., Griesenbeck J.S., Suarez L., Langlois P.H., Canfield M.A., Romitti P.A. & Weyer P.J. (2013) Maternal dietary intake of nitrates, nitrites and nitrosamines and selected birth defects in offspring: a case-control study. <i>Nutrition Journal</i> 12 , 34.	Case control study
Johansen A.M., Lie R.T., Wilcox A.J., Andersen L.F. & Drevon C.A. (2008) Maternal dietary intake of vitamin A and risk of orofacial clefts: a population-based case-control study in Norway. <i>American Journal of Epidemiology</i> 167 (10), 1164-1170.	Case control study
Johansen A.M., Wilcox A.J., Lie R.T., Andersen L.F. & Drevon C.A. (2009) Maternal consumption of coffee and caffeine-containing beverages and oral clefts: a population-based case-control study in Norway. <i>American Journal of Epidemiology</i> 169 (10), 1216-1222.	Case control study
Kesmodel U., Olsen S.F. & Salvig J.D. (1997) Marine n-3 fatty acid and calcium intake in relation to pregnancy induced hypertension, intrauterine growth retardation, and preterm delivery. A case-control study. <i>Acta Obstetrica et Gynecologica Scandinavica</i> 76 (1), 38-44.	Case control study
Mitchell E.A., Robinson E., Clark P.M., Becroft D.M., Glavish N., Pattison N.S., Pryor J.E., Thompson J.M. & Wild C.J. (2004) Maternal nutritional risk factors for small for gestational age babies in a developed country: a case-control study. <i>Archives of Disease in Childhood: Fetal & Neonatal Edition</i> 89 (5), F431-435.	Case control study

Petridou E., Stoikidou M., Diamantopoulou M., Mera E., Dessypris N. & Trichopoulos D. (1998) Diet during pregnancy in relation to birthweight in healthy singletons. <i>Child: Care, Health and Development</i> 24 (3), 229-242.	Case control study
Pogoda J.M., Preston-Martin S., Howe G., Lubin F., Mueller B.A., Holly E.A., Filippini G., Peris-Bonet R., McCredie M.R., Cordier S. & Choi W. (2009) An international case-control study of maternal diet during pregnancy and childhood brain tumor risk: a histology-specific analysis by food group. <i>Annals of Epidemiology</i> 19 (3), 148-160.	Case control study
Reyes L., Garcia R., Ruiz S., Dehghan M. & Lopez-Jaramillo P. (2012) Nutritional status among women with pre-eclampsia and healthy pregnant and non-pregnant women in a Latin American country. <i>Journal of Obstetrics and Gynaecology Research</i> 38 (3), 498-504.	Case control study
Rondo P.H., Rodrigues L.C. & Tomkins A.M. (1996) Coffee consumption and intrauterine growth retardation in Brazil. <i>European Journal of Clinical Nutrition</i> 50 (11), 705-709.	Case control study
Simmer K., Iles C.A., Slavin B., Keeling P.W. & Thompson R.P. (1987) Maternal nutrition and intrauterine growth retardation. <i>Human Nutrition: Clinical nutrition</i> 41 (3), 193-197.	Case control study
Thompson J.M., Wall C., Becroft D.M., Robinson E., Wild C.J. & Mitchell E.A. (2010) Maternal dietary patterns in pregnancy and the association with small-for-gestational-age infants. <i>British Journal of Nutrition</i> 103 (11), 1665-1673.	Case control study
van Rooij I.A., Ocke M.C., Straatman H., Zielhuis G.A., Merkus H.M. & Steegers-Theunissen R.P. (2004) Periconceptional folate intake by supplement and food reduces the risk of nonsyndromic cleft lip with or without cleft palate. <i>Preventive Medicine</i> 39 (4), 689-694.	Case control study
Vujkovic M., Steegers E.A., Looman C.W., Ocke M.C., van der Spek P.J. & Steegers-Theunissen R.P. (2009) The maternal Mediterranean dietary pattern is associated with a reduced risk of spina bifida in the offspring. <i>British Journal of Obstetrics and Gynaecology</i> 116 (3), 408-415.	Case control study
Wilcox A.J., Lie R.T., Solvoll K., Taylor J., McConaughy D.R., Abyholm F., Vindenes H., Vollset S.E. & Drevon C.A. (2007) Folic acid supplements and risk of facial clefts: national population based case-control study. <i>British Medical Journal</i> 334 (7591), 464.	Case control study
Wright M.E. (1995) A case-control study of maternal nutrition and neural tube defects in Northern Ireland. <i>Midwifery</i> 11 (3), 146-152.	Case control study
Yang W., Shaw G.M., Carmichael S.L., Rasmussen S.A., Waller D.K., Poer B.R. & Anderka M. (2008) Nutrient intakes in women and congenital diaphragmatic hernia in their offspring. <i>Birth Defects Research Part A: Clinical and Molecular Teratology</i> 82 (3), 131-138.	Case control study
Yazdy M.M., Liu S., Mitchell A.A. & Werler M.M. (2010) Maternal dietary glycemic intake and the risk of neural tube defects. <i>American Journal of Epidemiology</i> 171 (4), 407-414.	Case control study

Yazdy M.M., Mitchell A.A., Liu S. & Werler M.M. (2011) Maternal dietary glycaemic intake during pregnancy and the risk of birth defects. <i>Paediatric and Perinatal Epidemiology</i> 25 (4), 340-346.	Case control study
Zhang B.Y., Zhang T., Lin L.M., Wang F., Xin R.L., Gu X., He Y.N., Yu D.M., Li P.Z., Zhang Q.S., Zhao J., Qin Y.F., Yang X.F., Chen G., Liu J.F., Song X.M. & Zheng X.Y. (2008) Correlation between birth defects and dietary nutrition status in a high incidence area of China. <i>Biomedical and Environmental Sciences</i> 21 (1), 37-44.	Case control study
Zhang C., Williams M.A., Frederick I.O., King I.B., Sorensen T.K., Kestin M.M., Dashow E.E. & Luthy D.A. (2004) Vitamin C and the risk of gestational diabetes mellitus: a case-control study. <i>Journal of Reproductive Medicine</i> 49 (4), 257-266.	Case control study

Studies in another language

Study	Reason for exclusion
Belaisch J., Lazar P., Papoz L. & Papiernik E. (1982) [The role of maternal nutrition in determining birth weight]. <i>Journal de gynecologie, obstetrique et biologie de la reproduction</i> 11 (1), 64-67.	In French
Bellati U., Pompa P. & Liberati M. (1994) [Analytic evaluation of a "Mediterranean" diet in pregnancy]. <i>Minerva Ginecologica</i> 46 (4), 183-187.	In Italian
Campoy C., Martin-Bautista E., Garcia-Valdes L., Florido J., Agil A., Lorente J.A., Marcos A., Lopez-Sabater M.C., Miranda-Leon T., Sanz Y. & Molina-Font J.A. (2008) [Study of maternal nutrition and genetic on the foetal adiposity programming (The PREOBE study)]. <i>Nutrición Hospitalaria</i> 23 (6), 584-590.	In Spanish
Denguezli W., Faleh R., Hajjaji A., Saidani Z., Letaief M., Haddad A., Laajili H. & Sakouhi M. (2007) [Maternal nutrition as a determinant of fetal weight: role of trace elements and vitamins]. <i>Journal de gynecologie, obstetrique et biologie de la reproduction</i> 36 (5), 473-478.	In French
Martins A.P. & Benicio M.H. (2011) Influence of dietary intake during gestation on postpartum weight retention. <i>Revista de Saúde Pública</i> 45 (5), 870-877.	In Portuguese
Martins E.B. & Nunez Urquiza R.M. (2003) [Energy intake, maternal nutritional status and intrauterine growth retardation]. <i>Cadernos de Saúde Pública</i> 19 (1), 279-285.	In Spanish
Xu S.X. (1993) [Relation between nutrition of pregnant women and small-for-gestational age infants]. <i>Zhonghua Fu Chan Ke Za Zhi</i> 28 (10), 589-591, 634.	In Chinese
Ying H. & Wang D.F. (2006) [Effects of dietary fat on onset of gestational diabetes mellitus]. <i>Zhonghua Fu Chan Ke Za Zhi</i> 41 (11), 729-731.	In Chinese

Ineligible data on diet measurement

Study	Reason for exclusion
Bower C., Miller M., Payne J. & Serna P. (2006) Folate intake and the primary prevention of non-neural birth defects. <i>Australian & New Zealand Journal of Public Health</i> 30 (3), 258-261.	Pre-pregnancy diet
Bradshaw M.K. & Pfeiffer S. (1988) Feeding mode and anthropometric changes in primiparas. <i>Human Biology</i> 60 (2), 251-261.	Postpartum diet
Browne J.C., Scott K.M. & Silvers K.M. (2006) Fish consumption in pregnancy and omega-3 status after birth are not associated with postnatal depression. <i>Journal of Affective Disorders</i> 90 (2-3), 131-139.	Pre-pregnancy diet
Carmichael S.L., Shaw G.M., Schaffer D.M., Laurent C. & Selvin S. (2003) Dieting behaviors and risk of neural tube defects. <i>American Journal of Epidemiology</i> 158 (12), 1127-1131.	Pre-pregnancy diet (and case-control study)
Carmichael S.L., Shaw G.M., Selvin S. & Schaffer D.M. (2003) Diet quality and risk of neural tube defects. <i>Medical Hypotheses</i> 60 (3), 351-355.	Pre-pregnancy diet (and case-control study)
Carmichael S.L., Yang W. & Shaw G.M. (2013) Maternal dietary nutrient intake and risk of preterm delivery. <i>American Journal of Perinatology</i> 30 (7), 579-588.	Pre-pregnancy diet (1 year before pregnancy)
Carmichael S.L., Yang W., Correa A., Olney R.S. & Shaw G.M. (2009) Hypospadias and intake of nutrients related to one-carbon metabolism. <i>The Journal of Urology</i> 181 (1), 315-321.	Pre-pregnancy diet (and case-control study)
Dominguez L.J., Martinez-Gonzalez M.A., Basterra-Gortari F.J., Gea A., Barbagallo M. & Bes-Rastrollo M. (2014) Fast food consumption and gestational diabetes incidence in the SUN project. <i>PLOS One</i> 9 (9), e106627.	Pre-pregnancy diet
Drehmer M., Camey S.A., Nunes M.A., Duncan B.B., Lacerda M., Pinheiro A.P. & Schmidt M.I. (2013) Fibre intake and evolution of BMI: from pre-pregnancy to postpartum. <i>Public Health Nutrition</i> 16 (8), 1403-1413.	Pre-pregnancy to postpartum
Fowles E.R. & Walker L.O. (2006) Correlates of dietary quality and weight retention in postpartum women. <i>Journal of Community Health Nursing</i> 23 (3), 183-197.	Postpartum diet
Guldner L., Monfort C., Rouget F., Garlantezec R. & Cordier S. (2007) Maternal fish and shellfish intake and pregnancy outcomes: a prospective cohort study in Brittany, France. <i>Environmental Health</i> 6 , 33.	Pre-pregnancy diet
Krapels I.P., van Rooij I.A., Ocke M.C., van Cleef B.A., Kuijpers-Jagtman A.M. & Steegers-Theunissen R.P. (2004) Maternal dietary B vitamin intake, other than folate, and the association with orofacial cleft in the offspring. <i>European Journal of Nutrition</i> 43 (1), 7-14.	Data on dietary pattern was collected around 14 months after birth
Lukose A., Ramthal A., Thomas T., Bosch R., Kurpad A., Duggan C. & Srinivasan K. (2014) Nutritional Factors Associated with Antenatal Depressive Symptoms in the Early Stage of Pregnancy Among Urban South	Pre-pregnancy diet

Indian Women. <i>Maternal & Child Health Journal</i> 18 (1), 161-170.	
Lyu L.C., Lo C.C., Chen H.F., Wang C.Y. & Liu D.M. (2009) A prospective study of dietary intakes and influential factors from pregnancy to postpartum on maternal weight retention in Taipei, Taiwan. <i>British Journal of Nutrition</i> 102 (12), 1828-1837.	Postpartum diet
Borst-Obermann S.A., Vujković M., de Vries J.H., Dohle G.R., Lindemans J., Steegers E.A. & Steegers-Theunissen R.P. (2010) A maternal dietary pattern characterized by fish and seafood is associated with a reduced risk of congenital heart defects in the offspring. In <i>Dietary Patterns and Human Reproduction</i> (Vujković, M., ed), pp.78-93.	Pre-pregnancy diet
Pastor-Valero M., Navarrete-Munoz E.M., Rebagliato M., Iniguez C., Murcia M., Marco A., Ballester F. & Vioque J. (2011) Periconceptional folic acid supplementation and anthropometric measures at birth in a cohort of pregnant women in Valencia, Spain. <i>British Journal of Nutrition</i> 105 (9), 1352-1360.	Pre-pregnancy assessment of FA
Qiu C., Frederick I.O., Zhang C., Sorensen T.K., Enquobahrie D.A. & Williams M.A. (2011) Risk of gestational diabetes mellitus in relation to maternal egg and cholesterol intake. <i>American Journal of Epidemiology</i> 173 (6), 649-658.	Pre-pregnancy diet
Ricci E., Chiaffarino F., Cipriani S., Malvezzi M. & Parazzini F. (2010) Diet in pregnancy and risk of small for gestational age birth: results from a retrospective case-control study in Italy. <i>Maternal & Child Nutrition</i> 6 (4), 297-305.	Pre-pregnancy diet
Robitaille J., Carmichael S.L., Shaw G.M. & Olney R.S. (2009) Maternal nutrient intake and risks for transverse and longitudinal limb deficiencies: data from the National Birth Defects Prevention Study, 1997-2003. <i>Birth Defects Research Part A: Clinical and Molecular Teratology</i> 85 (9), 773-779.	Pre-pregnancy diet
Shaw G.M., Carmichael S.L., Laurent C. & Siega-Riz A.M. (2008) Periconceptional glycaemic load and intake of sugars and their association with neural tube defects in offspring. <i>Paediatric and Perinatal Epidemiology</i> 22 (6), 514-519.	Pre-pregnancy diet
Shaw G.M., Carmichael S.L., Yang W. & Lammer E.J. (2010) Periconceptional nutrient intakes and risks of conotruncal heart defects. <i>Birth Defects Research Part A: Clinical and Molecular Teratology</i> 88 (3), 144-151.	Pre-pregnancy diet
Shaw G.M., Carmichael S.L., Yang W. & Siega-Riz A.M. (2011) Periconceptional intake of folic acid and food folate and risks of preterm delivery. <i>American Journal of Perinatology</i> 28 (10), 747-752.	Pre-pregnancy diet
Shaw G.M., Quach T., Nelson V., Carmichael S.L., Schaffer D.M., Selvin S. & Yang W. (2003) Neural tube defects associated with maternal periconceptional dietary intake of simple sugars and glycemic index. <i>American Journal of Clinical Nutrition</i> 78 (5), 972-978.	Pre-pregnancy diet
Shaw G.M., Schaffer D., Velie E.M., Morland K. & Harris J.A. (1995) Periconceptional vitamin use, dietary folate, and the occurrence of neural	Pre-pregnancy diet

tube defects. <i>Epidemiology</i> 6 (3), 219-226.	
Smedts H.P., de Vries J.H., Rakhshandehroo M., Wildhagen M.F., Verkleij-Hagoort A.C., Steegers E.A. & Steegers-Theunissen R.P. (2009) High maternal vitamin E intake by diet or supplements is associated with congenital heart defects in the offspring. <i>BJOG: An International Journal of Obstetrics & Gynaecology</i> 116 (3), 416-423.	Postpartum diet
Sotres-Alvarez D., Siega-Riz A.M., Herring A.H., Carmichael S.L., Feldkamp M.L., Hobbs C.A. & Olshan A.F. (2013) Maternal dietary patterns are associated with risk of neural tube and congenital heart defects. <i>American Journal of Epidemiology</i> 177 (11), 1279-1288.	Pre-pregnancy diet
Thompson S.J., Torres M.E., Stevenson R.E., Dean J.H. & Best R.G. (2003) Periconceptional multivitamin folic acid use, dietary folate, total folate and risk of neural tube defects in South Carolina. <i>Annals of Epidemiology</i> 13 (6), 412-418.	Pre-pregnancy diet (also focus is on supplement use)
Wallenstein M.B., Shaw G.M., Yang W. & et al. (2013) Periconceptional nutrient intakes and risks of orofacial clefts in California. <i>Pediatric Research</i> 74 (4), 457-465.	Periconceptional diet (and intake of nutrients)
Wright M.E. (1995) A case-control study of maternal nutrition and neural tube defects in Northern Ireland. <i>Midwifery</i> 11 (3), 146-152.	Postpartum diet (also case-control study)
Yang W., Shaw G.M., Carmichael S.L., Rasmussen S.A., Waller D.K., Pober B.R. & Anderka M. (2008) Nutrient intakes in women and congenital diaphragmatic hernia in their offspring. <i>Birth Defects Research. Part A, Clinical and Molecular Teratology</i> 82 (3), 131-138.	Postpartum diet (also case-control study)
Yazdy M.M., Liu S., Mitchell A.A. & Werler M.M. (2010) Maternal dietary glycemic intake and the risk of neural tube defects. <i>American Journal of Epidemiology</i> 171 (4), 407-414.	Pre-pregnancy diet (also case-control study)
Yazdy M.M., Mitchell A.A., Liu S. & Werler M.M. (2011) Maternal dietary glycaemic intake during pregnancy and the risk of birth defects. <i>Paediatric and Perinatal Epidemiology</i> 25 (4), 340-346.	Pre-pregnancy diet (also case-control study)
Zhang C., Liu S., Solomon C.G. & Hu F.B. (2006) Dietary fiber intake, dietary glycemic load, and the risk for gestational diabetes mellitus. <i>Diabetes Care</i> 29 (10), 2223-2230.	Pre-pregnancy diet
Zhang C., Williams M.A., Frederick I.O., King I.B., Sorensen T.K., Kestin M.M., Dashow E.E. & Luthy D.A. (2004) Vitamin C and the risk of gestational diabetes mellitus: a case-control study. <i>The Journal of Reproductive Medicine</i> 49 (4), 257-266.	Periconceptional diet (and case-control study)
Zhang C., Williams M.A., King I.B. & et al. (2002) Vitamin C and the risk of preeclampsia - results from dietary questionnaire and plasma assay. <i>Epidemiology</i> 13 (4), 409-416.	Pre-pregnancy diet
Zhang C., Williams M.A., Sorensen T.K., King I.B., Kestin M.M., Thompson M.L., Leisenring W.M., Dashow E.E. & Luthy D.A. (2004) Maternal plasma ascorbic Acid (vitamin C) and risk of gestational diabetes mellitus.	Periconceptional diet

<i>Epidemiology</i> 15 (5), 597-604.	
van Rooij I.A., Ocke M.C., Straatman H., Zielhuis G.A., Merkus H.M. & Steegers-Theunissen R.P. (2004) Periconceptional folate intake by supplement and food reduces the risk of nonsyndromic cleft lip with or without cleft palate. <i>Preventive Medicine</i> 39 (4), 689-694.	Postpartum diet (also case-control study)
Vujkovic M., Steegers E.A., Looman C.W., Ocke M.C., van der Spek P.J. & Steegers-Theunissen R.P. (2009) The maternal Mediterranean dietary pattern is associated with a reduced risk of spina bifida in the offspring. <i>BJOG: An International Journal of Obstetrics & Gynaecology</i> 116 (3), 408-415.	Postpartum diet (also case-control study)

Ineligible (Non-comparable) population

Study	Reason for exclusion
Ding Y., Lv J., Mao C., Zhang H., Wang A., Zhu L., Zhu H. & Xu Z. (2010) High-salt diet during pregnancy and angiotensin-related cardiac changes. <i>Journal of Hypertension</i> 28 (6), 1290-1297.	Study in rats
Leventakou V., Roumeliotaki T., Martinez D., Barros H., Brantsaeter A.L., Casas M., Charles M.A., Cordier S., Eggesbo M., van Eijsden M., Forastiere F., Gehring U., Govarts E., Halldorsson T.I., Hanke W., Haugen M., Heppe D.H., Heude B., Inskip H.M., Jaddoe V.W., Jansen M., Kelleher C., Meltzer H.M., Merletti F., Molto-Puigmarti C., Mommers M., Murcia M., Oliveira A., Olsen S.F., Pele F., Polanska K., Porta D., Richiardi L., Robinson S.M., Stigum H., Strom M., Sunyer J., Thijs C., Viljoen K., Vrijkotte T.G., Wijga A.H., Kogevinas M., Vrijheid M. & Chatzi L. (2014) Fish intake during pregnancy, fetal growth, and gestational length in 19 European birth cohort studies. <i>American Journal of Clinical Nutrition</i> 99 (3), 506-516.	Follow up cohort even before women were pregnant
Mian C., Vitaliano P., Pozza D., Barollo S., Pitton M., Callegari G., Di Gianantonio E., Casaro A., Nacamulli D., Busnardo B., Mantero F. & Girelli M.E. (2009) Iodine status in pregnancy: role of dietary habits and geographical origin. <i>Clinical Endocrinology</i> 70 (5), 776-780.	Findings presented on specific population
Morrison J.A., Glueck C.J. & Wang P. (2008) Dietary trans fatty acid intake is associated with increased fetal loss. <i>Fertility and Sterility</i> 90 (2), 385-390.	Follow up cohort even before women were pregnant
Pogoda J.M., Preston-Martin S., Howe G., Lubin F., Mueller B.A., Holly E.A., Filippini G., Peris-Bonet R., McCredie M.R., Cordier S. & Choi W. (2009) An international case-control study of maternal diet during pregnancy and childhood brain tumor risk: a histology-specific analysis by food group. <i>Annals of Epidemiology</i> 19 (3), 148-160.	Women were not pregnant (also a case control study)
Reyes L., Garcia R., Ruiz S., Dehghan M. & Lopez-Jaramillo P. (2012) Nutritional status among women with pre-eclampsia and healthy pregnant and non-pregnant women in a Latin American country. <i>Journal of Obstetrics and Gynaecology Research</i> 38 (3), 498-504.	Women with pre-eclampsia, non pregnant women (also a case-control study)

Shah K.P. & Shah P.M. (1979) Relation of maternal nutrition and low birth weight. <i>Indian Pediatrics</i> 16 (11), 961-966.	Very rural groups in India

Outcomes not relevant to SR

Study	Reason for exclusion
Dwarkanath P., Muthayya S., Thomas T., Vaz M., Parikh P., Mehra R. & Kurpad A.V. (2009) Polyunsaturated fatty acid consumption and concentration among South Indian women during pregnancy. <i>Asia Pacific Journal of Clinical Nutrition</i> 18 (3), 389-394.	Not relevant
Fowles E.R., Walker L.O., Marti C.N., Ruiz R.J., Wommack J., Bryant M., Kim S. & Timmerman G.M. (2012) Relationships among maternal nutrient intake and placental biomarkers during the 1st trimester in low-income women. <i>Archives of Gynecology and Obstetrics</i> 285 (4), 891-899.	
Lagiou P., Samoli E., Lipworth L., Lagiou A., Fang F., Rossi M., Xu B., Yu G.P., Adami H.O., Hsieh C.C. & Trichopoulos D. (2011) Energy intake during pregnancy in relation to offspring gender by maternal height. <i>European Journal of Epidemiology</i> 26 (1), 39-44.	Not very relevant outcomes - This paper is looking at gender and association with energy intake
Leary S., Ness A., Emmett P. & Davey Smith G. (2005) Maternal diet in pregnancy and offspring height, sitting height, and leg length. <i>Journal of Epidemiology and Community Health</i> 59 (6), 467-472.	Not relevant - outcomes - Height measured at 7.5 years later
Lof M., Hilakivi-Clarke L., Sandin S.S., de Assis S., Yu W. & Weiderpass E. (2009) Dietary fat intake and gestational weight gain in relation to estradiol and progesterone plasma levels during pregnancy: a longitudinal study in Swedish women. <i>BMC Women's Health</i> 9 , 10.	Not relevant – mainly diet in relation to specific hormones
Murcia M., Rebagliato M., Espada M., Viogue J., Marina L.S., Alvarez-Pedrerol M., Lopez-Espinosa M.J., León G., Íñiguez C., Basterrechea M., Guxens M., Lertxundi A., Perales A., Ballester F. & Sunyer J. (2010) Iodine intake in a population of pregnant women: INMA mother and child cohort study, Spain. <i>Journal of Epidemiology & Community Health</i> 64 (12), 1094-1099.	Assessed iodine intake but no other maternal or fetal outcomes reported
Reid E.W., McNeill J.A., Alderdice F.A., Tully M.A. & Holmes V.A. (2014) Physical activity, sedentary behaviour and fetal macrosomia in uncomplicated pregnancies: A prospective cohort study. <i>Midwifery</i> 30 (12), 1202-1209.	Outcomes are not properly associated to diet
Rifas-Shiman S.L., Rich-Edwards J.W., Kleinman K.P., Oken E. & Gillman M.W. (2009) Dietary quality during pregnancy varies by maternal characteristics in Project Viva: a US cohort. <i>Journal of the American Dietetic Association</i> 109 (6), 1004-1011.	
Wu B.T., Dyer R.A., King D.J. & Innis S.M. (2013) Low fish intake is associated with low blood concentrations of vitamin D, choline and n-3 DHA in pregnant women. <i>British Journal of Nutrition</i> 109 (5), 936-943.	

Appendix 4-1: Faculty of Health Sciences' Ethics Committee (Trinity College Dublin) Ethical Approval Letter



COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH | TRINITY COLLEGE DUBLIN
Ollscoil Átha Cliath | The University of Dublin

Jamile Marchi
School of Nursing & Midwifery
University of Dublin, Trinity College
24 D'Olier Street
Dublin 2

Ref: 141211

Title of Study: Maternal Health and Maternal Morbidity in Ireland (MAMMI): Nutrition Strand

Dear Jamile,

Further to a meeting of the Faculty of Health Sciences Ethics Committee held in February 2015, we are pleased to inform you that the above project has been approved without further audit.

Yours sincerely,

Dr. Ruth Pilkington Chairperson
Faculty Research Ethics Committee

Faculty of Health Sciences,
Ground Floor, Chemistry Building, Trinity College, Dublin 2, Ireland
Tel: +353 1 896 4255

Appendix 4-2: Coombe Women and Infants University Hospital's (CWIUH) Ethics Committee Approval Letter



Coombe Women & Infants University Hospital

'Excellence in the Care of Women and Babies'

Foirfeacht i gCúram Ban agus Naíonán
JM/MJ

Cork Street
Dublin 8
telephone +353-1-408 5200
fax +353-1-453 6033
www.coombe.ie

29 May 2015

Prof. Deirdre Daly
Assistant Professor in Midwifery
School of Nursing & Midwifery
Trinity College Dublin
24 D'Olier Street
DUBLIN 2

Re.: Correspondence on Study No. 36 – 2014 – Request for REC approval of amendments to the MAMMI Study

Dear Prof. Daly

The new questionnaire submitted to the research ethics committee was approved under the MAMMI study.

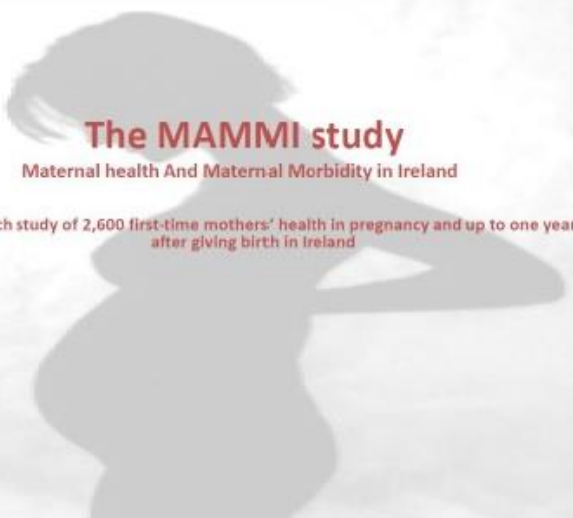
Yours sincerely


Dr Jan Miletin
Chairman



Appendix 4-3: MAMMI Survey

Study No



The MAMMI study
Maternal health And Maternal Morbidity in Ireland

A research study of 2,600 first-time mothers' health in pregnancy and up to one year after giving birth in Ireland

Survey Booklet One: Antenatal

1

Thank you for taking the time to complete this survey. It will take you about **45 minutes** to complete it and your answers are **confidential**. If you have any questions about any part of this survey, or need help answering any of the questions, please feel free to call us on 087 229 0989.

The MAMMI survey has been approved by the Research Ethics Committees of the Coombe Women and Infants University Hospital and the Faculty of Health Sciences, Trinity College Dublin.

Please tick here if you do NOT wish to complete this or future surveys ☐



TRINITY COLLEGE DUBLIN
COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH

THE
UNIVERSITY
OF DUBLIN

Contact: MAMMI Research Team (Deirdre Daly, Sunita Panda, Jamile Marchi, Deirdre O Malley and Francesca Wuytack)

Tel: 087 229 0989 E-mail: contact@mammi.ie

■ MAMMI-Survey One

Structure of the MAMMI Study

The Maternal health And Maternal Morbidity in Ireland (MAMMI) study is in six (6) parts: (1) antenatal (early pregnancy); (1A) antenatal (middle to late pregnancy - when you are about 7 months pregnant); (2) 3 months after the birth; (3) 6 months after the birth; (4) 9 months after the birth and (5) 12 months after the birth.

This is the first (1) part of the six surveys. It is about your health NOW (antenatally) and before you became pregnant. It has five (5) sections, numbered A through to E:

- A questions about your general health and well-being;
- B your health BEFORE your pregnancy;
- C your health SINCE THE START of your pregnancy;
- D your emotional health and well-being NOW;
- E you, your household and your thoughts on some issues.

You may notice that some questions are very similar or the same, however, the questions apply to different times in your life.

Please note, there is space after Section E for any comments you might like to make on the survey.

How to fill in the Survey

Most of the questions can be answered by putting a tick in the box next to the answer that best applies to you. For example:

Has tiredness been a problem for you in the past month?

Yes ☒

No ☐

This filled-in sample indicates that tiredness was a problem in the past month.

A few questions may ask you to fill in a number in a box. For example:

What is your date of birth?

Day /Month / Year
30 / 04 / 1980

This filled-in sample represents a date of birth of 30th April 1980

MAMMI-Survey One

Section A: This section is about your general health and wellbeing

A1 What is your date of birth?

		/			/				
d	d		m	m		y	y	y	y

A1a What date is your baby (or your babies) due on?

		/			/				
d	d		m	m		y	y	y	y

A1b How many babies you are expecting? *(Please tick just ONE response)*

One	Twins	Triplets or more	I don't know
☐ 1	☐ 2	☐ 3	☐ 4

A2 How tall are you with your shoes off?

	cms	OR		feet and		inches

A3 What weight were you just BEFORE you became pregnant?

	kgs	OR		stones and		pounds

A4 Was your pregnancy conceived with treatment for infertility?

No	☐ 1
Yes, fertility drugs	☐ 2
Yes, IVF/ICSI	☐ 3
Yes, other <i>(please say what was involved)</i>	☐ 4

A5 Have you ever had any of the following conditions? *(Please tick as many boxes as necessary)*

	Yes, as a child (Up to age 17 yrs)	Yes, as an adult (Since age 18 yrs)	No, never	Not sure
a. Asthma	☐ 1	☐ 2	☐ 3	☐ 4
b. Crohn's disease	☐ 1	☐ 2	☐ 3	☐ 4
c. Diabetes	☐ 1	☐ 2	☐ 3	☐ 4
d. Irritable bowel syndrome	☐ 1	☐ 2	☐ 3	☐ 4
e. Ulcerative colitis	☐ 1	☐ 2	☐ 3	☐ 4
f. Thyroid problems	☐ 1	☐ 2	☐ 3	☐ 4
g. Depression <i>(requiring treatment or medication)</i>	☐ 1	☐ 2	☐ 3	☐ 4
h. Other mental health conditions	☐ 1	☐ 2	☐ 3	☐ 4
i. Kidney problems	☐ 1	☐ 2	☐ 3	☐ 4
j. Urinary tract infections <i>(requiring treatment with antibiotics)</i>	☐ 1	☐ 2	☐ 3	☐ 4
k. Vaginal infections	☐ 1	☐ 2	☐ 3	☐ 4
l. High blood pressure	☐ 1	☐ 2	☐ 3	☐ 4
m. Epilepsy	☐ 1	☐ 2	☐ 3	☐ 4
n. Eating disorders (anorexia or bulimia)	☐ 1	☐ 2	☐ 3	☐ 4
o. Other <i>(please give details)</i>	☐ 1	☐ 2	☐ 3	☐ 4

A6 Have you ever had any of the following operations or procedures? *(Please tick as many boxes as necessary)*

	Yes, as a child (Up to age 17 yrs)	Yes, as an adult (Since age 18 yrs)	No, never	Not sure
a. Appendectomy	☐ 1	☐ 2	☐ 3	☐ 4
b. Colonoscopy <i>(A medical examination of the bowel using a tube passed through the rectum [back passage])</i>	☐ 1	☐ 2	☐ 3	☐ 4
c. Sigmoidoscopy <i>(A medical examination of a part of the bowel using a tube passed through the rectum [back passage]).</i>	☐ 1	☐ 2	☐ 3	☐ 4
d. Laparoscopy <i>(An operation in the abdomen [tummy area] performed through a small cut.)</i>	☐ 1	☐ 2	☐ 3	☐ 4
e. Haemorrhoidectomy <i>(An operation to remove piles [haemorrhoids] from the rectum. [back passage])</i>	☐ 1	☐ 2	☐ 3	☐ 4
f. Curette (often called a D and C) <i>(An operation on the uterus [womb] using a tube passed through the vagina)</i>	☐ 1	☐ 2	☐ 3	☐ 4
g. Kidney investigations	☐ 1	☐ 2	☐ 3	☐ 4
h. Surgery on the bones in your back	☐ 1	☐ 2	☐ 3	☐ 4
i. Injury to the bones in your back	☐ 1	☐ 2	☐ 3	☐ 4
j. Other (please give details)	☐ 1	☐ 2	☐ 3	☐ 4

A7 Have you ever used any of the following medications or treatments? (please tick as many boxes as necessary)

	Yes, as a child (Up to age 17 yrs)	Yes, as an adult (Since age 18 yrs)	No, never	Not sure
a. Laxatives (Tablets or medication to help you with constipation/pass a bowel motion [stool/faeces])	☐ 1	☐ 2	☐ 3	☐ 4

a1. If you used this treatment as an ADULT, did you use it

Rarely	Occasionally	Often
☐ 1	☐ 2	☐ 3

	Yes, as a child (Up to age 17 yrs)	Yes, as an adult (Since age 18 yrs)	No, never	Not sure
b. Enemas (Fluid inserted into your back passage to help you with constipation/pass a bowel motion[stool/faeces])	☐ 1	☐ 2	☐ 3	☐ 4

b1. If you used this treatment as an ADULT, did you use it

Rarely	Occasionally	Often
☐ 1	☐ 2	☐ 3

	Yes, as a child (Up to age 17 yrs)	Yes, as an adult (Since age 18 yrs)	No, never	Not sure
c. Anti-diarrhoea medication (Tablets or medication to help you from having diarrhoea/loose stool/faeces)	☐ 1	☐ 2	☐ 3	☐ 4

c1. If you used this treatment as an ADULT, did you use it

Rarely	Occasionally	Often
☐ 1	☐ 2	☐ 3

	Yes, as a child (Up to age 17 yrs)	Yes, as an adult (Since age 18 yrs)	No, never	Not sure
d. Colonic lavage / irrigation (Fluid inserted into your back passage to help you with constipation/pass a bowel motion[stool/faeces])	☐ 1	☐ 2	☐ 3	☐ 4

d1. If you used this treatment as an ADULT, did you use it

Rarely	Occasionally	Often
☐ 1	☐ 2	☐ 3

	Yes, as a child (Up to age 17 yrs)	Yes, as an adult (Since age 18 yrs)	No, never	Not sure
e. Tablets to help lose weight	☐ 1	☐ 2	☐ 3	☐ 4

e1. If you used this treatment as an ADULT, did you use it

Rarely	Occasionally	Often
☐ 1	☐ 2	☐ 3

	Yes, as a child (Up to age 17 yrs)	Yes, as an adult (Since age 18 yrs)	No, never	Not sure
f. Treatment to help lose weight	☐ 1	☐ 2	☐ 3	☐ 4

f1. If you used this treatment as an ADULT, did you use it

Rarely	Occasionally	Often
☐ 1	☐ 2	☐ 3

	Yes, as a child (Up to age 17 yrs)	Yes, as an adult (Since age 18 yrs)	No, never
g. Other medications or treatments (Please give details)	☐ 1	☐ 2	☐ 3

- A8 Do you currently have any other medical conditions or health problems that mean you need regular medication or medical care or any other treatment?

Yes	No
☐ 1	☐ 2

If yes, please give details

- A9 Have you ever felt afraid of any partner?

Yes	No
☐ 1	☐ 2

Section B: This section is about your health BEFORE your pregnancy

B1 At any time in your life BEFORE your pregnancy, have you experienced any of the following:

	Never	Rarely	Occasionally	Often
a. Extreme tiredness or exhaustion	☐ 1	☐ 2	☐ 3	☐ 4
b. Frequent coughs, colds or other minor illnesses	☐ 1	☐ 2	☐ 3	☐ 4
c. Severe headaches or migraines	☐ 1	☐ 2	☐ 3	☐ 4
d. Back pain	☐ 1	☐ 2	☐ 3	☐ 4
e. Constipation (<i>opening your bowels only twice a week or less, or pushing or straining to open your bowels every fourth time you go</i>)	☐ 1	☐ 2	☐ 3	☐ 4
f. Haemorrhoids (<i>Swollen veins around your back passage</i>)	☐ 1	☐ 2	☐ 3	☐ 4
g. Leaked urine (<i>when you did not mean to</i>)	☐ 1	☐ 2	☐ 3	☐ 4
h. Trouble controlling your bowel movements or experienced leakage when you did not mean to	☐ 1	☐ 2	☐ 3	☐ 4
i. Trouble controlling when you pass wind (flatus)	☐ 1	☐ 2	☐ 3	☐ 4
j. Feeling depressed, low mood or sad (<i>lasting two weeks or more</i>)	☐ 1	☐ 2	☐ 3	☐ 4
k. Intense anxiety (<i>such as panic attacks</i>)	☐ 1	☐ 2	☐ 3	☐ 4
l. Severe period pain	☐ 1	☐ 2	☐ 3	☐ 4
m. Heavy periods or vaginal bleeding that worried you	☐ 1	☐ 2	☐ 3	☐ 4

	Never	Rarely	Occasionally	Often
n. Relationship problems with your partner / spouse	☐ 1	☐ 2	☐ 3	☐ 4
o. Not able to put on weight	☐ 1	☐ 2	☐ 3	☐ 4
p. Not able to lose weight	☐ 1	☐ 2	☐ 3	☐ 4
q. Other health problems (please give details)	☐ 1	☐ 2	☐ 3	☐ 4

B2 How would you describe your general health in the last 12 months BEFORE your pregnancy?

Excellent	Very good	Good	Fair	Poor	Very poor
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

B3 During the last 12 months BEFORE your pregnancy did you experience any of the following?

	Never	Rarely	Occasionally	Often
a. Extreme tiredness or exhaustion	☐ 1	☐ 2	☐ 3	☐ 4
b. Frequent coughs, colds or other minor illness	☐ 1	☐ 2	☐ 3	☐ 4
c. Severe headaches or migraines	☐ 1	☐ 2	☐ 3	☐ 4
d. Back pain	☐ 1	☐ 2	☐ 3	☐ 4
e. Constipation (opening your bowels only twice a week or less, or pushing or straining to open your bowels every fourth time you go)	☐ 1	☐ 2	☐ 3	☐ 4

	Never	Rarely	Occasionally	Often
f. Haemorrhoids (<i>Swollen veins around your back passage</i>)	☐ 1	☐ 2	☐ 3	☐ 4
g. Leaked urine (<i>when you did not mean to</i>)	☐ 1	☐ 2	☐ 3	☐ 4
h. Trouble controlling your bowel movements or experienced leakage when you did not mean to	☐ 1	☐ 2	☐ 3	☐ 4
i. Trouble controlling when you pass wind (flatus)	☐ 1	☐ 2	☐ 3	☐ 4
j. Feeling depressed, low mood or sad (<i>lasting two weeks or more</i>)	☐ 1	☐ 2	☐ 3	☐ 4
k. Intense anxiety (<i>such as panic attacks</i>)	☐ 1	☐ 2	☐ 3	☐ 4
l. Severe period pain	☐ 1	☐ 2	☐ 3	☐ 4
m. Heavy periods or vaginal bleeding that worried you	☐ 1	☐ 2	☐ 3	☐ 4
n. Relationship problems with your partner / spouse	☐ 1	☐ 2	☐ 3	☐ 4
o. Not able to put on weight	☐ 1	☐ 2	☐ 3	☐ 4
p. Not able to lose weight	☐ 1	☐ 2	☐ 3	☐ 4
q. Other health problems (<i>please give details</i>)	☐ 1	☐ 2	☐ 3	☐ 4

B3a During the last 12 months BEFORE your pregnancy, did you feel afraid of your partner?

Yes	No
☐ 1	☐ 2

The next few questions ask in more detail about urinary symptoms. If you feel uncomfortable answering any of these questions or they are too personal, you do not have to answer them. However, if you have experienced any of the symptoms or issues asked about, it would help us to understand them and it might help other women to know they are not alone in their experiences when the findings are published. Again, we would like to reassure you that all the information that you provide is strictly confidential and all the findings from this survey will be presented and published in a way that does not identify you or any individual woman.

B4 Thinking back to when you were a child (6 years to 12 years), did you ever experience any of the following? *(Please tick one response on each line)*

	Yes	No	Not sure
a. Wet the bed occasionally at night	☐ 1	☐ 2	☐ 3
b. Wet the bed several times a week	☐ 1	☐ 2	☐ 3
c. Wet occasionally during the day	☐ 1	☐ 2	☐ 3
d. Wet several times a week during the day	☐ 1	☐ 2	☐ 3

Please comment if you wish _____

B5 During the 12 months BEFORE your pregnancy did you ever leak even a small amount of urine?

a. When you coughed, laughed, sneezed or did physical exercise

- No, never ☐ 1
- Yes, less than once a month ☐ 2
- Yes, one or several times a month ☐ 3
- Yes, one or several times a week ☐ 4
- Yes, every day ☐ 5

b. When you were on the way to the toilet

- No, never ☐ 1
- Yes, less than once a month ☐ 2
- Yes, one or several times a month ☐ 3
- Yes, one or several times a week ☐ 4
- Yes, every day ☐ 5

c. When you had to wait to use the toilet

- No, never ☐ 1
- Yes, less than once a month ☐ 2
- Yes, one or several times a month ☐ 3
- Yes, one or several times a week ☐ 4
- Yes, every day ☐ 5

d. If you did not go to the toilet immediately

- No, never ☐ 1
- Yes, less than once a month ☐ 2
- Yes, one or several times a month ☐ 3
- Yes, one or several times a week ☐ 4
- Yes, every day ☐ 5

If you have answered 'no, never' to the above questions (a-d) please go to B8

B6 During the 12 months BEFORE your pregnancy if/when you experienced leakage of urine, was it:

- Drops or just a little ☐ 1
- More like a trickle ☐ 2
- More than a trickle ☐ 3

B7 If you experienced leakage, when did you first experience this?

As a child (up to 12 years) ☐ 1

As a teenager (13-17 years) ☐ 2

As an adult (18 years or more) ☐ 3

Not sure ☐ 4

If you experienced leakage of urine, and you can remember, please fill in your age when this first happened to you

Years

B8 During the 12 months BEFORE your pregnancy, did you ever feel an URGENT need to pass urine which was accompanied by a fear of leakage?

No, never ☐ 1 Yes ☐ 2

B8a During the 12 months BEFORE your pregnancy, did you ever feel an URGENT need to pass urine which was accompanied by actual leakage?

No, never ☐ 1 Yes ☐ 2

B9 BEFORE you became pregnant had you ever talked to a doctor or other health care professional about controlling when you pass urine?

Yes ☐ 1 No ☐ 2

If yes, who did you talk to (please tick all that apply)

General practitioner (doctor) ☐ 1

Gynaecologist ☐ 2

Physiotherapist ☐ 3

Nurse ☐ 4

☐ 5

1 MAMMI-Survey One

Pharmacist / chemist 5

Alternative practitioner ☐ 6

Other (*please describe*) ☐ 7

If you are worried or concerned about leaking urine and wish to get help, you can discuss it with your doctor or midwife at your antenatal visits or you can call the Coombe Hospital's physiotherapy department.

Coombe Hospital number: 01 4085200 and ask to be put through to the physiotherapy department. Web: www.coombe.ie

Opening hours: 9.00am to 4.30pm Monday – Friday

Outside these hours, an answering service is available and you can leave a message and someone will return your call.

The next few questions ask about bowel symptoms you may have experienced **BEFORE** you became pregnant. If you have experienced any of the symptoms or issues asked about, it would help us to understand them and it might help other women to know they are not alone in their experiences when the findings are published. Again, we would like to reassure you that all the information that you provide is strictly confidential and all the findings from this survey will be presented and published in a way that does not identify you or any individual woman.

B10 Thinking back to when you were a child (6 years to 12 years), did you ever experience any of the following? (please tick one response on each line)

	Yes, occasionally	Yes, often	No	Not sure
a. Constipation (opening your bowels only twice a week or less, or pushing or straining to open your bowels every fourth time you go)	☐ 1	☐ 2	☐ 3	☐ 4
b. Soiling your underwear when you were constipated	☐ 1	☐ 2	☐ 3	☐ 4
c. Soiling your underwear when you were not constipated	☐ 1	☐ 2	☐ 3	☐ 4

Please comment if you wish _____

B11 During the 12 months BEFORE your pregnancy did you ever

	No, never	Minor amount	Major amount
a. Notice soiling from your back passage on your underwear	☐ 1	☐ 2	☐ 3
b. Pass wind when you really didn't want to	☐ 1	☐ 2	☐ 3

B12 a During the 12 months BEFORE your pregnancy did you ever, even very occasionally, experience leakage of LIQUID bowel motions at an inappropriate time or place?

- No, never ☐ 1
- Yes, less than once a month ☐ 2
- Yes, one or several times a month ☐ 3
- Yes, one or several times a week ☐ 4
- Yes, every day ☐ 5

B12 b If yes, how much leakage typically occurred?

- Small amount (*with stain about the size of a 50 cent coin*) ☐ 1
- Moderate amounts (*often requiring a change of pad or underwear*) ☐ 2
- Large amounts (*often requiring a complete change of clothes*) ☐ 3

B13 a During the 12 months BEFORE your pregnancy did you ever, even very occasionally, experience leakage of SOLID bowel motions at an inappropriate time or inappropriate place?

- No, never ☐ 1
- Yes, less than once a month ☐ 2
- Yes, one or several times a month ☐ 3
- Yes, one or several times a week ☐ 4
- Yes, every day ☐ 5

B13 b If yes, when this happened, how much leakage typically occurred?

- Small amount (*with stain about the size of a 50 cent coin*) ☐ 1
- Moderate amounts (*often requiring a change of pad or underwear*) ☐ 2
- Large amounts (*often requiring a complete change of clothes*) ☐ 3

B14a During the 12 months BEFORE your pregnancy did you ever experience an URGENT need to open your bowels that made you rush to the toilet immediately?

No, never	☐ 1
Yes, less than once a month	☐ 2
Yes, one or several times a month	☐ 3
Yes, one or several times a week	☐ 4
Yes, every day	☐ 5

B14b During the 12 months BEFORE your pregnancy did you ever experience an URGENT need to open your bowels that you could not defer or delay for more than 5 minutes?

No, never	☐ 1
Yes, less than once a month	☐ 2
Yes, one or several times a month	☐ 3
Yes, one or several times a week	☐ 4
Yes, every day	☐ 5

B15 a If you experienced an urgent need to open your bowels that made you soil yourself/underwear, when did you first experience problems with control of your bowel?

As a child	☐ 1
As a teenager (13-17 years)	☐ 2
As an adult (18 years or more)	☐ 3
Not sure	☐ 4

B15 b If you can remember, please fill in your age when this first happened to you

years

B16 BEFORE you became pregnant had you ever talked to a doctor or other health care professional about controlling when you pass wind or having a bowel movement?

Yes ☐ 1 No ☐ 2

If yes, who did you talk to (please tick all that apply)

General practitioner (doctor) ☐ 1

Gynaecologist ☐ 2

Physiotherapist ☐ 3

Nurse ☐ 4

Pharmacist / chemist ☐ 5

Alternative practitioner ☐ 6

Other (please describe) ☐ 7

If you are worried or concerned about soiling from your back passage and wish to get help, you can discuss it with your doctor or midwife at your antenatal visits or you can call the Coombe Hospital's physiotherapy department.

Coombe Hospital number: 01 4085200 and ask to be put through to the physiotherapy department. Web: www.coombe.ie

Opening hours: 9.00am to 4.30pm Monday – Friday

Outside these hours, an answering service is available and you can leave a message and someone will return your call.

The next few questions are about your sexuality and your sexual health **BEFORE** your pregnancy. If you feel uncomfortable answering any of these questions or they are too personal, you do not have to answer them. However, if you have experienced any of the symptoms or issues asked about, it might help other women to know they are not alone in their experiences when the findings are published. Again, we would like to reassure you that all the information that you provide is strictly confidential.

B17 During the 12 months **BEFORE** your pregnancy did you ever experience any of the following (*please tick one response on each line*)

	Yes	No	Prefer not to answer
a. Lack of vaginal lubrication	☐ 1	☐ 2	☐ 3
b. Painful penetration	☐ 1	☐ 2	☐ 3
c. Pain during sexual intercourse	☐ 1	☐ 2	☐ 3
d. Pain on orgasm	☐ 1	☐ 2	☐ 3
e. Difficulty reaching orgasm	☐ 1	☐ 2	☐ 3
f. Unable to reach orgasm	☐ 1	☐ 2	☐ 3
g. Vaginal tightness	☐ 1	☐ 2	☐ 3
h. Vaginal looseness / lack of muscle tone	☐ 1	☐ 2	☐ 3
i. Bleeding or vaginal irritation after sex	☐ 1	☐ 2	☐ 3
j. Lack of interest in sex	☐ 1	☐ 2	☐ 3
k. More interest in sex than previously	☐ 1	☐ 2	☐ 3
l. Being pressured to take part in unwanted sexual activity	☐ 1	☐ 2	☐ 3
m. Being forced to take part in unwanted sexual activity	☐ 1	☐ 2	☐ 3
n. Other (<i>please describe</i>)	☐ 1	☐ 2	☐ 3

B18 During the 12 months BEFORE your pregnancy did your sexual activities include:

	Yes	No	Prefer not to answer
a. Vaginal sex	☐ 1	☐ 2	☐ 3
b. Oral sex	☐ 1	☐ 2	☐ 3
c. Anal sex	☐ 1	☐ 2	☐ 3
d. Other	☐ 1	☐ 2	☐ 3

Please comment if you wish _____

B19 During the 12 months BEFORE your pregnancy, which of the following best describes the frequency of your sexual activity (please tick only one response)

a. 1-2 times per month	☐ 1	Prefer not to answer	☐ 5
b. 1-2 times per week	☐ 2		
c. 3-4 times per week	☐ 3		
d. More than 4 times per week	☐ 4		

Please comment if you wish _____

B 20 During the 12 months BEFORE your pregnancy, how satisfied were you with your overall sexual life *(please tick only one response)*

- a. Very satisfied ☐ 1 Prefer not to answer ☐ 6
- b. Moderately satisfied ☐ 2
- c. Equally satisfied/dissatisfied ☐ 3
- d. Moderately dissatisfied ☐ 4
- e. Very dissatisfied ☐ 5

Please comment if you wish _____

B21 If you experienced any problems or pain when having sexual intercourse BEFORE you became pregnant, did you ever talked to a doctor or other health care professional about this?

Yes ☐ 1 No ☐ 2

If yes, who did you talk to (please tick all that apply)

- General practitioner (doctor) ☐ 1
- Gynaecologist ☐ 2
- Physiotherapist ☐ 3
- Nurse ☐ 4
- Pharmacist / chemist ☐ 5
- Alternative practitioner ☐ 6
- Other (please describe) ☐ 7

If you are worried or concerned about unwanted or forced sexual activity and wish to get help, you can call the Sexual Assault Treatment Unit (SATU) based in the Rotunda hospital.

SATU telephone number: 01 8171736

SATU e-mail: SATU@ROTUNDA.IE

Web: <http://www.rotunda.ie/>

Opening hours: 9.00am to 4.30pm Mon – Fri

Outside of these hours please contact the
Rotunda Hospital at 01 8171700

Or you can call the National Dublin Rape Crisis Centre. The Dublin Rape Crisis Centre was established in 1979 and is a national organisation offering a wide range of services to women and men who are affected by rape, sexual assault, sexual harassment or childhood sexual abuse.

The services include a national 24-hour helpline, one to one counselling, court accompaniment, outreach services, training, awareness raising and lobbying.

Dublin Rape Crisis Centre telephone number: HELPLINE 1800 778888

B22 Did you experience pain in any of these parts of your body in the 12 months BEFORE your pregnancy?

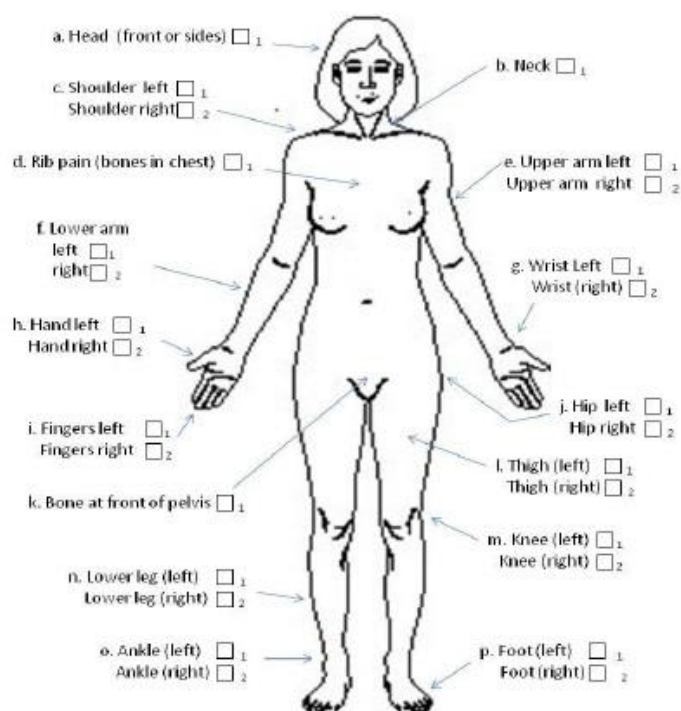
Yes ☐ 1

No ☐ 2

If yes, please look at the two pictures below. Picture A is looking at the body from the front. Picture B is looking at the body from the back.

A. Please tick the boxes if you have experienced pain in any of the parts of the body named in the 12 months BEFORE your pregnancy.

Picture A
Front of Body

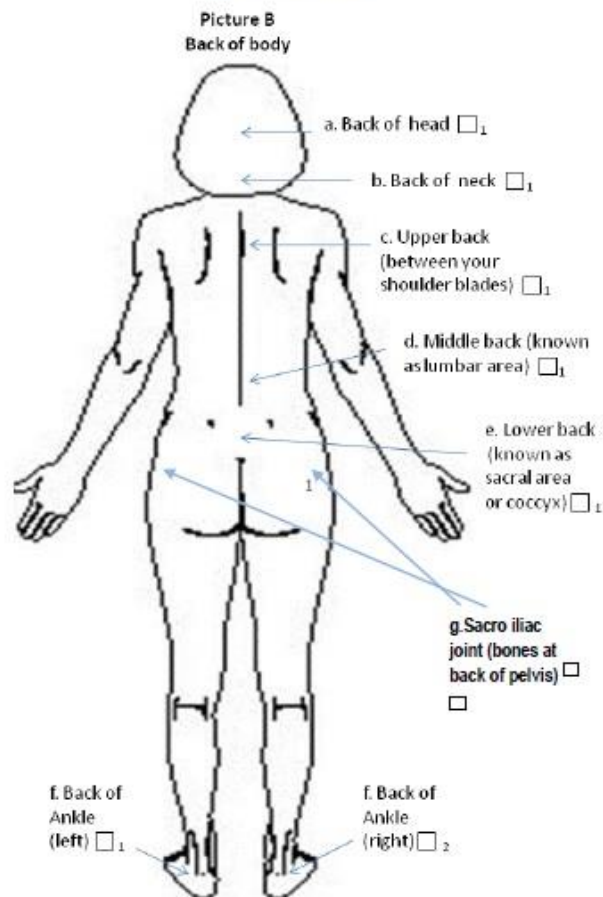


If you experienced pain in any OTHER parts not named here, please tick here ☐

Please give details

B. Please tick the boxes if you have experienced pain in any of the parts of the body named in the 12 months BEFORE your pregnancy.

Picture B
Back of Body



If you experienced pain in any OTHER parts not named here, please tick here ☐

Please give details

Section C: This section is about your health SINCE THE START of your pregnancy

C1 Since the start of your pregnancy, have you experienced any of the following:

	Never	Rarely	Occasionally	Often
a. Extreme tiredness or exhaustion	☐ 1	☐ 2	☐ 3	☐ 4
b. Frequent coughs, colds or other minor illness	☐ 1	☐ 2	☐ 3	☐ 4
c. Severe headaches or migraines	☐ 1	☐ 2	☐ 3	☐ 4
d. Back pain	☐ 1	☐ 2	☐ 3	☐ 4
e. Constipation (<i>opening your bowels only twice a week or less, or pushing or straining to open your bowels every fourth time you go</i>)	☐ 1	☐ 2	☐ 3	☐ 4
f. Haemorrhoids (<i>Swollen veins around your back passage, sometimes called piles</i>)	☐ 1	☐ 2	☐ 3	☐ 4
g. Feeling depressed, low mood or sad (<i>lasting two weeks or more</i>)	☐ 1	☐ 2	☐ 3	☐ 4
h. Intense anxiety (<i>such as panic attacks</i>)	☐ 1	☐ 2	☐ 3	☐ 4
i. Pelvic pain that worried you	☐ 1	☐ 2	☐ 3	☐ 4
j. Vaginal bleeding	☐ 1	☐ 2	☐ 3	☐ 4
k. Relationship problems with your partner / spouse	☐ 1	☐ 2	☐ 3	☐ 4
l. Not able to put on weight	☐ 1	☐ 2	☐ 3	☐ 4
m. Not able to lose weight	☐ 1	☐ 2	☐ 3	☐ 4
n. Other health problems (<i>please give details</i>)	☐ 1	☐ 2	☐ 3	☐ 4

C2 SINCE THE START of your pregnancy have you leaked even small amounts of urine:

a. When you coughed, laughed, sneezed or did physical exercise

No, never	☐	1
Yes, less than once a month	☐	2
Yes, one or several times a month	☐	3
Yes, one or several times a week	☐	4
Yes, every day	☐	5

b. When you were on the way to the toilet

No, never	☐	1
Yes, less than once a month	☐	2
Yes, one or several times a month	☐	3
Yes, one or several times a week	☐	4
Yes, every day	☐	5

c. When you had to wait to use the toilet

No, never	☐	1
Yes, less than once a month	☐	2
Yes, one or several times a month	☐	3
Yes, one or several times a week	☐	4
Yes, every day	☐	5

d. If you did not go to the toilet immediately

No, never	☐	1
Yes, less than once a month	☐	2
Yes, one or several times a month	☐	3
Yes, one or several times a week	☐	4
Yes, every day	☐	

Please go to C5 if you have answered 'no' to above (a-d) questions.

C3 If/when you leak urine, is it

Drops or just a little	☐	1
More like a trickle	☐	2
More than a trickle	☐	3

C4 Which of the following best describes how you manage this (please tick ONE response only)

It is a minor problem, I ignore it	☐	1
I carry a change of underwear with me wherever I go and change whenever I need to	☐	2
I wear protection (e.g., pads or pantyliners) whenever I need to (e.g., when doing physical exercise)	☐	3
I make sure I know where the nearest toilet is whenever I go out	☐	4
I wear protection (e.g., pads or panty liners) all the time	☐	5
Other (please describe)	☐	6

C5a SINCE THE START of your pregnancy, have you ever felt an URGENT need to pass urine which was accompanied by a fear of leakage?

No, never ☐ 1 Yes ☐ 2

C5b SINCE THE START of your pregnancy, have you ever felt an URGENT need to pass urine which was accompanied by actual leakage?

No, never ☐ 1 Yes ☐ 2

C6a SINCE THE START of your pregnancy have you talked to a doctor or a midwife or another health professional about controlling when you pass urine?

Yes ☐ 1 (Go to 6b) No ☐ 2 (Go to 6c)

C6b If yes, who did you talk to (*please tick all that apply*)

Talked to my doctor at the hospital during a pregnancy check-up ☐ 1

Talked to a GP (doctor) during a pregnancy check-up ☐ 2

Talked to a midwife during a pregnancy check-up ☐ 3

Talked to someone else (*please describe*) ☐ 4

C6c If no, is it because

Have thought about it but haven't felt able to talk about it ☐ 1

Don't want to discuss it ☐ 2

Other (*please describe*) ☐ 3

C7 SINCE THE START of your pregnancy have you

	No, never	Yes minor amount	Yes major amount
a. Noticed soiling from your back passage	☐ 1	☐ 2	☐ 3
b. Passed wind when you really didn't want to	☐ 1	☐ 2	☐ 3

C8a SINCE THE START of your pregnancy have you ever, even very occasionally, experienced leakage of LIQUID bowel motions at an inappropriate time or place?

No, never	☐ 1
Yes, less than once a month	☐ 2
Yes, one or several times a month	☐ 3
Yes, one or several times a week	☐ 4
Yes, every day	☐ 5

C8b If yes, when this happened how much leakage typically occurred?

Small amount (<i>with stain about the size of a 50 cent coin</i>)	☐ 1
Moderate amounts (<i>often requiring a change of pad or underwear</i>)	☐ 2
Large amounts (<i>often requiring a complete change of clothes</i>)	☐ 3

C9a SINCE THE START of your pregnancy have you ever, even very occasionally, experienced leakage of SOLID bowel motions at an inappropriate time or inappropriate place?

No, never	☐ 1
Yes, less than once a month	☐ 2
Yes, one or several times a month	☐ 3
Yes, one or several times a week	☐ 4
Yes, every day	☐ 5

C9b If yes, when this happened how much leakage typically occurred?

Small amount (*with stain about the size of a 50 cent coin*) ☐ 1

Moderate amounts (*often requiring a change of pad or underwear*) ☐ 2

Large amounts (*often requiring a complete change of clothes*) ☐ 3

C10a SINCE THE START of your pregnancy have you ever experienced an URGENT need to open your bowels that made you rush to the toilet immediately?

No, never ☐ 1

Yes, less than once a month ☐ 2

Yes, one or several times a month ☐ 3

Yes, one or several times a week ☐ 4

Yes, every day ☐ 5

C10b SINCE THE START of your pregnancy have you ever experienced an URGENT need to open your bowels that you could not defer/delay for more than 5 minutes?

No, never ☐ 1

Yes, less than once a month ☐ 2

Yes, one or several times a month ☐ 3

Yes, one or several times a week ☐ 4

Yes, every day ☐ 5

C11a SINCE THE START of your pregnancy have you talked to a doctor or a midwife or another health professional about controlling when your bowels move?

Yes ☐ 1(Go to 11b) No ☐ 2(Go to 11c)

C11b If yes, who did you talk to? *(Please tick all that apply.)*

Talked to my doctor at the hospital during a pregnancy check-up ☐ 1

Talked to a GP during a pregnancy check-up ☐ 2

Yes, talked to a midwife during a pregnancy check-up ☐ 3

Yes, talked to someone else *(please describe)* ☐ 4

C11c If no, is it because

Have thought about it but haven't felt able to talk about it ☐ 1

Don't want to discuss it ☐ 2

Other *(please describe)* ☐ 3

C12 Which of these best describes how you manage your problem controlling your bowel movements? *(Please tick only ONE response)*

It doesn't happen very often and I just cope when it does ☐ 1

I carry a change of underwear with me wherever I go ☐ 2

I make sure I know where the nearest toilet is whenever I go out ☐ 3

I wear protection *(e.g. pads or panty liners)* when I need to ☐ 4

I wear protection *(e.g. pads or panty liners)* all the time ☐ 5

Other *(please describe)* ☐ 6

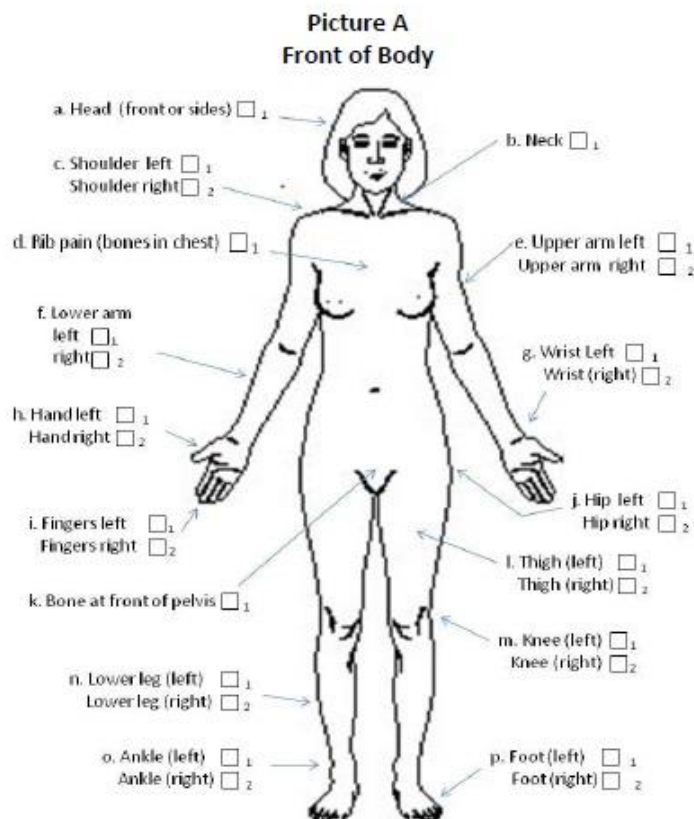
C13 SINCE THE START OF YOUR PREGNANCY have you experienced pain in any of these parts of your body?

Yes ☐ 1

No ☐ 2

If yes, please look at the two pictures below. Picture A shows the body looking at the front. Picture B shows the body looking at the back.

A Please tick the boxes if you have experienced pain in any of the parts of the body named SINCE THE START OF your pregnancy.

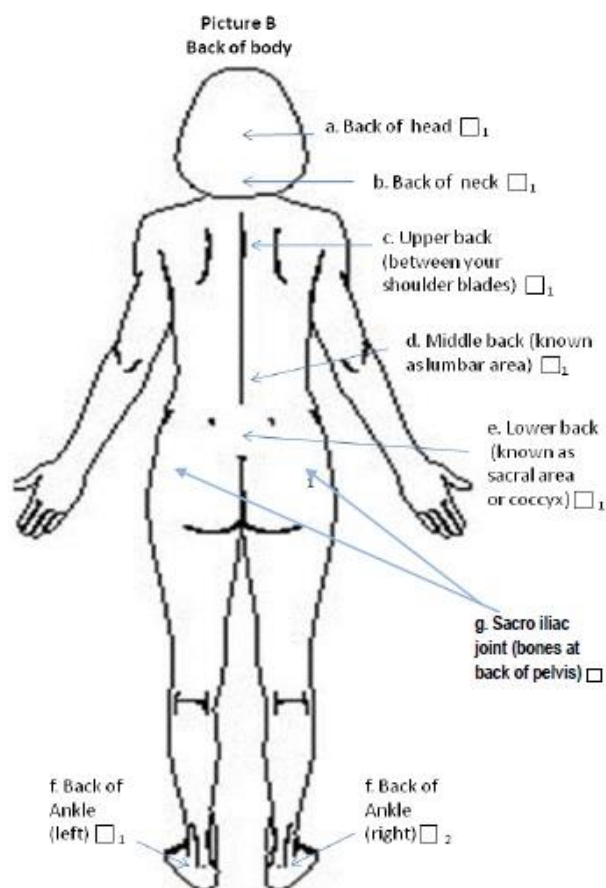


If you experienced pain in any OTHER parts of your body not named here, please tick here ☐

Please give details

B Please tick the boxes if you have experienced pain in any of the parts of the body named SINCE THE START OF your pregnancy

Picture B



If you experienced pain in any OTHER parts of your body not named here, please tick here ☐

Please give details

The next few questions are about your sexuality and your sexual health since the **START OF YOUR PREGNANCY**. Again, if you feel uncomfortable answering any of these questions or they are too personal, you do not have to answer them. However, if you have experienced any of the symptoms or issues asked about, it would help us to understand them and it might help other women to know they are not alone in their experiences when the findings are published. Again, we would like to reassure you that all the information that you provide is strictly confidential and all the findings from this survey will be presented and published in a way that does not identify you or any individual woman.

C14 SINCE THE START of your pregnancy, have you experienced any of the following?

(Please tick one response on each line.)

	Yes	No	Prefer not to answer
a. Lack of vaginal lubrication	☐ 1	☐ 2	☐ 3
b. Painful penetration	☐ 1	☐ 2	☐ 3
c. Pain during sexual intercourse	☐ 1	☐ 2	☐ 3
d. Pain on orgasm	☐ 1	☐ 2	☐ 3
e. Difficulty reaching orgasm	☐ 1	☐ 2	☐ 3
f. Unable to reach orgasm	☐ 1	☐ 2	☐ 3
g. Vaginal tightness	☐ 1	☐ 2	☐ 3
h. Vaginal looseness / lack of muscle tone	☐ 1	☐ 2	☐ 3
i. Bleeding or vaginal irritation after sex	☐ 1	☐ 2	☐ 3
j. Loss of interest in sex compared with before your pregnancy	☐ 1	☐ 2	☐ 3
k. More interest in sex compared with before your pregnancy	☐ 1	☐ 2	☐ 3
l. Being pressured to take part in unwanted sexual activity	☐ 1	☐ 2	☐ 3
m. Being forced to take part in unwanted sexual activity	☐ 1	☐ 2	☐ 3
n. Other (please describe)	☐ 1	☐ 2	☐ 3

C14a If you said YES to any of the above experiences, have you ever talked to a doctor or other health care professional about these SINCE THE START of your pregnancy?

Yes ☐ 1 No ☐ 2

If yes, who did you talk to (please tick all that apply)

- General practitioner (doctor) ☐ 1
- Gynaecologist ☐ 2
- Physiotherapist ☐ 3
- Midwife ☐ 4
- Pharmacist / chemist ☐ 5
- Alternative practitioner ☐ 6
- Other (please describe) ☐ 7

C15 SINCE THE START of your pregnancy have you had:

	Yes	No	Prefer not to answer
a. Vaginal intercourse	☐ 1	☐ 2	☐ 3
b. Oral sex	☐ 1	☐ 2	☐ 3
c. Anal sex	☐ 1	☐ 2	☐ 3
d. No sexual contact since the start of pregnancy	☐ 1	☐ 2	☐ 3 (Please Go to C18)

Please comment if you wish

C16 SINCE THE START of your pregnancy, which of the following best describes the frequency of your sexual activity (please tick only one response)

- a. 1-2 times per month ☐ 1 Prefer not to answer ☐ 5
- b. 1-2 times per week ☐ 2
- c. 3-4 times per week ☐ 3
- d. More than 4 times per week ☐ 4

Please comment if you wish _____

C17 SINCE THE START of your pregnancy, how satisfied are you with your overall sexual life (please tick only one response)

- a. Very satisfied ☐ 1 Prefer not to answer ☐ 6
- b. Moderately satisfied ☐ 2
- c. Equally satisfied/dissatisfied ☐ 3
- d. Moderately dissatisfied ☐ 4
- e. Very dissatisfied ☐ 5

Please comment if you wish _____

If you are worried or concerned about unwanted or forced sexual activity and wish to get help, you can call the Sexual Assault Treatment Unit (SATU) based in the Rotunda hospital

SATU telephone number: 01 8171736

SATU e-mail: SATU@ROTUNDA.IE

Web: <http://www.rotunda.ie/>

Opening hours: 9.00am to 4.30pm Mon – Fri

Outside of these hours please contact the
Rotunda Hospital at 01 8171700

Or you can call the national Dublin Rape Crisis Centre. The Dublin Rape Crisis Centre was established in 1979 and is a national organisation offering a wide range of services to women and men who are affected by rape, sexual assault, sexual harassment or childhood sexual abuse.

The services include a national 24-hour helpline, one to one counselling, court accompaniment, outreach services, training, awareness raising and lobbying.

Dublin Rape Crisis Centre HELPLINE 1800 778888

C18 Since the start of your pregnancy have you ever felt depressed for two weeks or longer? *(Please tick only one response.)*

- Yes, I am still depressed ☐ 1
- Yes, I felt depressed a while ago but am alright now ☐ 2
- Yes, I felt depressed but I am getting treatment now ☐ 3
- No, I haven't been depressed since I became pregnant ☐ 4 *(Go to C21)*

C19 When did you start feeling depressed?

Around weeks ago

C20 Since the start of your pregnancy have you talked to your doctor or midwife or another health professional about feeling depressed?

Yes ☐ 1 *(Go to 20a)* No ☐ 2 *(Go to 20b)*

C20a If yes, who did you talk to? *(Please tick all that apply)*

- Talked to my doctor at the hospital during a pregnancy check-up ☐ 1
- Talked to a GP (doctor) during a pregnancy check-up ☐ 2
- Talked to a midwife during a pregnancy check-up ☐ 3
- Talked to someone else *(please describe)* ☐ 4

C20b If no, is this because

- Have thought about it but I haven't felt able to talk about it ☐ 1
- Don't want to discuss it ☐ 2
- Other (please describe) ☐ 3
-

C21 During your pregnancy, have you ever felt afraid of your partner? Yes ☐ 1 No ☐ 2

C22 How many times have you consulted or visited a general practitioner (GP) or local doctor in the last 12 months about your own health for reasons NOT related to your pregnancy or any other pregnancy you may have had?

None ☐ 1
 Once ☐ 2
 Twice ☐ 3
 3 times ☐ 4
 4 times ☐ 5
 5-6 times ☐ 6
 7 times or more ☐ 7

C23 When you go to see a general practitioner (GP) or local doctor

	Always	Mostly	Sometimes	Rarely/Never
a. Do you usually go to the same place?	☐ 1	☐ 2	☐ 3	☐ 4
b. Do you usually see the same doctor?	☐ 1	☐ 2	☐ 3	☐ 4

IF you do not see the same doctor, is this your own personal choice? Yes ☐ 1 No ☐ 2

C24 When you go to the doctor, do you feel able to talk about things that are troubling you regarding your health and wellbeing? *(Please tick ONE response only)*

Yes, I can talk to him/her about any issue that is troubling me	☐	1
Yes, but I am not sure that he/she understands	☐	2
Yes, he/she is supportive	☐	3
No, he/she is not someone I can talk to about issues that are troubling me	☐	4
There isn't anything about my own health or wellbeing that I have wanted to talk about	☐	5

Please comment if you wish _____

C25 About cigarettes, which of the following best describes you

I smoke regularly now – about the same as before finding out I was pregnant	☐	1
I smoke regularly now – but I have cut down since I found out I was pregnant	☐	2
I smoke more now than I used to before I found out I was pregnant	☐	3
I smoke once in a while	☐	4
I stopped smoking when I found out I was pregnant	☐	5
I used to smoke but stopped before I got pregnant and I don't smoke cigarettes now	☐	6
I have never smoked cigarettes	☐	7

Please comment if you wish _____

C26 If you smoke cigarettes every day, how many do you usually smoke?

cigarettes a day

C27 If you smoke cigarettes less often than every day, how many do you usually smoke per week?

cigarettes a week

C28 About alcohol, which of the following best describes you

I drink alcohol regularly now – about the same as before finding out I was pregnant ☐ 1

I drink alcohol regularly now – but I have cut down since I found out I was pregnant ☐ 2

I drink alcohol more now than I used to before I found out I was pregnant ☐ 3

I drink alcohol once in a while ☐ 4

I stopped drinking alcohol when I found out I was pregnant (Go to Section D) ☐ 5

I used to drink alcohol but stopped before I got pregnant and I don't drink alcohol now (Go to Section D) ☐ 6

I have never drank alcohol (Go to Section D) ☐ 7

Please comment if you wish _____



Now that you are pregnant

C29 If you drink alcohol every day, how many units do you usually drink per day?
(Please refer to the Units of Alcohol guide above.)

units a day

C30 If you drink alcohol less often than every day, how many units of alcohol do you usually drink per week?

units a week

C31 How often would you drink five (5) or more units of alcohol on one occasion?
(Please tick only ONE response)

Every day	5-6 times a week	2-4 per week	Once a week	1-3 times a month	Less often	Never
☐	☐	☐	☐	☐	☐	☐

**Section D: This section is about your emotional health and well-being
NOW**

D1 Please look at the following statements and for each one think about how you have been feeling in the last week:

a. During the last week I have been able to laugh and see the funny side of things:

As much as I always could ☐ 1

Not quite so much now ☐ 2

Definitely not so much now ☐ 3

Not at all ☐ 4

b. During the last week I have looked forward with enjoyment to things:

As much as I ever did ☐ 1

Rather less than I used to ☐ 2

Definitely less than I used to ☐ 3

Hardly at all ☐ 4

c. During the last week I blamed myself unnecessarily when things went wrong:

Yes, most of the time ☐ 1

Yes, some of the time ☐ 2

Not very often ☐ 3

No, never ☐ 4

d. During the last week I have felt worried and anxious for no very good reason:

No, not at all	☐	1
Hardly ever	☐	2
Yes, sometimes	☐	3
Yes, very often	☐	4

e. During the last week I have felt scared or panicky for no very good reason:

Yes, quite a lot	☐	1
Yes, sometimes	☐	2
No, not much	☐	3
No, not at all	☐	4

f. During the last week things have been getting on top of me:

Yes, most of the time I haven't been able to cope at all	☐	1
Yes, sometimes I haven't been coping as well as usual	☐	2
No, most of the time I have coped quite well	☐	3
No, I have been coping as well as ever	☐	4

g. During the last week I have been so unhappy I have had difficulty sleeping:

Yes, most of the time	☐	1
Yes, sometimes	☐	2
Not very often	☐	3
No, not at all	☐	4

h. During the last week I have felt sad or miserable:

Yes, most of the time ☐ 1

Yes, quite often ☐ 2

Not very often ☐ 3

No, not at all ☐ 4

i. During the last week I have been so unhappy I have been crying:

Yes, most of the time ☐ 1

Yes, quite often ☐ 2

Only occasionally ☐ 3

No, never ☐ 4

j. During the last week the thought of harming myself has occurred to me:

Yes, quite often ☐ 1

Sometimes ☐ 2

Hardly ever ☐ 3

Never ☐ 4

D2 Is there anyone you can talk to about how you are feeling (please tick only ONE response)

Yes, but I am not sure they understand ☐ 1

Yes, and they are very supportive ☐ 2

No, there isn't anyone I can talk to ☐ 3

I don't particularly want to talk about how I feel ☐ 4

There isn't anything I feel I need to talk about ☐ 5

Please comment if you wish _____

D3 Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you over the past week. There are no right or wrong answers.

		Not at all	Some of the time	A good part of the time	Most of the time
1	I found it hard to wind down	0	1	2	3
2	I was aware of dryness of my mouth	0	1	2	3
3	I couldn't seem to experience any positive feeling at all	0	1	2	3
4	I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5	I found it difficult to work up the initiative to do things	0	1	2	3
6	I tended to over-react to situations	0	1	2	3
7	I experienced trembling (eg, in the hands)	0	1	2	3
8	I felt that I was using a lot of nervous energy	0	1	2	3
9	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10	I felt that I had nothing to look forward to	0	1	2	3
11	I found myself getting agitated	0	1	2	3
12	I found it difficult to relax	0	1	2	3
13	I felt down-hearted and blue	0	1	2	3
14	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15	I felt I was close to panic	0	1	2	3
16	I was unable to become enthusiastic about anything	0	1	2	3
17	I felt I wasn't worth much as a person	0	1	2	3
18	I felt that I was rather touchy	0	1	2	3
19	I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	0	1	2	3
20	I felt scared without any good reason	0	1	2	3
21	I felt that life was meaningless	0	1	2	3

If you are experiencing any problems with your emotional health and wellbeing and wish to talk to someone, you can telephone the mental health midwife/nurse Brid Shine and Elaine McGoldrick at the Coombe Hospital.

Telephone: 01- 4085200

Or you can call the Aware (Depression) Helpline on 1890 303 302

TEXT MESSAGING

Information on where to go for help in a crisis is now available through your mobile phone. Text the word HeadsUp to 50424. The HeadsUp text service is run by RehabCare and sponsored by Meteor.

ONLINE information and support

A number of support services are now using the internet to reach out to people.

For example, www.yourmentalhealth.ie

Section E: This section is about you, your household and your thoughts on some issues.

Thank you for taking the time to complete the survey so far. The next few questions ask for personal details about your household, money and social factors. Sometimes social factors can affect women's health in pregnancy and this is why these questions have been included here.

All the information that you provide is confidential and cannot be linked to you as an individual or your household and there is no possibility that any of this information will be passed on to any other agency or department, government or otherwise.

E1 Are you currently

Married ☐ 1

Divorced or separated ☐ 2

Widowed ☐ 3

Single ☐ 4

Living with partner ☐ 5

In a relationship – not living together ☐ 6

Other (*please describe*) ☐ 7

E2 Who else lives together with you in your household? (*Please tick ALL that apply.*)

Your partner/husband ☐ 1

Your mother ☐ 2

Your father ☐ 3

Your partner's mother ☐ 4

Your partner's father ☐ 5

Partner's child/children from previous relationship ☐ 6

Your sister(s) and/or brother(s)	☐	7
A friend/friends	☐	8
No one	☐	9
Nanny/au pair	☐	10
Other (please describe)	☐	11
-

E3 How would you describe your current living accommodation? (Please tick ONE only)

House (with a mortgage)	☐	1
House (with no mortgage)	☐	2
Apartment (with a mortgage)	☐	3
Apartment (with no mortgage)	☐	4
Rented house (rented privately)	☐	5
Rented house (rented from local authority)	☐	6
Rented apartment (rented privately)	☐	7
Rented apartment (rented from local authority)	☐	8
Caravan / Mobile Home	☐	9
Bed and breakfast accommodation	☐	10
Hostel accommodation	☐	11
No fixed accommodation (homeless)	☐	12
Other (please give detail)	☐	13
-
-
-

E4 What is the highest qualification you have completed *(Please tick ONE only)*

No formal qualifications	☐ 1
Primary or first school	☐ 2
Lower secondary	☐ 3
Junior/Intermediate/Group certificate, 'O' levels/ GCSE, NCVA Foundation certificate, basic skills training certificate, or equivalent	☐ 4
Upper secondary Leaving certificate – applied and vocational programmes, 'A' levels, NCVA level 1 certificate, or equivalent	☐ 5
Completed apprenticeship, NCVA level 2/3 certificate, Teagasc certificate, Diploma, or equivalent	☐ 6
Both Upper secondary and Technical or Vocational qualification	☐ 7
National certificate, Diploma NCEA / Institute of Technology or equivalent, Nursing Diploma	☐ 8
Primary degree Third level Bachelor degree	☐ 9
Professional qualification of degree status at least	☐ 10
Postgraduate certificate or diploma	☐ 11
Postgraduate degree Masters	☐ 12
Doctorate PhD	☐ 13

E5 How would you describe your current employment status *(Please tick ONE only)*

Full-time paid work	☐	1
Part-time paid work	☐	2
Casual paid work	☐	3
Looking for first job	☐	4
Unemployed	☐	5
Student or pupil	☐	6
Looking after home/family	☐	7
Unable to work due to sickness / disability	☐	8
Unpaid voluntary work	☐	9
Others <i>(Please describe)</i>	☐	10

E6 What is your ethnic background?

Irish	☐	1
Irish traveller	☐	2
African	☐	3
Chinese	☐	4
Any other white background	☐	5
Any other black background	☐	6
Any other Asian background	☐	7
Other, including mixed background	☐	8
Others (please tick and write in)	☐	9 _____

E7 Which country were you born in? _____

E8 How long have you lived in the Republic of Ireland?

All your life ☐ 1

Other ☐ 2 (please state) years and months

The final set of questions ask about your thoughts on some issues and how much time you spend, if any, finding information regarding various issues.

E9 Have you thought about the type of birth you would like to have?

No, I haven't thought about it ☐ 1

I would like to have a normal (natural) birth ☐ 2

I would like to have a planned caesarean section (no labour) ☐ 3

Please comment if you wish

E10 How much time do you spend finding any of the information listed below during an average day (whether you use the internet, TV, radio, newspaper etc). Please tick/circle the response that reflects your opinion on each question

a. Information about children (education, how to raise children etc.)

None	10 minutes	20 minutes	30 minutes	40 minutes	50 minutes	1 hour	1 hour, 10 minutes	1 hour, 20 minutes	1 hour, 30 minutes	More than 1 hour & 30 minutes

b. Pregnancy and birth giving

None	10 minutes	20 minutes	30 minutes	40 minutes	50 minutes	1 hour	1 hour, 10 minutes	1 hour, 20 minutes	1 hour, 30 minutes	More than 1 hour & 30 minutes

c. Household issues (recipes, gardening etc.)

None	10 minutes	20 minutes	30 minutes	40 minutes	50 minutes	1 hour	1 hour, 10 minutes	1 hour, 20 minutes	1 hour, 30 minutes

d. World politics

None	10 minutes	20 minutes	30 minutes	40 minutes	50 minutes	1 hour	1 hour, 10 minutes	1 hour, 20 minutes	1 hour, 30 minutes

e. Irish politics

None	10 minutes	20 minutes	30 minutes	40 minutes	50 minutes	1 hour	1 hour, 10 minutes	1 hour, 20 minutes	1 hour, 30 minutes

f. Health care services

None	10 minutes	20 minutes	30 minutes	40 minutes	50 minutes	1 hour	1 hour, 10 minutes	1 hour, 20 minutes	1 hour, 30 minutes

g. Community issues

None	10 minutes	20 minutes	30 minutes	40 minutes	50 minutes	1 hour	1 hour, 10 minutes	1 hour, 20 minutes	1 hour, 30 minutes

h. Celebrities

None	10 minutes	20 minutes	30 minutes	40 minutes	50 minutes	1 hour	1 hour, 10 minutes	1 hour, 20 minutes	1 hour, 30 minutes

i. Local entertainment (restaurants, movies, going out etc)

None	10 minutes	20 minutes	30 minutes	40 minutes	50 minutes	1 hour	1 hour, 10 minutes	1 hour, 20 minutes	1 hour, 30 minutes

E11 How interested are you in politics? *(Please tick/circle the response that reflects your opinion)*

1	2	3	4	5	6	7
Not at all interested						Very interested

E12 How much confidence do you have in the way the following institutions carry out their work?

a. The Government

1	2	3	4	5	6	7
Very little confidence						Full confidence

b. The Department of Social protection

1	2	3	4	5	6	7
Very little confidence						Full confidence

c. Maternity services

1	2	3	4	5	6	7
Very little confidence						Full confidence

d. Courts (and legal systems)

1	2	3	4	5	6	7
Very little confidence						Full confidence

e. The Political Parties

1	2	3	4	5	6	7
Very little confidence						Full confidence

E 13 Did you do any of the following in the last 3 months:

	Yes	No
Sign a petition	Yes ☐ 1	No ☐ 2
Bought a product for political, environmental or ethical considerations	Yes ☐ 1	No ☐ 2
Participate in a protest or march	Yes ☐ 1	No ☐ 2
Participate in a societal or political group/organization meeting	Yes ☐ 1	No ☐ 2
Post a blog, message or link with political or societal content	Yes ☐ 1	No ☐ 2

What date did you complete this survey on? _____

When posting this survey, please ensure that you also enclose a copy of the **consent form containing your personal details**. Please keep one copy of the consent form for your own records.

Thank you.

Your comments on this survey

If you wish to write any further comments please do so on this page. Thank you.

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper has a slight shadow on the right side, suggesting it's resting on a surface.

Please help us to keep in touch with you.

If your address or other contact details have changed (or you are about to move), please fill in the details below:

Your NEW address:	Your NEW phone number(s):

Thank you for taking the time to complete this survey.

Please use the **reply paid** envelope to send it back to us. If no envelope was enclosed with this survey or you have mislaid it, please call us on 087 229 0989 and we will send you out another one.

We are very grateful for the time and trouble you have taken to participate in this part of the MAMMI study.

The results from this part of the study will not be available until all of the women taking part in the study have given birth. As soon as the first study results are available, we will let you know via the website and the study newsletter for women.

Please do call us if you have any questions about the study.

We look forward to contacting you again when you are about 7 to 8 months pregnant.

Best wishes.

The MAMMI study team

087 2290989

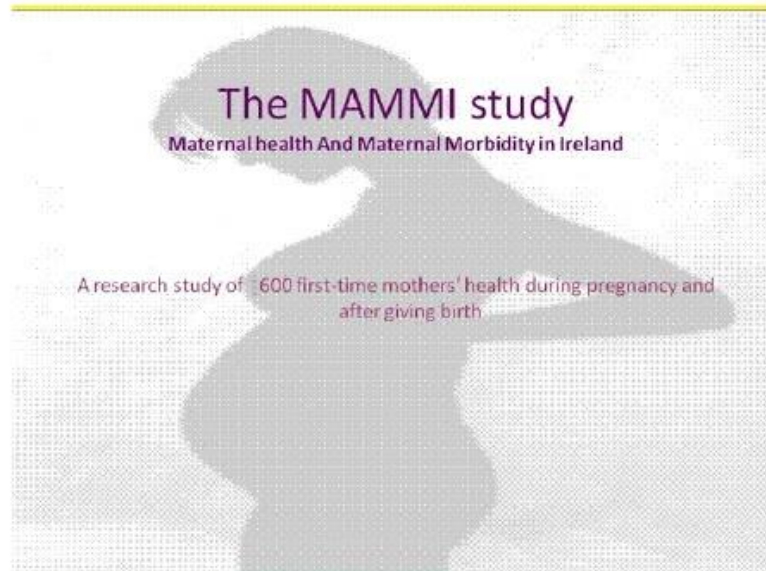
www.mammi.ie



Our sincerest thanks to Professor Stephanie Brown, Murdock Children's Research Institute, Melbourne, Australia for granting us permission to amend and use this survey in an Irish setting.

Appendix 4-4: MAMMI Survey 1A

Study Number



Survey Booklet One A: Antenatal – Diet and Physical Activity

1A

Thank you for taking the time to complete this survey. It will take you about 30 minutes to complete it and your answers are confidential. If you have any questions about any part of this survey, or need help answering any of the questions, please feel free to call us on 087 2290989.

The MAMMI survey has been approved by the Research Ethics Committees of the Coombe Women and Infants University Hospital and the Faculty of Health Sciences, Trinity College Dublin.

Please tick here if you do NOT wish to complete this or receive future surveys ☐



TRINITY COLLEGE DUBLIN
COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH

THE UNIVERSITY
OF DUBLIN

Contact: MAMMI Research Team
(Deirdre Daly, Sunita Panda, Jamile Marchi, Deirdre O'Malley, Francesca Wuytack)
Tel: 087 2290989
E-mail: contact@mammi.ie

MAMMI-Survey One A

Structure of the MAMMI Study

The Maternal health And Maternal Morbidity in Ireland (MAMMI) study is in six (6) parts: there are 2 antenatal surveys (1) antenatal and (1A) antenatal diet (nutrition) and physical activity; (2) 3 months after the birth; (3) 6 months after the birth; (4) 9 months after the birth and (5) 12 months after the birth.

This is the diet and physical activity part of the study. It is about your diet and lifestyle NOW (antenatally) and before you became pregnant. It has four (4) sections, numbered A through to D:

- A questions about your general health, physical activity, food habits and life style;
- B your diet/nutrition and health SINCE THE START of your pregnancy;
- C Breast feeding intention;
- D Physical activity DURING your pregnancy;

You may notice that some questions are very similar or the same, however, the questions apply to different times in your life.

How to fill in the Survey

Most of the questions can be answered by putting a tick in the box next to the answer that best applies to you. For example:

Has tiredness been a problem for you in the past month?

Yes	☒
No	☐

This filled-in sample indicates that tiredness was a problem in the past month.

A few questions may ask you to fill in a number in a box. For example:

What is your date of birth?

Day	/Month	/Year
3 0	0 4	1 9 8 0

This filled-in sample represents a date of birth of 30th April 1980

Section A: This section is about your general health and diet in the 12 months BEFORE your pregnancy

A1 How would you describe your general health in the 12 months BEFORE your pregnancy?

Excellent	Very good	Good	Fair	Poor	Very poor
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

A2 What, if anything, do you think could have improved your health? (Please tick all that apply)

Losing weight	☐ 1
Gaining weight	☐ 2
Regular checks from your family doctor	☐ 3
Fewer changes in your life	☐ 4
Less stress	☐ 5
Employment	☐ 6
More money	☐ 7
More willpower	☐ 8
A different job	☐ 9
Less alcohol	☐ 10
Less/stop smoking	☐ 11
Less time in smoky places	☐ 12
Someone to talk to	☐ 13
Better information about where to go for health care	☐ 14
'Easier to read' health information	☐ 15
Better information about how to stay healthy	☐ 16
Less international/national pollution	☐ 17
Less local pollution (e.g. noise)	☐ 18
None of the above	☐ 19

In the 12 months BEFORE your pregnancy, were you told by a doctor (or healthcare professional) that you:

A3 Had high blood pressure?

Yes ☐ ¹

No ☐ ²

I haven't had it checked ☐ ³

A4 Had high cholesterol?

Yes ☐ ¹

No ☐ ²

I haven't had it checked ☐ ³

A5 a. In the 12 months BEFORE your pregnancy, did you follow any specific diet?

Yes ☐ ¹

No ☐ ²

→ Please go to A6

b. If YES, which of the following diets did you follow? (Please tick all that apply)

Weight loss ☐ ¹

Vegetarian ☐ ²

Vegan ☐ ³

Diet to control diabetes ☐ ⁴

Gluten Free ☐ ⁵

Cholesterol lowering ☐ ⁶

Other (please describe) ☐ ⁷

A6 In the 12 months BEFORE your pregnancy, how would you describe your diet?

Very healthy ☐ ¹

Healthy ☐ ²

Fair ☐ ³

Not so good ☐ ⁴

Bad ☐ ⁵

Very bad ☐ ⁶

Other (please describe) ☐ ⁷

A7 In the 12 months BEFORE your pregnancy, were you trying to lose weight?

Yes ☐ 1 No ☐ 2

A8 Did your weight change in the 12 months before your pregnancy?

a)	I lost a lot of weight	I lost a few pounds/kgs	I stayed about the same weight	I gained a few pounds/kgs	I gained a lot of weight	Other (Please describe)
	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

Other (Please describe)

b) I lost/gained:

kgs OR stones and pounds

A9 In the 12 months BEFORE your pregnancy, were you satisfied with your body image?

Always	Sometimes	Never
☐ 1	☐ 2	☐ 3

Please comment if you wish

A10 a. In the 12 months BEFORE pregnancy did you read food labels? (the nutritional information on the side/back of the food packaging that tells you what it contains)

Yes, always ☐ 1 Yes, sometimes ☐ 2

No, never ☐ 3 → Please go to A11

b. If YES, which of the following did you look for on the label? (Please tick ALL that apply)

Ingredients	☐ 1
Nutrients (e.g. Fat, Fibre, Sugar)	☐ 2
Calorie value	☐ 3
Weight of food	☐ 4
Additives (e.g. E numbers)	☐ 5
Serving size	☐ 6
Instructions for competitions	☐ 7
Cooking Instructions	☐ 8
Other (please describe)	☐ 9
-

A11 In the 12 months BEFORE your pregnancy, how often did you have the following meals per week? (Please tick ONE response on EACH line)

(A snack is a smaller meal consisting of, for example, a fruit, biscuit, bun, cake, yoghurt or sweets/candy.)

	Every day	1-3 times a week	4-6 times a week	Never
Breakfast	☐ 1	☐ 2	☐ 3	☐ 4
Morning snack	☐ 1	☐ 2	☐ 3	☐ 4
Lunch	☐ 1	☐ 2	☐ 3	☐ 4
Afternoon snack	☐ 1	☐ 2	☐ 3	☐ 4
Dinner	☐ 1	☐ 2	☐ 3	☐ 4
Night snack	☐ 1	☐ 2	☐ 3	☐ 4
Any other meal	☐ 1	☐ 2	☐ 3	☐ 4

(Please, describe which ones)

A12 Can you afford to buy enough food for your household?

- Always ☐ 1
- Usually ☐ 2
- Sometimes ☐ 3
- Rarely ☐ 4
- Never ☐ 5

The next few questions ask about physical activities you may have done in the 12 months BEFORE your pregnancy.

If possible, we would like you to tell us the type and amount of exercise that you did in an average week:

In an average week...

A13 a. How many times did you walk continuously, for at least 10 minutes, for recreation, exercise or to get from place to place?

times₁ ☐ none₂ → Please go to A14

b. What do you estimate was the total time you spent walking in this way?

hours₁ minutes₂

A14 a. How many times did you do any vigorous gardening or heavy work around the house or garden which made you breathe harder or puff and pant?

times₁ ☐ none₂ → Please go to A15

b. What do you estimate was the total time you spent doing vigorous gardening or heavy work around the house or garden?

hours₁ minutes₂

A15 a. How many times did you do any strenuous household chores involving moderate physical activity? (For example, vacuum cleaning, washing windows, carrying shopping up several flights of stairs, scrubbing floors)

times₁ ☐ none₂ → Please go to A16

b. What do you estimate was the total time you spent doing these kinds of household chores?

hours₁ minutes₂

The next questions are about the types of exercise, if any, you did in the **12 months BEFORE your pregnancy**

Intensity refers to the rate at which the activity is being performed or the amount of effort required to perform an activity or exercise. It can be thought of "How hard a person works to do the activity". The intensity of different forms of physical activity varies between people. The examples given below are provided as a guide only and will vary between individuals.

Moderate-intensity Physical Activity Requires a moderate amount of effort and noticeably accelerates the heart rate	Vigorous-intensity Physical Activity Requires a large amount of effort and causes rapid breathing and a substantial increase in heart rate
Examples of moderate physical activity include:	Examples of vigorous physical activity include:
• Walking	• Running
• Dancing	• Brisk Walking / climbing up a hill
• Cycling at a regular pace	• Fast cycling
• Jogging	• Aerobics
• Golfing	• Fast swimming
• Badminton	• Football, hockey, basketball
• Carrying / moving moderate loads	• Carrying / moving heavy loads

In an average week (on the 12 months BEFORE your pregnancy):

- A16 a. How many times did you do any **Moderate-intensity Physical Activity** which made you breathe harder or puff and pant? (For example, jogging)

times₁

none₂ → Please go to A17

- b. What do you estimate was the total time you spent doing these activities?

hours₁

minutes₂

- A17 a. How many times did you do any other more **Vigorous-intensity Physical Activity**? (For example, fast swimming)

times₁

none₂ → Please go to A18

- b. What do you estimate was the total time you spent doing these activities?

hours₁

minutes₂

A18 a. Did you do any regular exercise for 10 minutes or more at least ONCE a week?

Yes ☐ 1 No ☐ 2 → Please go to A19

b. If YES Please tick the types of exercise you did and how many times per week you did them)

Exercise	Yes	Times per Week	
Fast walking			1
Jogging/running			2
Aerobics			3
Weight training			4
Dancing			5
Swimming			6
Cycling			7
Ball games (soccer, GAA, rugby)			8
Racket sports (tennis, badminton)			9
Weight lifting			10
Other			11

Other (Please describe) _____

Section B: DIET AND NUTRITION – This section is about your general eating habits since the START of your pregnancy.

B1 Have you experienced nausea during this pregnancy?

Yes ☐ ₁ No ☐ ₂ → Please go to B5

B2 Are you still experiencing nausea?

Yes ☐ ₁ No ☐ ₂

B3 In which week(s) were you most bothered with nausea?

From pregnancy week _____ to pregnancy week _____

B4 a. Did the feeling of nausea affect your appetite?

Yes ☐ ₁ No ☐ ₂ → Please go to B5

b. If yes, how was your appetite affected?

I ate less
than usual

I ate less but
more often

I ate the
same as usual

I ate more
than usual

☐ ₁

☐ ₂

☐ ₃

☐ ₄

Please comment if you wish: _____

B5 Have you vomited during this pregnancy?

Yes ☐ ₁ No ☐ ₂ → Please go to B9

B6 Are you still vomiting?

Yes ☐ ₁ No ☐ ₂

B7 In which week(s) did you vomit?

From pregnancy week _____ to pregnancy week _____

B8 a. Did the vomiting affect your appetite?

Yes ☐ 1

No ☐ 2

→ Please go to B9

b. If yes, how was your appetite affected?

I ate less
than usual

☐ 1

I ate less but
more often

☐ 2

I ate the
same as usual

☐ 3

I ate more
than usual

☐ 4

Please comment if you wish: _____

B9 a. During your pregnancy have you been following/followed any specific diet?

Yes ☐ 1

No ☐ 2

b. If YES, which of the following diets? (Please tick all that apply)

Weight loss

☐ 1

Vegetarian

☐ 2

Vegan

☐ 3

Diet to control diabetes

☐ 4

Gluten Free

☐ 5

Cholesterol lowering

☐ 6

Other (please describe)

☐ 7

B10 During your pregnancy, are you concerned that you might:

Gain too MUCH
weight

☐ 1

Gain too LITTLE
weight

☐ 2

Please comment if you wish:

B11 Now that you are pregnant, are you satisfied with your body image?

Always

☐ 1

Sometimes

☐ 2

Never

☐ 3

Please comment if you wish _____

B12 How often have you had the following meals per week since you became pregnant?

(Please tick ONE response on EACH line)

(A snack is a smaller meal consisting of, for example, a fruit, biscuit, bun, cake, yoghurt or sweets/candy.)

	Every day	1-3 times a week	4-6 times a week	Never
Breakfast	☐ 1	☐ 2	☐ 3	☐ 4
Morning snack	☐ 1	☐ 2	☐ 3	☐ 4
Lunch	☐ 1	☐ 2	☐ 3	☐ 4
Afternoon snack	☐ 1	☐ 2	☐ 3	☐ 4
Dinner	☐ 1	☐ 2	☐ 3	☐ 4
Night snack	☐ 1	☐ 2	☐ 3	☐ 4
Any other meal	☐ 1	☐ 2	☐ 3	☐ 4

B13 How often do you eat fried food (i.e. use of oil or other fats when cooking)?

Never	☐ 1
Less than once a month	☐ 2
One or several times a month	☐ 3
One or several times a week	☐ 4
Every day	☐ 5

B14 What type of milk do you use most often?

None	☐ 1
Whole milk/Full fat	☐ 2
Low fat	☐ 3
Skimmed	☐ 4
Super/fortified	☐ 5
Soya	☐ 6
Other (Please describe)	☐ 7
-

B15 About how much milk do you drink each day?

None	☐ 1
250ml (half pint, ¼ litre)	☐ 2
568ml (one pint)	☐ 3
1000 ml (1 litre)	☐ 4
More than 1 litre	☐ 5

B16 How often do you add salt to food while cooking?

Always	☐ 1
Usually	☐ 2
Sometimes	☐ 3
Rarely	☐ 4
Never	☐ 5

B17 How often do you add salt to food while at the table?

Always	☐ 1
Usually	☐ 2
Sometimes	☐ 3
Rarely	☐ 4
Never	☐ 5

B18 What type of spread do you usually use on bread? (Please tick ALL that apply or use most often)

Butter or hard margarine	☐ 1
A low fat spread	☐ 2
A polyunsaturated spread	☐ 3
A cholesterol lowering spread	☐ 4
None	☐ 5
Other (Please describe)	☐ 6
-

B19 What type of fat/oil would you usually use for cooking? (Please tick ALL that apply OR use most often)

Vegetable oil	☐ 1
Sunflower oil	☐ 2
Olive oil	☐ 3
Coconut oil	☐ 4
Rapeseed oil	☐ 5
Lard or dripping	☐ 6
Butter (or hard margarine)	☐ 7
Other	☐ 8
None	☐ 9

B20 Now that you are pregnant, can you afford to buy enough food for your household?

Always	☐ 1
Usually	☐ 2
Sometimes	☐ 3
Rarely	☐ 4
Never	☐ 5

Please comment if you wish _____

The next section is still about your diet and eating habits since you became pregnant.

We know very little about what pregnant women in Ireland eat during pregnancy. Your answers to these questions will help us to learn more and will be really useful, thank you.

B21 Your diet during your pregnancy

For each food there is an amount shown, either what we think is a "medium serving" or a common household unit such as a slice or teaspoon. Please put a tick in the box to indicate how often, on average, you have eaten the specified amount of each food, to the nearest whole number during your pregnancy. If you think the portion of food you eat is greater or less than the indicated serving please tick in the box which best suits. Please estimate your average food consumption as best as you can. Please answer every question, do not leave ANY lines blank.

EXAMPLES:

The following are examples on how to estimate how often and how much bread and potatoes you ate SINCE YOU BECAME PREGNANT. Please estimate your food intake for all foodstuffs in the same way.

Example 1

Potatoes: If you ate a medium serving of potatoes 3 times per week during your pregnancy put a tick in the box "2-4 per week". If you think you usually ate more or less than a medium serving please try to estimate which box suits best.

Potatoes, Rice and Pasta (medium serving)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Boiled, instant or jacket potatoes				√					

Example 2

For white bread a medium serving is one medium sized slice. Therefore if you usually ate 1 medium slice 4 or 5 times per day, you should put a tick in the column headed "4-5 per day". If you ate 2 medium slices 4 or 5 times per day, then you should put a tick in the column "6+ per day".

BREAD AND SAVOURY BISCUITS (One slice or one biscuit)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
White bread and rolls (including ciabatta bread)								√	

Please check that you put a tick (√) on every line

A. MEAT, FISH AND POULTRY (Medium serving – the size of a deck of cards OR palm of hands without fingers)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Beef roast									
Beef: steak									
Beef: mince									
Beef: stew									
Beef burger (1 burger)									
Pork: roast									
Pork: chops									
Pork: slices/steak/escalopes									
Lamb: roast									
Lamb: chops									
Lamb: stew									
Chicken portion OR other poultry e.g. turkey: roast									
Breaded chicken, chicken nuggets, chicken burger									
Bacon									
Ham									
Corned beef									
Luncheon meats									
Sausages, Frankfurters (1 sausage)									
Savoury pies (e.g. meat pie, pork pie, steak & kidney pie, sausage rolls)									
Heart, kidney									
Fish fried in batter, as in fish and chips									
Fish fried in bread crumbs									
Oven baked/grilled fish (in bread crumbs OR batter)									
Fish fingers/fish cakes									
Other white fish, fresh OR frozen (e.g. cod, haddock, plaice, sole, halibut, colli)									

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1A MAMMI-Survey One A

A. MEAT, FISH AND POULTRY (Medium serving – the size of a deck of cards OR palm of hands without fingers)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Oily fish (fresh) - (e.g. mackerel, kippers, tuna, salmon, sardines, herring)									
Oily fish (canned) - (e.g. mackerel, kippers, tuna, salmon, sardines, herring)									
Shellfish (e.g. crab, prawns, mussels)									

Please check that you put a tick (✓) on every line

B. BREAD AND SAVOURY BISCUITS (One slice OR one biscuit)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
White bread and rolls (including ciabatta and pannini bread)									1
Brown bread and rolls									2
Wholemeal bread and rolls									3
Cream crackers, cheese biscuits									4
Crisp bread, e.g. Ryvita									5
Pancakes, muffins, oatcakes									6
Baguette									7

Please check that you put a tick (✓) on every line

C. CEREALS (One medium sized bowl)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Porridge, Readybrek									
All Bran, Weetabix, Shredded Wheat									

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1A MAMMI-Survey One A

C. CEREALS (One medium sized bowl)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Branflakes, Bran Buds									
Cornflakes, Rice Krispies									
Muesli (e.g. Country Store, Alpen, sugar coated, Granola)									
Sugar Coated Cereals (e.g. Frosties, Crunchy Nut Cornflakes, Crunchy Sugar Coated Muesli)									

Please check that you put a tick (✓) on every line

D. POTATOES, RICE AND PASTA (Medium serving – about a cupful)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Boiled, instant or jacket potatoes									
Mashed potatoes									
Chips									
Roast potatoes									
Potato Salad									
White rice									
Brown rice									
White/yellow/green pastas (e.g. spaghetti, macaroni, noodles)									
Wholemeal pasta									
Lasagne (meat based)									
Lasagne (vegetarian)									
Moussaka									
Pizza									
Macaroni Cheese									

Please check that you put a tick (✓) on every line

E. DAIRY PRODUCTS AND FATS										
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day	
Cream (1 tablespoon)										1
Full-fat yoghurt OR Greek- style Yoghurt (125g carton)										2
Dairy desserts (125g carton)										3
Cheddar cheese (medium serving)										4
Low-fat cheddar cheese (medium serving OR 1 slice - 25g)										5
Eggs as boiled, fried, scrambled, poached (1)										6
Quiche (medium serving)										7
Light salad cream OR light mayonnaise (1 tablespoon)										8
Salad cream, mayonnaise (1 tablespoon)										9
French dressing										10
Other salad dressing										11
The following on bread OR vegetables										
Butter (1 teaspoon)										12
Light Butter e.g. Dawn light, Connacht Gold (teaspoon)										13
Sunflower margarine e.g. Flora (1 teaspoon)										14
Low-fat margarine e.g. low- low (1 teaspoon)										15
Cholesterol lowering spreads e.g. Flora Pro Active, Dairy Gold Heart (1 teaspoon)										16
Cream and vegetable oil spread e.g. Golden Pasture, Kerrymaid, Dairy Gold (1 teaspoon)										17
Olive oil spread e.g. Golden Olive (1 teaspoon)										18

Please check that you put a tick (✓) on every line

F. FRUIT (1 fruit OR medium serving)										
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day	
Apples										1
Pears										2
Oranges, Satsuma, mandarins										3
Grapefruit										4
Bananas										5
Grapes										6
Melon										7
Peaches, plums										8
Apricots										9
Strawberries, raspberries, kiwi fruit										10
Tinned fruit										11
Dried fruit e.g. raisins										12
Frozen fruit										13

Please check that you put a tick (✓) on every line

G. VEGETABLES Fresh, frozen OR tinned (Medium serving – 2 tablespoons OR 4 desert spoons)										
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day	
Carrots										1
Spinach										2
Broccoli, spring greens, kale										3
Brussel sprouts										4
Cabbage										5
Peas										6

G. VEGETABLES Fresh, frozen OR tinned (Medium serving – 2 tablespoons OR 4 desert spoons)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Green beans, broad beans, runner beans									7
Courgettes									8
Cauliflower									9
Parsnips, turnips									10
Leeks									11
Onions									12
Garlic									13
Mushrooms									14
Sweet peppers									15
Beansprouts									16
Green salad, Lettuce									17
Cucumber, celery									18
Tomatoes									19
Sweetcorn									20
Beetroot									21
Coleslaw									22
Baked beans									23
Dried lentils, beans, peas									24
Tofu, soya meat, TVP, veggieburger									25

Please check that you put a tick (✓) on every line

H. SWEETS AND SNACKS (Medium serving)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Chocolate coated sweet biscuits e.g. digestive (1)									1
Plain sweet biscuits e.g. Marietta, Digestives, Rich									2

H. SWEETS AND SNACKS (Medium serving)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Tea (1)									
Cakes e.g. fruit, sponge									3
Buns, pastries e.g. croissants, doughnuts									4
Fruit pies, tarts, crumbles									5
Sponge puddings									6
Milk puddings e.g. rice, custard, trifle									7
Ice cream, choc ices, Frozen desserts									8
Chocolates, single OR square									9
Sweets, toffees, mints									10
Sugar added to tea, coffee, cereal (1 teaspoon)									11
Sugar substitute e.g. Canderel added to tea, coffee, cereal (1 teaspoon)									12
Crisps OR other packet snacks									13
Peanuts OR other nuts									14

Please check that you put a tick (✓) on every line

I. SOUPS, SAUCES AND SPREADS									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Vegetable soups: homemade/fresh (1 bowl)									1
Vegetable soups: tinned/packet (1 bowl)									2
Meat OR cream soups: homemade/fresh (1 bowl)									3
Meat OR cream soups: tinned/packet (1 bowl)									4
Sauces e.g. white sauce,									5

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I. SOUPS, SAUCES AND SPREADS									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
cheese sauce, gravy (1 tablespoon)									
Tomato based sauces e.g. pasta sauces									6
Curry-type sauces									7
Pickles, chutney (1 tablespoon)									8
Marmite, Bovril (1 tablespoon)									9
Jam, marmalade, honey, syrup (1 tablespoon)									10
Peanut butter (1 teaspoon)									11

Please check that you put a tick (✓) on every line

J. DRINKS									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Tea (cup)									1
Coffee instant (cup)									2
Coffee ground (cup)									3
Coffee, decaffeinated (cup)									4
Coffee whitener e.g. coffee-mate (teaspoon)									5
Cocoa, Hot Chocolate (cup)									6
Horlicks, Ovaltine (cup)									7
Low calorie OR diet soft fizzy drinks (glass)									8
Fizzy Soft drinks e.g. Cocoa Cola (glass)									9
Pure fruit drinks e.g. orange juice (small glass)									10
Fruit squash (small glass)									11

B22 How many glasses of water would you say you drink per day/each day (small glass)?

None	☐ 1
1-2 glasses	☐ 2
More than 2 and less than 4 glasses	☐ 3
More than 4 and less than 6 glasses	☐ 4
More than 6 and less than 8 glasses	☐ 5
More than 8 and less than 10 glasses	☐ 6
More than 10 glasses per day	☐ 7
Other	☐ 8

Please describe & comment if you wish _____

B23 Now that you are pregnant, would you say that you have changed your daily water intake?

I used to drink more water – before pregnancy	☐ 1
I drink about the same	☐ 2
I used to drink less water – before pregnancy	☐ 3

Please describe & comment if you wish _____

B24 Other food items

It is difficult to ask about all the food you have eaten since you became pregnant. Please write down the names of any food items that you have eaten and that you have not yet been asked about.

Please, tick here IF you have **NOTHING ELSE** (any other food) to add ☐ → Please go to B23

Other foods									
Name of food <u>AND</u> average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
									1
									2
									3
									4
									5
									6
									7
									8
									9
									10
									11

Please, comment if you wish _____

B25 Dietary changes during this pregnancy

Please mark if you have eaten more, less OR the same amount of the following food items compared to before becoming pregnant.

	Started since pregnant	Same	More	Less	Stopped since pregnant	Never eat
a. Milk, dairy products, cheese	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
b. Bread, cereals	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
c. Biscuits	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
d. Fat	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
e. Meat	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
f. Fish	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
g. Eggs	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
h. Vegetables	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
i. Fruits	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
j. Chocolate	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
k. Other sweets	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
l. Coffee	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
m. Tea	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
n. Juice	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
o. Soft drinks with sugar	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
p. Soft drinks (sugar free)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
q. Alcohol	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

Please, comment if you wish _____

B26 a. Did you receive any advice about what to eat/not to eat, since you became pregnant?

Yes ☐ 1 No ☐ 2 → Please go to B25

b. If YES, did you get advice from the following people or sources? (Please tick all that apply)

General practitioner / local doctor	☐ 1
Public Health Nurse	☐ 2
GP Practice Nurse	☐ 3
Dietician	☐ 4
Midwife	☐ 5
Other health professional	☐ 6
Partner/husband	☐ 7
Friend	☐ 8
Sister	☐ 9
Mother	☐ 10
Neighbour	☐ 11
Internet	☐ 12
Other (Please describe)	☐ 13
-

B27 a. Since you became pregnant, were you advised to stop eating/drinking any particular item?

Yes ☐ 1 No ☐ 2 → Please go to B26

b. If YES, what food and/or drink were you advised to stop eating?

B28 a. Since you became pregnant, were you advised to start taking any food/drink in particular?

Yes ☐ 1

No ☐ 2 → Please go to B27

b. If YES, what food(s) and/or drink(s) were you advised to start eating/drinking?

B29 Would you have liked more information about what to eat/drink or what NOT to eat/drink during pregnancy?

Yes ☐ 1

No ☐ 2

Please comment if you wish

B30 Dietary Supplements

A dietary supplement is intended to provide nutrients that may otherwise not be consumed in sufficient quantities. Supplements as generally understood include vitamins, minerals, fibre, fatty acids, or amino acids, among other substances.

a. Did you take any dietary supplements BEFORE your pregnancy?

Yes ☐ 1

No ☐ 2

b. If yes, please describe the supplements that you took

c. Have you taken or are you currently taking any dietary supplements DURING your pregnancy?

Yes ☐ 1

No ☐ 2 → Please go to B29

Please comment if you wish

d. If yes, please go to the table on the next page and describe the supplements that you took

Supplement	Times a week/day e.g. 1 a day or twice a week	Quantity	Where did you buy it? e.g. Chemist/pharmacy, hospital, other	When did you start taking it?	When did you stop taking it? (if you have stopped) e.g. 'when I became pregnant' or at X weeks pregnant
PregnaCare original					
PregnaCare Max					
PregnaCare plus-omega 3					
Clonfollic					
Folic Acid (400 mcg)					
Galfer or Galfer FA					
Pregnancy 1 plus (Boots)					
Pregnaplan (Sona)					
Pregnancy (Seven seas)					
Pharmaton (Matruelle)					
Sanatogen Mum to be					
Sanatogen Mum to be + Omega 3					
Spatone Iron Supplement (sache)					
Spatone Apple Liquid Iron Supplement with added Vitamin C					
Centrum Pregnancy Care Plus Omega-3					

Supplement	Times a week/day e.g. 1 a day or twice a week	Quantity	Where did you buy it? e.g. Chemist/ pharmacy, hospital, other	When did you start taking it?	When did you stop taking it? (if you have stopped) e.g. 'when I became pregnant' or at x weeks pregnant
Flax seeds					
Flax Oil					
Other name and brand:					
Other name and brand:					
Other name and brand:					

B31 a. Were you advised to take dietary supplements during pregnancy?

Yes ☐ 1 No ☐ 2 → Please go to B30

b. If YES, who advised you? (Please tick ALL that apply)

- General practitioner / local doctor ☐ 1
- Public Health Nurse ☐ 2
- GP Practice Nurse ☐ 3
- Dietician ☐ 4
- Midwife ☐ 5
- Pharmacist ☐ 6
- Other health professional ☐ 7
- Partner/husband ☐ 8
- Friend ☐ 9

Sister	☐	10
Mother	☐	11
Neighbour	☐	12
Internet	☐	13
Other (Please describe)	☐	14
-

B32 Food cravings and aversions

A food craving is that strong feeling that you must have a specific food while an aversion is the complete incapacity to eat certain food (and sometimes even to smell it).

a. Since you became pregnant, did you have CRAVING(s) for any food or drink?

Yes ☐ 1 No ☐ 2

If Yes, please tell us about this _____

b. Since you became pregnant, did you have an AVERSION (a strong dislike) for any food or drink?

Yes ☐ 1 No ☐ 2

If Yes, please tell us about this _____

Section C: Breast feeding intention

C1 Are you planning to breast feed?

Yes ☐ 1 No ☐ 2

Please comment if you wish: _____

C2 a. Have you received any advice on breast-feeding?

Yes ☐ 1 No ☐ 2

Please comment if you wish: _____

b. If YES, who advised you? (Please tick all that apply)

General practitioner / local doctor	☐ 1
Public Health Nurse	☐ 2
GP Practice Nurse	☐ 3
Dietician	☐ 4
Midwife	☐ 5
Lactation Consultant	☐ 6
Partner/husband	☐ 7
Friend	☐ 8
Sister	☐ 9
Mother	☐ 10
Neighbour	☐ 11
Internet	☐ 12
Other (Please describe)	☐ 13

Section D: Physical activity DURING your pregnancy in the LAST WEEK

This section is about the physical activity you did, if any, during the last week.

In the LAST WEEK...

- D1 a. How many times did you walk continuously, for at least 10 minutes, for recreation, exercise or to get from place to place?

times ₁

none ₂

→ Please go to D2

- b. What do you estimate was the total time you spent walking in this way LAST WEEK?

hours ₁

minutes ₂

- D2 a. Are you still exercising?

Yes

₁

No

₂

→ Please go to D4

Please comment if you wish: _____

In the LAST WEEK...

- D3 a. How many times did you do moderate physical activity? (For example, gentle swimming)

times ₁

none ₂

→ Please go to D4

- b. What do you estimate is the total time you spend doing these activities LAST WEEK?

hours ₁

minutes ₂

- D4. If you are not doing any exercise now but did exercise earlier in pregnancy, please tell us about the type of exercise you did (for 10 minutes or more at least ONCE a week, DURING YOUR PREGNANCY), please tick the types of exercise you did/do and how many times per week you have done it.

Please, tick here IF you have **NOT EXERCISED AT ALL DURING** your pregnancy → Please go to D5

Exercise	Yes	Times per Week	
Fast walking			1
Jogging/running			2
Aerobics			3
Weight training			4
Dancing			5
Swimming			6
Cycling			7
Ball games (soccer, GAA, rugby)			8
Racket sports (tennis, badminton)			9
Weight lifting			10
Other (Please describe below)			11

Other (Please describe) _____

- D5 a. Did you ask for advice on taking exercise during your pregnancy?

Yes ☐ 1 No ☐ 2

- b. If Yes, please state who and what advice you were given

What date did you complete this survey on? _____

Your comments on this survey

If you wish to write any further comments please do so on this page. Thank you.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Please help me to keep in touch with you.

If your address or other contact details have changed (or you are about to move), please fill in the details below:

Your NEW address:	Your NEW phone number(s):

Thank you for taking the time to complete this survey.

Please use the reply paid (FREE POST) envelope to send it back to me. If no envelope was enclosed with this survey or you have mislaid it, please text or call me, Jamile Marchi, at 087 2290989 and I will send you out another one.

I am very grateful for the time and trouble you have taken to participate in this part of the MAMMI study.

The results from this part of the study will not be available until all of the women taking part in the study have given birth. As soon as the first study results are available, I will let you know via the website and the study newsletter for women.

Please do call me if you have any questions about the study.

I look forward to contacting you again when your baby is three months old.

Best wishes.

The MAMMI study

087 2290989

www.mammi.ie

Appendix 4-5: Face validity (researchers' feedback)

#	The time it took to answer	Changes suggested	Overall comment
01	27 minutes	-	-
02	27 minutes	-	-
03	25 minutes		"Excellent survey, great detail on diet. We use the IPAQ on physical activity. Very similar to yours. A couple of routine typos, have highlighted them in yellow."
04	-	Add Galfer FA as a supplement and to add "pharmacist" as an option on who advised taking dietary supplements during pregnancy?	
05	-	-	No major comments

Appendix 4-6: Cover Letter to pregnant women- letter re: acceptability of survey



The MAMMI study

Your opinion on survey 1a: 'Diet and Physical activity survey' (NEW)

Dear

Many thanks for taking our call and offering to tell us what you think about this new survey, we really appreciate your help.

The MAMMI study is starting in the Coombe Hospital in March 2015 and we hope to offer this new survey on ***Diet and Physical Activity*** to women when they are about 30 to 36 weeks pregnant.

Before offering the women this new survey, we would really like to know what you and other pregnant women think about it, if you would complete a survey like this and how long it takes to complete. Please feel free to write as little or as much as you want on the survey, try to answer all the questions and write down anything that does not make sense to you.

Again, thanks a million for offering to do this for us, we really appreciate it and look forward to hearing from you. If you want to ask us anything about this process, please feel free to email me, Jamile, at contact@mammi.ie or call or text me on 087 1956441.

Every good wish for the birth of your baby.

Regards

Jamile Marchi

Appendix 4-7: Women's views on acceptability of 'Diet and Physical Activity survey':

- ✓ **Women # 1** – took over an hour

COMMENTS:

Page 3	Should put a "sometimes" tick box?
Page 6	A16A – These questions are phrased in a way I found difficult to answer. Easier to answer either how many hours rather than how many times.

"This survey took me over an hour to complete. The food/diet section was simple to complete + follow. But I found the sections on exercise = physical activity a bit difficult to follow and answer. I would exercise (brisk walking) 2-4 times a week for approx. an hour. The question asking how many times would I walk continuously for more than 10 min I was unsure how to correctly answer. Some days in work I would walk for over 10 minutes, or walk to the shops or around the shops. Over all this was a very good survey & I am happy to help with any research that could help pregnant women in the future. Thank you "

- ✓ **Women # 2** –completed survey, no comments

- ✓ **Women# 3** – took 34 mins

COMMENTS:

Page 2	Is this what could have improved my life in general in the past year?
Page 5	She made a few comments re. the exercise section – "confusing"
Page 31	Lactation consultant

"The survey took me 34 min to complete. I was confused by one or two questions and wrote some notes where I was confused. It would be worthwhile to ask if women seek advice on exercise when pregnant and from whom they seek that advice. I am still doing a little gentle running at 35 weeks pregnant and many people feel I shouldn't be running at all in my pregnancy. Of course I have checked this with my GP, midwife and consultant on each visit. They have advised me that 'my body will tell me when to stop' and I'm starting to feel that could be quite soon! Perhaps a question relating to attitudes towards exercise in pregnancy would be warranted too."

- ✓ **Women # 4** – took over an hour to complete

COMMENTS:

Page 5	Difficult to quantify as not sure if washing and cooking is included
Page 6	Last year or Last year before pregnancy?
Page 18	Dairy desserts – do they include ice cream?
Page 18	French dressing – oil based?
Page 24	Think the questionnaire is already covering things I am eating → perhaps chickpeas/hummus/coconut oil but probably not as a relevant food group You may ask later about “cravings”
Page 31	Lactation consultant
Page 32	NOTE on Section D - It would be hard to remind the participant of what this exercise is. does this include walking or not?

“It took me just over an hour to complete so within guide but was also looking for potential clarifications + writing notes, so could take someone else less time. I made notes as I went on. Very interesting study! It would also be interesting to do one also AFTER pregnancy to see differences.”

- ✓ **Women # 5** – completed survey, no comments
- ✓ **Women # 6** – completed survey, no comments
- ✓ **Women # 8** – completed survey with the comment below:

“I found this a good survey, did not take too long to complete. There was no questions in relation to fast food habits while pregnant, I feel this needs to be asked to get a broader picture, as the survey asks about healthy food rather than fatty foods.”

- ✓ **Women # 10** – completed survey, no comments

Appendix 4-8: Content Validity Cover Letter:



Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

Dear

Re. Assessing the content of the 'Diet and Physical Activity survey'

Survey 1A of the MAMMI study

Many thanks for offering to help me by telling me what you think about this new survey, I really appreciate it. My name is Jamile Marchi and I am a first-year PhD student in the School of Nursing and Midwifery, Trinity College Dublin researching ***Diet and Physical Activity*** in first-time mothers before and during pregnancy and outcomes for women.

In order to give you background to the MAMMI study, I have attached the protocol with these documents.

The MAMMI study, which consists of 5 surveys is ongoing the Rotunda Hospital and Galway University Hospital. The study is starting in the Coombe Hospital in February 2015 and we hope to offer this new survey on ***Diet and Physical Activity*** to women when they are about 30 to 36 weeks pregnant. The study website is at <http://www.mammi.ie/>

Before offering the women this new survey, we would really like to have the content assessed by experts.

I have devised a document to enable you to rate content and relevance of each item on the survey. Also, please feel free to write as little or as much as you want on the form and write down anything that does not make sense to you.

I realise that this is a lengthy process and am really grateful for your time and efforts.

Thank you for your interest and support.

Kindest Regards

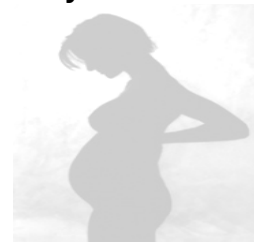
Jamile Marchi

PhD student

Appendix 4-9: Content Validity Protocol for The MAMMI Study



Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin



The MAMMI Study

The **aim of the MAMMI study** is to explore the health and health problems experienced by first-time mothers during pregnancy and during the first year after the baby's birth.

The **objectives** are

- (i) to describe the existence, extent and prevalence of morbidity during pregnancy and the first year postpartum in primiparous women
- (ii) to determine the associated risk factors that may be amenable to intervention
- (iii) to gain an in-depth understanding of the impact of childbirth, motherhood and any related morbidity on women's health and health needs
- (iv) to identify the health-service and self-help seeking behaviour of women

These objectives will be achieved through a **cohort study** with a population of **2600 primiparous women** recruited in early pregnancy from **three large maternity hospitals in Ireland**, the **eligibility** criteria being aged 18 years or over and the ability to read and understand English. Recruitment **bias** will be checked by documenting participants and non-participants. **Sample size calculations** are based on prevalence of urinary incontinence (UI) found in international studies.

Data will be collected from **self-completion surveys** administered antenatally, at 3, 6, 9 and 12 months postpartum and from **women's records**. **In-depth interviews** with a sample of women will identify their health-service seeking behaviour and barriers encountered.

Data analyses will include descriptive statistics (means, standard deviations, proportions) with regard to demographic and clinical information. Differences of urinary incontinence (UI) and other morbidities between groups of women within this primiparous population will be estimated with the criterion for a significant difference set at $p=0.05$. Groups will be classified according to mode of birth and variables explored will include: age; body mass index (BMI); perineal trauma and birth weight. Themes and categories from the interviews with women will show how women with UI and other morbidities address their health needs. The findings will be **disseminated** nationally to health service providers and policy makers and internationally through conferences and publications.

Research ethics committee approval has been granted by the Faculty of Health Sciences, TCD, the Rotunda Hospital, Galway University Hospital and the Coombe Women and Infants University Hospital.

Progress to January 2015

To date, 1841 women have been recruited Rotunda Hospital. Recruitment closed in October

The MAMMI (Maternal health And Maternal Morbidity in Ireland) Study

Content validity rating tool

'Diet and physical activity survey' (Survey 1A)

2014 and postpartum follow-up is ongoing. Over 200 women have been recruited from Galway University Hospital and recruitment and follow-up in ongoing. The study will start in the Coombe Women and Infants Hospital in February 2015.

January 2015.

Appendix 4-10: Content Validity Lynns Rating Tool Survey 1a

Background

The MAMMI Study is a study looking at the health and health problems of women during pregnancy and during the first year after the birth of their first baby. At the moment, it consists of **FIVE surveys** that are being administered to 2600 primiparous women antenatally and at 3, 6, 9 and 12 months postpartum.

The study started in the Rotunda Hospital in 2012 (recruitment ended October 2014 and follow-up is ongoing), in Galway University Hospital in 2013 (recruitment commenced September 2013 and is ongoing) and will start in the Coombe Women's and Infants University Hospital (CWIUH) in February 2015.

The '**Diet and physical activity survey**' is new and is part of the nutrition study of the MAMMI study which will be offered to the 600 nulliparous women recruited from CWIUH when they are around 30-36 weeks of pregnancy.

CONTENT VALIDITY is concerned with **adequacy of coverage** of the content area being measured (Polit, Beck and Hungler 2001, p309) and your assessment will help identify gaps or omissions.

I should be very grateful if you would:

- (i) Review the instructions, responses and options for each item in the survey for clarity and write your concerns in the 'comment' column of this rating tool
- (ii) Determine the **RELEVANCE** of each item in this survey, that is, determine that the item and the response options are relevant diet and exercise by rating it on a scale of 1-4 (as shown overleaf). Please indicate the relevance of each item by placing an X or ✓ in the box in the appropriate column. The item numbers in this document correspond to the items in **SURVEY 1a of the MAMMI study** (attached).

The last page of this document contains a section for you to write your comments on the completeness of the survey. Here, you can include comments on the overall style and presentation of the survey.

Explanation of rating scale:

For this rating tool, **RELEVANCE** is determined using the *relevance rating scale* employed by Lynn (1986). This scores items on a scale of 1 to 4 as outlined below:

1. The item is NOT RELEVANT to the aim of this study	Comments on scores 1-3 will help me decide on the inclusion, exclusion or revision of a particular item. Please write your concerns about the clarity of the instructions, responses and options in this column.
2. The item NEEDS MAJOR REVISION to be relevant to the aim of this study	
3. The item NEEDS MINOR REVISION to	

be relevant to the aim of this study	
4. The item is RELEVANT to the aim of this study	A score of 4 requires no comment

Example

Section	Relevance rating				Comment
Score	1. The item IS NOT RELEVANT to the aim of this study	2 The item needs MAJOR REVISION to be RELEVANT to the aim of this study	3. The item needs MINOR REVISION to be RELEVANT to the aim of this study	4. The item IS RELEVANT to the aim of this study	Comment on scores 1-3 please. Your comments will help me decide on the inclusion, exclusion or revision of a particular item. A score of 4 indicates that the item requires no revision. Please write your concerns about the clarity of the instructions, responses and options in this column.
A3	X				Not relevant
B21		X			Too long and confusing
C2a			X		Comment section not needed

Section	Relevance rating				Comment
A	General health and diet in the 12 months BEFORE your pregnancy				
Score	1. The item IS NOT RELEVANT to the aim of this study	2 The item needs MAJOR REVISION to be RELEVANT to the aim of this study	3. The item needs MINOR REVISION to be RELEVANT to the aim of this study	4. The item IS RELEVANT to the aim of this study	Comment on scores 1-3 please. A score of 4 indicates that the item requires no revision. Please write your concerns about the clarity of the instructions, responses and options in this column.
A1					
A2					
A3					
A4					
A5					
A6					
A7					
A8					
A9					
A10					
A11					
A12					
A13					
A14					
A15					
A16					

Section A	Relevance rating General health and diet in the 12 months BEFORE your pregnancy				Comment
Score	1. The item IS NOT RELEVANT to the aim of this study	2 The item needs MAJOR REVISION to be RELEVANT to the aim of this study	3. The item needs MINOR REVISION to be RELEVANT to the aim of this study	4. The item IS RELEVANT to the aim of this study	Comment on scores 1-3 please. A score of 4 indicates that the item requires no revision. Please write your concerns about the clarity of the instructions, responses and options in this column.
A17					
A18					

Section	Relevance rating				Comment
B	DIET AND NUTRITION – This section is about your general eating habits since the START of your pregnancy				
Score	1. The item IS NOT RELEVANT to the aim of this study	2 The item needs MAJOR REVISION to be RELEVANT to the aim of this study	3. The item needs MINOR REVISION to be RELEVANT to the aim of this study	4. The item IS RELEVANT to the aim of this study	Comment on scores 1-3 please. A score of 4 indicates that the item requires no revision. Please write your concerns about the clarity of the instructions, responses and options in this column.
B1					
B2					
B3					
B4					
B5					
B6					
B7					
B8					
B9					
B10					
B11					
B12					
B13					
B14					
B15					
B16					

Section	Relevance rating				Comment
B	DIET AND NUTRITION – This section is about your general eating habits since the START of your pregnancy				
Score	1. The item IS NOT RELEVANT to the aim of this study	2 The item needs MAJOR REVISION to be RELEVANT to the aim of this study	3. The item needs MINOR REVISION to be RELEVANT to the aim of this study	4. The item IS RELEVANT to the aim of this study	Comment on scores 1-3 please. A score of 4 indicates that the item requires no revision. Please write your concerns about the clarity of the instructions, responses and options in this column.
B17					
B18					
B19					
B20					
B21*					
Question 21 has sections A to J. Please feel free to write on any individual section here					
B21A					
B21B					
B21C					
B21D					
B21E					
B21F					
B21G					
B21H					
B21I					
B21J					
B22					
B23					

Section	Relevance rating				Comment
B	DIET AND NUTRITION – This section is about your general eating habits since the START of your pregnancy				
Score	1. The item IS NOT RELEVANT to the aim of this study	2 The item needs MAJOR REVISION to be RELEVANT to the aim of this study	3. The item needs MINOR REVISION to be RELEVANT to the aim of this study	4. The item IS RELEVANT to the aim of this study	Comment on scores 1-3 please. A score of 4 indicates that the item requires no revision. Please write your concerns about the clarity of the instructions, responses and options in this column.
B24					
B25					
B26					
B27					
B28					
B29					

Section C	Relevance rating				Comment
	Breast feeding intention				
Score	1. The item IS NOT RELEVANT to the aim of this study	2 The item needs MAJOR REVISION to be RELEVANT to the aim of this study	3. The item needs MINOR REVISION to be RELEVANT to the aim of this study	4. The item IS RELEVANT to the aim of this study	Comment on scores 1-3 please. A score of 4 indicates that the item requires no revision. Please write your concerns about the clarity of the instructions, responses and options in this column.
C1					
C2					

Section	Relevance rating				Comment
D	Physical activity during your pregnancy				
Score	1. The item IS NOT RELEVANT to the aim of this study	2 The item needs MAJOR REVISION to be RELEVANT to the aim of this study	3. The item needs MINOR REVISION to be RELEVANT to the aim of this study	4. The item IS RELEVANT to the aim of this study	Comment on scores 1-3 please. A score of 4 indicates that the item requires no revision. Please write your concerns about the clarity of the instructions, responses and options in this column.
D1					
D2					
D2					

GENERAL comments on SURVEY 1a ('Diet and Physical Activity survey')	
Please write your comments on the completeness of the survey. You can include comments on the deletion or inclusion of items and/or sections, on the clarity of the instructions and on the overall style and presentation of the survey.	
Section A	
Section B	
Section C	
Section D	
Style/layout	

Thank you very much, I value your comments.

Appendix 4-11: Content validity experts (researchers' feedback)

Four experts in total:

- ✓ 38 out of the 52 items (61.2%) received a maximum score of 4 from all four experts
- ✓ 21 items scored 3-4 among all experts (34%)
- ✓ Altogether 59 items (out of 62) received between 3-4 (relevant to the study) - 95% of the questions
- ✓ Only 3 questions, all from the IPAQ, received a two from two experts meanwhile the two others gave a three and four to the same questions. On average, those questions rated: 2.7; 3 and 3.

Appendix 4-12: Content Validity rating tool – experts (researchers' feedback)

SURVEY 1A

Section A	Relevance rating General health and diet in the 12 months BEFORE your pregnancy				Comment
Score	Expert 1	Expert 2 and 3	Expert 4		Comments
A1	4	4			
A2	3	3			Expert 1: “Before pregnancy” Expert 2: Should it be worded with health instead of life- ? relevance of more willpower very random Expert 3: (suggestion) Do you think any of the following could have improved your life? Do you mean life or health in this instance? If life, do you mean quality of life or health? Perhaps be specific so as not to cause misinterpretation. Should you have ‘other’ or do you believe that other factors won’t be relevant?
A3	4	4			Expert 3: What about if told by a nurse e.g. a practice nurse?
A4	4	4			Expert 3: What about if told by a nurse e.g. a practice nurse?
A5	3	4			Expert 1: Instead of “diabetic” – diet to control diabetes Expert 2: A5 (a)-ok A5(b)- should include a diet for weight loss e.g. weight watchers/slimming world/paleo/fad diet/juice diet -most common dieting. This should be first option.
A6	4	4			Expert 3: Will people be able to distinguish between healthy and fairly healthy

					Would it be easier to have very healthy and fairly healthy? Similarly, will people distinguish between a diet that is bad and one that is very bad? I am not sure that I could do so.
A7	4	4			
A8	4	3			Expert 2: A lot of weight need to be quantified e.g. > 1stone/14lbs too vague open to interpretation
A9	4	4			Expert 3: Will this be understood? ? use body shape???
A10	4	3			Expert 2: Unsure what this will bring Expert 3: Would more people understand calorie value rather than caloric value?
A11	4	3			Expert 2: What does any other meal mean- any additional meals or snacks e.g. 2 lunches or 2 breakfasts or night time eating need to add comment
A12	4	4			
A13	3	2			Expert 1: what is the relevance of 10 minutes – National Guidelines relevance: 30 minutes, 5 days/week Expert 2: Impossible to fill this in too retrospective should start with did you perform structured exercise i.e. move A18 up to A13- is A13 relevant at all
A14	4	2			Expert 2: Same as A13 not relevant- do these activities stop when you are pregnant you still need to do housework Expert 3: ? would it be enough here to have any vigorous/heavy work around the house or garden which.....
A15	4	2			Expert 2: Impossible to quantify, in the last year Expert 3: omit the word “any”
A16	4	4			Expert 3: omit the word “any”
A17	4	4			Expert 3: omit the word “any”
A18	3	4			Expert 1: What is the relevance of 10 minutes?

					Expert 3: Is this different to the walking in QA.13. Will people be able to distinguish between walking continuously and fast walking?

Section B	Relevance rating DIET AND NUTRITION – This section is about your general eating habits since the START of your pregnancy				Comment
Score	Expert 1 (Laura)	Expert 2 and 3 (Linda and Deirdre - together)	Expert 4 (Clare - comments on the survey)		Comments
B1	4	4			
B2	4	4			
B3	4	4			
B4	4	4			
B5	4	4			
B6	4	4			
B7	4	4			
B8	4	4			
B9	3	3			Expert 1: Change “diabetic” to – diet to control diabetes Expert 2: Need to address weight loss diets again here
B10	4	4			
B11	4	4			Expert 3: Will this be understood? ? use body shape???
B12	4	4			
B13	4	3			Expert 2: Maybe define fried food (i.e. use of oil or other fats when cooking)

B14	4	4			
B15	3	4			Expert 1: Portion of milk here is each 200ml/600ml (pint) Expert 3: Some may take a little more or less than the categories you describe below Otherwise, you would need to put into categories of milk consumption e.g. less than 200 mL. Between 200 mL and 568 ML etc.
B16	4	4			
B17	4	4			
B18	4	4			Expert 3: Use most often may be easier wording to interpret. It might be an idea to give an example of what you mean by a hard margarine as you don't mean one that is hard because it has just come out of the fridge Do you want to distinguish between those who use a low fat and those who use a polyunsaturated spread? Do you want to know what this might be?
B19	4	4			Expert 3: Use most often may be easier wording to interpret. ?Also list butter?
B20	4	4			Expert 2: I am unsure how pregnancy will effect cost of food for household
B21	3	4			Expert 3: Do you need to give some guidance e.g. a medium serving is two egg sized potatoes as you have done below with bread? Medium serving of potatoes could be quite different depending on who is asked. Similarly with rice and pasta ?plastic cups of cooked rice or pasta as per 2011 FSAI guidance document on healthy eating, see attached. 200 mL disposable cup was the easiest measure for

					consumers to visualise One savoury biscuit could be tiny. I know this comes from EPIC/SLAN but ?indicate more precisely what you want reported
B21 A	3	4			Expert 1: We use “palm of hand without fingers” as portion guide. Corned beef is not the same category as luncheon meat Expert 3: Do you need such detailed breakdown of red meats? What is the aim of the detailed data. Would red meat be sufficient for what you need to find out about ?purpose of distinguishing between beef, lamb and pork? I wonder if you should consider 2011 FSAI document=palm of hand recommended for meat???? See attached. Do you want to look at liver consumption separately? Are pregnant women compliant with FSAI guidance? Do you need such detailed breakdown of red meats? What is the aim of the detailed data? Would red meat be sufficient for what you need to find out about ?purpose of distinguishing between beef, lamb and pork? ?omit the word ‘other’?
B21 B	3	4			Expert 1: Add baguettes Expert 3: One savoury biscuit could be tiny. I know this comes from EPIC/SLAN but ?indicate more precisely what you want reported Will people be able to distinguish between

					brown/wholemeal/wholegrain?
B21 C	4	4			
B21 D	4	4			Expert 3: See wording from FSAI document, 2011 (suggested: (Medium serving (cooked) – about a plastic disposable cupful) Not clear to me why you ask here about meat-based lasagne? Could have lots of different lasagnes e.g. vegetarian, fish etc. Do you want to know how much lasagne pasta or how much lasagne? Purpose of collecting data on these specific foods? Pizza and Macaroni Cheese - Plastic cup not a useful measure for these
B21 E	3	4			Expert 1: Eggs are not dairy, should be in meat/poultry section Cheese portion = 1 slice Expert 3: People get mixed up with tablespoons and dessertspoons, see FSAI document ?better to use teaspoon Need to indicate size of medium serving French dressing - an indicative amount ? 1 restaurant pat, see FSAI 2011 --- for teaspoon Just check light or lite? Do you need the categories broken down to this extent? Purpose as relates to pregnancy?
B21 F	3	4			Expert 1: Portion grapes = 10 Dried fruit portion $\frac{1}{4}$ - $\frac{1}{2}$ Add fruit juice – 125 ml Expert 3: fruit – medium serving –

					define amount approximately Do you need such breakdown ? citrus fruits/berry fruits/soft fruits and give an example of what you mean Or even citrus versus other fruits? Purpose of collecting data in so many categories? Tinned fruit: ?in syrup ? in fruit juice Do you want to distinguish? Purpose???? Frozen fruit: ? purpose?
B21 G	3	4			Expert 1: Tofu, etc. should be in meat section Veg portion – 4 dessert spoon Expert 3: Do you need so many categories Purpose of distinguishing fresh versus frozen? Tablespoons - See FSAI doc
B21 H	3	4			Expert 1: Crisp portion = 25g packet Expert 3: ?purpose of so many categories for this study Sugar teaspoons or tablets?
B21 I	3	4			Expert 3: See previous comments about tablespoons and FSAI document
B21 J	4	4			Expert 3: See FSAI 2011 doc
B22	4	4			
B23	4	4			Expert 3: What do you mean by fat? Fat on meat? Frying? Butter/spreads? Oils?

B24	4	4			Expert 3: “other pregnant woman?”
B25	4	4			
B26	4	4			Expert 3: ? need to include question for nutrients too? e.g. FA/Fe etc.
B27	4	4			
B28	3	3			Expert 1: Supplements mentioned twice Wording might be too advanced level i.e. “consumed insufficient” Expert 2: Should read dose- 5mg is confusing in the heading as it implies that it relates to all supplements but only relates to folic acid need to change this
B29	4	4			Expert 3: “other pregnant woman?”

Section	Relevance rating				Comment
C	Breast feeding intention				
Score	Expert 1 (Laura)	Expert 2 and 3 (Linda and Deirdre - together)	Expert 4 (Clare - comments on the survey)		Comments
C1	4	4			
C2	4	4			Expert 3: “other pregnant woman?”

Section D	Relevance rating Physical activity during your pregnancy				Comment
Score	Expert 1 (Laura)	Expert 2 and 3 (Linda and Deirdre - together)	Expert 4 (Clare - comments on the survey)		Comments
D1	3	3			Expert 1: What is the relevance of 10 minutes? Expert 2: I think using the example of 10 mins is really vague-too difficult to do
D2	4	3			Expert 2: Again, too difficult to do Expert 3: ? reasonably fast walking ?overlap with Q2 2 and QD1
D3	3	4			Expert 1: What is the relevance of 10 minutes?

GENERAL comments on SURVEY 1a ('Diet and Physical Activity survey')	
Please write your comments on the completeness of the survey. You can include comments on the deletion or inclusion of items and/or sections, on the clarity of the instructions and on the overall style and presentation of the survey.	
Section A	
<u>Expert 2:</u>	Gives no breakdown of the composition of the diet before pregnancy how does this allow for comparison. Does not look at the major issue of supplementation pre-pregnancy e.g. folic acid and vitamin D. We know that women do not take folic acid pre-preg and particularly the obese women do not take correct dose. Also weight should be addressed better- 50% of women here are overweight or obese at booking- weight loss efforts pre-pregnancy should be better quantified here it is not. Also it would be useful to establish if weight was discussed with these women by health care workers pre-pregnancy if they knew their pre-preg weight should this be added in

	as a question- do they know their BMI pre-pregnancy. The questions re physical activity versus exercise are confusing- very difficult to remember 1 year ago how much time was spent gardening.
Section B	
<u>Expert 2:</u>	Ok but list of foods exceptionally long-
<u>Expert 3:</u>	Do we not know quite a bit from the work done in [REDACTED] and the work that [REDACTED] and [REDACTED] are doing?
Section C	
<u>Expert 2:</u>	No issues
Section D	
<u>Expert 2:</u>	Again the 10 min quantification- I would find this very difficult to complete
Style/layout	
<u>Expert 2:</u>	Nice style, nice layout- but very long

Appendix 4-13: Lynn's rating scale (researchers' feedback)

Ratings on Survey 1A scale by Four Experts: Items rated 3-4 on a 4-Point Relevance Scale.

ITEM	EXPERT 1	EXPERT 2	EXPERT 3	EXPERT 4	Number in agreement	Item CVI	Total CVI
Section A							
A1-A12	3-4	3-4	3-4	3-4	4	1.00	12
A13	3	2	2	4	2	0.50	0.50
A14	4	2	2	4	2	0.50	0.50
A15	4	2	2	4	2	0.50	0.50
A16-A18	3-4	3-4	3-4	3-4	4	1.00	3
Section B							
B1-B8	4	4	4	4	4	1.00	8
B9	3	3	3	4	4	1.00	1
B10-B12	4	4	4	4	4	1.00	3
B13	4	3	3	4	4	1.00	1
B14	4	4	4	4	4	1.00	1
B15	3	4	4	4	4	1.00	1
B16-B20	4	4	4	4	4	1.00	5
B21-B21B	3-4	3-4	3-4	3-4	4	1.00	3
B21C-B21D	4	4	4	4	4	1.00	2
B21E	3	4	4	4	4	1.00	1
B21F-B21I	3-4	3-4	3-4	3-4	4	1.00	4
B21J-B22-B27	4	4	4	4	4	1.00	7
B28	3	3	3	4	4	1.00	1
B29	4	4	4	4	4	1.00	1
Section C							
C1-C2	4	4	4	4	4	1.00	2
Section D							
D1-D3	3-4	3-4	3-4	3-4	4	1.00	3
Proportion relevant:	60.5 out of 62 – 97.58 – 0.98 CVI = 0.98						

Appendix 4-14: Reliability pre-selected questions

Pre-selected questions for test-retest from section A

A1	"How would you describe your general health in the 12 months BEFORE your pregnancy?"
A4	"In the 12 months BEFORE your pregnancy, were you told by a doctor (or healthcare professional) that you: Had high cholesterol?"
A7	"In the 12 months BEFORE your pregnancy, were you trying to lose weight?"
A9	"In the 12 months BEFORE your pregnancy, were you satisfied with your body image?"
A12	"Can you afford to buy enough food for your household?"

Pre-selected questions for test-retest from section B

B1	"Have you experienced nausea during this pregnancy?"
B5	"Have you vomited during this pregnancy?"
B13	"How often do you eat fried food (i.e. use of oil or other fats when cooking)?"
B17	"How often do you add salt to food while at the table?"
B23	"Now that you are pregnant, would you say that you have changed your daily water intake?"
B26a	"Did you receive any advice about what to eat/not to eat, since you became pregnant?"
B27a	"Since you became pregnant, were you advised to stop eating/drinking any particular item?"
B29	"Would you have liked more information about what to eat/drink or what NOT to eat/drink during pregnancy?"
B30a	"Did you take any dietary supplements BEFORE your pregnancy?"
B31a	"Were you advised to take dietary supplements during pregnancy?"

Appendix 4-15: Test-Retest Letter to women



Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

School of Nursing and Midwifery

Trinity College Dublin

24 D'Olier Street

Dublin 2

15 September 2015

The MAMMI (Maternal health And Maternal Morbidity in Ireland) Study

Nutrition Study - Survey 1A: 'Diet and Physical Activity survey'

(in the Coombe Women and Infants University Hospital)

Dear mother-to be,

My name is Jamile Marchi and I am a dietitian and a PhD student doing research on the Nutrition Study of the MAMMI Study, Trinity College Dublin.

The MAMMI study (www.mammi.ie) started in the Rotunda Hospital, Dublin in 2012 and in Galway Maternity Hospital in 2013. More than 2,200 women are taking part and follow-up with these women is ongoing. The study started in the Coombe Women and Infants University Hospital (CWIUH) on 26 August 2015 and, as part of the study in the CWIUH, we will be offering participating women, first-time mothers (who can understand English and are aged 18 years and over), a new survey on '**Diet and Physical Activity survey**' when they are about 28 to 36 weeks pregnant.

After we developed the survey, we asked ten pregnant women if they would tell us what they thought about it and if they would be willing to complete it. Overall their comments were very positive: they told us they enjoyed completing the survey and that it took them 25-35 minutes to complete.

Now, we would like to see if the findings from the survey are reliable, that is, if we get the same answers to the questions from the same person on more than one occasion.

To do this, we would like to ask about 50 pregnant women if they would be willing to complete the '**Diet and Physical Activity survey**' twice, at two different times. If you are willing to do this, we would like you complete the survey now, and again one week from now.

I have prepared this information pack containing

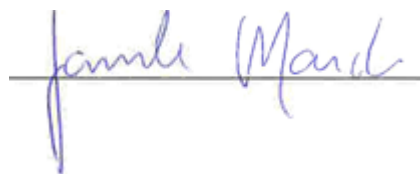
- (1) this cover letter
- (2) an information booklet about the full MAMMI study in the CWIUH
- (3) two copies of the consent form
- (4) two copies of the survey
- (5) two FREEPOST envelopes for returning the complete survey free of charge to you.

Thank you for taking the time to read this information, we appreciate it. We do hope you have the time and are willing to take part and look forward to hearing from you.

If you want to ask anything about this survey, or the MAMMI study, please feel free to email me, Jamile, at contact@mammi.ie or call or text me on 087 2290989.

Every good wish for the birth of your baby.

Regards



Jamile Marchi

Appendix 4-16: MAMMI Poster for Coombe Women and Infants University Hospital (CWIUH): Coombe Women and Infants University Hospital's (CWIUH)

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Coombe Women & Infants University Hospital
Dedicated to the Care of Women and Babies
Treoir do Ghairneoirí agus do Ghairneoirí

Are you expecting your first baby?

Are you interested in taking part in a study on your health during pregnancy and after the birth of your baby?

This research is funded by the Friends of the Coombe, Dublin, Ireland

This research is funded by the Health Research Board, Ireland (HRB)

This research is funded by Science Without Borders (SWB) - Brazilian Government

The MAMMI study

Maternal health And Maternal Morbidity in Ireland (MAMMI)

A research study of 2600 first-time mothers' health in pregnancy and up to one year after giving birth in Ireland

Why do the study?

Currently, very little is known about women's health during pregnancy and the first year after giving birth.

What does the study involve for you?

Completing a survey six times: twice during your pregnancy (once in early pregnancy and then at 7-8 months pregnancy) and again at 3, 6, 9 and 12 months after your baby's birth.

For more information about the study text or telephone

The Research Team: Deirdre, Sunita, Jamile, Deirdre and Francesca - 087 2290989

SCIENCE
WITHOUT BORDERS

Appendix 4-17: MAMMI Study Information Booklet



Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

Your invitation to join

The MAMMI Study

A study to find out more about the health and health problems of first-time mothers during pregnancy and during the first year after the baby's birth.

The MAMMI study has been approved by the Research Ethics Committees of the Coombe Women's and Infants University Hospital (CWIUH) and the Faculty of Health Sciences, Trinity College Dublin. MAMMI stands for **M**aternal health **A**nd **M**aternal **M**orbidity in **I**reland.

If you have any questions about this study, please contact any researcher member from the MAMMI team at 087 195 6441.

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Why have I been given this booklet?

You were given this booklet because you are having your first baby. This booklet tells you about the MAMMI study and what it means if you decide to take part.

What is the MAMMI study?

MAMMI stands for Maternal health And Maternal Morbidity in Ireland. It is a study to look into the health and health problems of first-time mothers during pregnancy and during the year after the birth.

Why are you doing this study?

We want to find out:

- what health problems, if any, women experience during pregnancy and after the birth of their first baby;
- what health services, if any, pregnant women use; and
- how to improve women's health during and after pregnancy.

What sort of questions will you ask me?

We will ask you about:

- your general health and whether you have any medical conditions or have had any operations;
- what you eat and the type of activity and exercise, if any, that you do (in survey 1A)
- any problems you have passing urine (water);
- any problems you have with your bowel movements such as soiling yourself or passing wind when you don't mean to;
- any problems or pain you may have during sex;
- your relationship with your partner and if you are worried about or experiencing violence in the home;
- how often you talk to a doctor, nurse or midwife about your health problems;
- your work or study; and
- the type of flat, apartment or house you live in.

Who else is taking part in this study?

We are inviting women, aged 18 and over, who are having their first baby to take part in the study. **Women who have had miscarriages or abortions before this pregnancy are welcome to take part.** Altogether, we are asking 2,600 women, 600 women attending the Coombe Hospital, to take part.

What does taking part in the study mean for me?

We are asking you to complete **six** surveys please. You should fill out the first survey (which came with this booklet) while you are pregnant and the second antenatal survey, 1A, when you are about 7 or 8 months pregnant (about 28 to 36 weeks) (we will post this one to you closer to the time). . The other four surveys you will be completing at 3, 6, 9 and 12 months after you have given birth. We will post these surveys to you closer to the time also. The surveys are also on the website, www.MAMMI.ie. Each survey takes about 45 minutes to complete.

If you decide to take part in the study, we will ask you to:

- sign the consent form which came with this booklet;
- fill out the survey form that came with this booklet while you are pregnant and a second one, two months later (about your diet and physical activity);
- complete four surveys about your health and health problems at 3, 6, 9 and 12 months after your baby's birth; and
- agree to let the research team have access to your and your baby's medical records held by the Coombe Hospital.

Are there any risks for me or my baby?

We do not see any risks with taking part in this study. However, if we find out during the study that a woman or her baby is being harmed or that there may have been a problem with the care a woman received, we must tell the Study Data Monitoring Group

.

What is the Study Data Monitoring Group?

The Study Data Monitoring Group has been set up to:

- guide the research team;
- manage any problems that may arise during the study; and
- deal with complaints.

If you raise a serious complaint, the group will discuss it. They won't know who you are. If they decide that your complaint should be brought up with midwives or medical regulatory

authorities, they will ask your consent to share your personal details but can no longer protect your identity. The regulatory bodies need to know who they are representing.

The group is made up of senior staff from the Coombe Hospital and Trinity College Dublin.

Are there any benefits for me or my baby?

The study will not benefit you personally. The information you give will be pooled with the information given by all the other women in the study. This will help us to better understand some of the health problems that women experience during pregnancy and after birth and what can be done to help them.

By taking part in the study you will be helping other mothers and their babies in the future.

Can anyone take part in the study?

To take part in the study you must be aged 18 or over and able to read and understand English.

How will you protect my personal information?

- We will keep all the information you give us private and confidential.
- We will give your survey information a unique number (a code). We will also remove your personal details from the first survey. This means that your answers will not be linked to your personal details.
- We will store your personal details and your code number securely and separately from the completed surveys. They will be kept in a locked cabinet, in a locked office in an area where few people have access.
- Paper copies of the information you give on the surveys will be identified by your code.
- We will keep an electronic version of the information you give us on a computer. Only the research team will have access to this information. We will use passwords,

encryption (special software to scramble the information so it cannot be read) and anti-virus software to protect the information on the computer.

- If we do a face-to-face interview with you, we will record the interview. We will make a paper copy of the recording and show it to you so that you can confirm it is an accurate copy of the interview. We will transfer the audio recording to a secure hard disk, and then destroy the recording. We will use your code number to identify you on the paper copy. We will store the paper copy in a locked cabinet, in a locked office in an area to which few people have access.
- All members of the study team who have access to your information must sign a confidentiality agreement form.
- We will only disclose your personal details in **exceptional circumstances** for example if you or your baby is being harmed or you complain about the researchers (for more information see 'What is the Study Data Monitoring Group' on page 6).

What happens to the information at the end of the study?

We will publish the findings from the study and may give talks about the findings at healthcare conferences. It will not be possible to identify you or your answers in these publications or talks.

The information from the surveys may also be used in future research projects. However, the **researchers will not contact you unless you give your consent** to future contact. This is explained below.

What do the options on the consent form mean?

The consent form asks you to sign your name to show that you agree to take part in this study.

The consent form also asks you to agree to the following options:

- **Paragraph 5** lets you say if you want a member of the research team to call you after your baby's birth. If you say yes, they will contact you and invite you to take part in an interview.

- **Paragraph 9** lets you agree to information collected from you as part of this study being used for future research studies.
- **Paragraph 10** lets you say if you want your personal details such as your name and address to be destroyed after stage 1 of this research. If you say yes, the research team will not be able to contact you when this stage of the research is over.
- **Paragraph 11** lets you agree to us keeping your personal details for five years after the end of the first stage of this research. If you say yes, the research team will contact you and invite you to take part in future studies.

Remember, **you do not have to agree to any of these options**. However, if you do agree, you will help us to continue our study of the health problems of pregnant women, mothers and their babies.

What do I do next?

1. Sign the consent form.
2. Keep a copy for yourself.
3. Post the original signed consent form and your completed survey form using the stamped address envelope that came with this booklet.

Can I leave the study?

Taking part in the study is voluntary. You can withdraw from the study at any time without giving a reason. This will not affect the care you or your baby receives.

How can I get in touch with you?

You can get in touch with any member of the MAMMI team, Deirdre Daly, Dee O' Malley, Francesca Wuytack, Sunita Panda and Jamile Marchi by texting or calling (087) 195 6441.

You can also get information on our website, www.mammi.ie.

Appendix 4-18: Test Retest Consent Form



Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin



CONSENT FORM

Research title: 'Diet and Physical Activity survey' (The MAMMI study)

Researcher: Jamile Marchi **Tel:** 087 2290989 **E-mail:** contact@mammi.ie

DECLARATION by participant: Please tick (X o r V) and provide your initials

1. I have read the information letter for this research study and I understand the contents.	Yes No Initials [] [] []
2. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction.	Yes No Initials [] [] []
3. I fully understand that my participation is completely voluntary and that I am free to withdraw from the study at any time without giving a reason and that this will not affect my care or the care that my baby receives in any way.	Yes No Initials [] [] []
4. I understand that my personal details (name and address and other identifying information that links my identity to the study data) will be destroyed when this study is complete.	Yes No Initials [] [] []
5. I understand that the researchers undertaking this research will hold in confidence and securely all collected data and other relevant information.	Yes No Initials [] [] []
6. I freely and voluntarily consent to participating in this research study.	Yes No Initials [] [] []

PARTICIPANT'S NAME

Contact Address

.....

Phone number

Participant's signature:

Date:

E-mail

One copy of this form must be retained by the participant and one copy must be retained by the researcher

Appendix 4-19: Test-retest reminders and thank you letter

Time 1: gentle reminder (e-mail)	‘Diet and Physical Activity survey’, Coombe Hospital - Jamile Hello, It's Jamile from Trinity College Dublin and the MAMMI study here. I hope you are healthy and well. I'm the person that asked for your help with the ‘Diet and Physical Activity survey’ when you attended the Parent Education class at the Coombe Hospital recently. This is just a gentle reminder to ask if you are still willing to complete the survey please. If you are willing to complete it, please post the survey and the consent form back to me in the FREEPOST envelope provided. Feel free to e-mail, text or call me (on 0872290984) if you have any questions. Thanks a million, and keep well. Jamile (Marchi), PhD student http://www.mammi.ie/
Time 2: gentle reminder (e-mail)	‘Diet and Physical Activity survey’, Coombe Hospital - Jamile Hello, it's Jamile from Trinity College Dublin and the MAMMI study again. I hope you are healthy and well. Thanks a million for sending me your first completed 'Diet and Physical Activity survey', I really appreciate it. The second survey is due anytime now please. If you are still willing to complete the survey for the second time, please post it back to me in the FREEPOST envelope provided. Feel free to e-mail, text or call me (on 0872290984) if you have any questions. I really appreciate your help and hope the findings from the study will make a positive difference to women's health in the future. All the best and keep well Jamile (Marchi), PhD student http://www.mammi.ie/
Thank you e-mail	Sincere thank you - ‘Diet and Physical Activity survey’, Coombe Hospital Hello, it's Jamile from Trinity College Dublin and the MAMMI study again. I hope you are healthy and well. I just wanted to say sincere thank you for sending me your completed 'Diet and Physical Activity survey', I really appreciate your time and help with this, and I hope the findings from the study will make a positive difference to women's health in the future. All the best and keep well Jamile (Marchi), PhD student http://www.mammi.ie/

Appendix 4-20: Results from test-retest

Study #	T1 - A1	T2 - A1	Changes?	T1 - A4	T2 - A4	Changes?	T1 - A7	T2 - A7	Changes?	T1 - A9	T2 - A9	Changes?
3	2	2	No	2	2	No	1	1	No	2	2	No
4	2	3	Yes	1	2	Yes	2	2	No	2	2	No
5	3	3	No	2	2	No	2	2	No	1	1	No
7	1	2	Yes	2	2	No	1	1	No	2	2	No
9	2	2	No	2	2	No	2	2	No	2	2	No
11	3	3	No	2	2	No	1	1	No	2	2	No
12	2	2	No	2	2	No	1	1	No	2	2	No
13	2	2	No	3	3	No	2	2	No	1	1	No
15	2	2	No	2	2	No	2	2	No	1	2	Yes
16	2	2	No	2	2	No	2	2	No	1	1	No
18	2	2	No	2	2	No	2	2	No	2	2	No
27	2	2	No	2	2	No	2	2	No	1	1	No
30	1	1	No	3	2	Yes	1	1	No	2	2	No
31	1	1	No	1	2	Yes	2	2	No	1	1	No
33	1	1	No	2	2	No	2	2	No	1	1	No
36	2	2	No	2	2	No	1	1	No	2	2	No
38	3	3	No	2	2	No	1	1	No	2	2	No
41	1	1	No	3	3	No	1	1	No	1	1	No
42	1	1	No	2	2	No	2	2	No	1	1	No

46	1	1	No	2	2	No	2	2	No	2	2	No
47	3	3	No	1	1	No	1	1	No	2	2	No
49	3	3	No	2	2	No	2	2	No	1	1	No
51	2	3	Yes	1	2	Yes	1	1	No	2	2	No
60	2	999	Yes	2	2	No	2	2	No	2	2	No
61	2	2	No	2	2	No	1	1	No	2	2	No
63	2	2	No	2	2	No	2	2	No	3	3	No
65	1	1	No	2	2	No	2	2	No	2	2	No
66	3	3	No	2	2	No	1	1	No	2	1	Yes
TOTAL SCORE			4/28 = 86%			4/28 = 86%			100% AGREEMENT			2/28 = 93%

Part II: questions A12-B13

Study #	T1 - A12	T2 - A12	Changes?	T1 - B1	T2 - B1	Changes?	T1 - B5	T2 - B5	Changes?	T1 - B13	T2 - B13	Changes?
3	1	1	No	1	1	No	1	1	No	3	3	No
4	1	1	No	1	1	No	2	2	No	4	3	Yes
5	1	1	No	1	1	No	2	2	No	2	2	No
7	1	1	No	1	1	No	2	2	No	4	4	No
9	1	1	No	1	1	No	2	2	No	3	4	Yes
11	1	1	No	1	1	No	1	1	No	4	4	No
12	1	1	No	1	1	No	1	1	No	3	3	No
13	1	1	No	1	1	No	1	1	No	5	4	Yes
15	1	1	No	1	1	No	2	2	No	1	1	No
16	1	1	No	2	2	No	2	2	No	3	4	Yes
18	1	1	No	1	1	No	1	1	No	4	4	No
27	1	1	No	1	1	No	1	1	No	3	3	No
30	1	1	No	1	1	No	2	2	No	4	4	No
31	1	1	No	1	1	No	2	2	No	4	4	No
33	1	1	No	1	1	No	1	1	No	3	2	Yes
36	1	1	No	2	2	No	2	2	No	4	4	No
38	1	1	No	1	1	No	2	2	No	4	4	No
41	1	1	No	1	1	No	2	2	No	3	3	No

42	1	1	No	1	1	No	2	2	No	2	2	No
46	1	1	No	2	2	No	2	2	No	2	2	No
47	1	1	No	1	1	No	2	2	No	3	3	No
49	1	1	No	1	1	No	2	2	No	3	2	Yes
51	2	2	No	2	2	No	2	2	No	3	2	Yes
60	1	1	No	1	1	No	1	1	No	3	4	Yes
61	1	1	No	2	2	No	2	2	No	3	3	No
63	1	1	No	1	1	No	2	2	No	2	2	No
65	1	1	No	1	1	No	2	2	No	4	4	No
66	2	1	Yes	1	1	No	1	1	No	2	2	No
TOTAL SCORE			1/28 = 96%			100% AGREEMENT			100% AGREEMENT			8/28 = 71.5%

Part III: questions B17-B27a

Study #	T1 - B17	T2 - B17	Changes?	T1 - B23	T2 - B23	Changes?	T1 - B26a	T2 - B26a	Changes?	T1 - B27a	T2 - B27a	Changes?
3	3	3	No	3	3	No	1	1	No	1	1	No
4	4	4	No	3	3	No	1	1	No	1	1	No
5	4	4	No	3	3	No	1	1	No	1	1	No
7	3	3	No	3	3	No	2	2	No	2	2	No
9	3	3	No	3	3	No	1	1	No	2	2	No

11	3	3	No	3	3	No	1	1	No	1	1	No
12	5	5	No	1	2	Yes	1	1	No	1	1	No
13	2	1	Yes	3	3	No	1	1	No	2	2	No
15	5	5	No	3	3	No	1	1	No	1	1	No
16	5	5	No	2	2	No	2	2	No	2	2	No
18	4	5	Yes	3	3	No	1	1	No	2	2	No
27	3	3	No	2	2	No	1	1	No	1	2	Yes
30	4	4	No	2	2	No	1	1	No	1	1	No
31	5	5	No	2	2	No	1	1	No	2	1	Yes
33	4	4	No	3	3	No	1	1	No	1	1	No
36	2	3	Yes	3	1	Yes	1	1	No	1	1	No
38	3	3	No	3	3	No	2	1	Yes	2	1	Yes
41	4	4	No	2	2	No	1	1	No	1	1	No
42	2	1	Yes	3	3	No	1	1	No	1	1	No
46	4	4	No	2	2	No	1	2	Yes	2	2	No
47	3	3	No	3	3	No	1	1	No	1	1	No
49	3	3	No	3	3	No	2	2	No	1	1	No
51	5	5	No	2	2	No	1	1	No	1	1	No
60	4	3	Yes	3	3	No	1	1	No	1	1	No
61	3	4	Yes	2	2	No	1	1	No	1	1	No

63	5	5	No	2	2	No	2	2	No	2	2	No
65	5	5	No	3	3	No	2	2	No	1	1	No
66	5	5	No	2	1	Yes	1	1	No	1	1	No
TOTAL SCORE			6/28 = 78.6%			3/28 = 89.3%			2/28 = 93%			3/28 = 89.3%

Part IV: questions B29-B31a

Study #	T1 - B29	T2 - B29	Changes?	T1 - B30a	T2 - B30a	Changes?	T1 - B31a	T2 - B31a	Changes?
3	2	1	Yes	2	2	No	2	1	Yes
4	2	2	No	1	1	No	2	1	Yes
5	1	1	No	2	2	No	1	1	No
7	1	1	No	2	2	No	2	2	No
9	1	2	Yes	1	1	No	1	1	No
11	1	1	No	1	1	No	1	1	No
12	1	2	Yes	1	1	No	1	1	No
13	1	1	No	2	2	No	1	1	No
15	2	1	Yes	2	2	No	1	1	No
16	2	2	No	2	2	No	1	1	No
18	1	1	No	1	1	No	1	1	No

27	2	2	No	1	1	No	1	1	No
30	1	1	No	1	1	No	1	1	No
31	1	2	Yes	1	1	No	2	2	No
33	2	2	No	2	1	Yes	1	1	No
36	1	2	Yes	1	1	No	1	1	No
38	1	1	No	1	1	No	1	1	No
41	2	2	No	1	1	No	1	1	No
42	2	2	No	1	1	No	1	1	No
46	1	2	Yes	1	1	No	2	2	No
47	2	2	No	2	1	Yes	1	1	No
49	2	2	No	1	1	No	1	1	No
51	1	2	Yes	1	2	Yes	1	1	No
60	2	2	No	2	1	Yes	1	1	No
61	2	1	Yes	1	1	No	1	1	No
63	2	2	No	1	1	No	2	2	No
65	1	1	No	1	1	No	1	1	No
66	1	2	Yes	1	1	No	1	1	No
TOTAL SCORE			10/28 = 64%			4/28 = 86%			2/28 = 93%
AVERAGE SCORE		1325.7 TOTAL SUM	DIVIDED BY 15		88.38% OF AGREEMENT				

Appendix 4-21: Kappa values and ICC results

	Cohen's Kappa			Intraclass correlation coefficient (ICC)	
	Kappa Value	P value	Interpretation	ICC Value	Interpretation
A1	0.827	0	Strong Agreement	0.901	Almost perfect correlation agreement
A4	0.550	0	Moderate agreement	0.612	Moderate correlation agreement
A7	1	0	Strong Agreement	1	Perfect correlation agreement
A9	0.858	0	Strong Agreement	0.881	Almost perfect correlation agreement
A12	0.650	0.000	Moderate agreement	0.658	Moderate correlation agreement
B1	1	0	Strong Agreement	1	Perfect correlation agreement
B5	1	0	Strong Agreement	1	Perfect correlation agreement
B13	0.593	0	Moderate agreement	0.829	Almost perfect correlation agreement
B17	0.703	0	Good agreement	0.907	Almost perfect correlation agreement
B23	0.795	0	Good agreement	0.708	Strong correlation agreement
B26a	0.788	0	Good agreement	0.794	Strong correlation agreement
B27a	0.747	0	Good agreement	0.754	Strong correlation agreement
B29	0.296	0.102	Low agreement	0.304	Fair correlation agreement
B30a	0.652	0	Moderate agreement	0.660	Moderate correlation agreement
B31a	0.759	0	Good agreement	0.765	Strong correlation agreement
	Average KAPPA= 0.748		Good agreement	Average ICC = 0.785	Strong correlation agreement

Appendix 4-22: Food portion conversion

A. MEAT, FISH AND POULTRY (Medium serving – the size of a deck of cards OR palm of hands without fingers)

Average use during your pregnancy	EPIC MANUAL (and grams)	Agreement on calculation (that I will be using in Nutritics)	Translation to Nutritics 'menu' (option chosen from Nutritics)
Beef roast	Beef sirloin joint roasted lean and fat - 120g	120g	Beef, sirloin joint, roasted, lean and fat
Beef: steak	N/A	108 g (suggested from Nutritics)	Beef, fillet steak, grilled, lean
Beef: mince	N/A	100g (average portion?)	Beef, mince, fried in olive oil
Beef: stew	Beef stew made with lean beef - 330g	330g	Stew, beef, made with lean beef, homemade
Beef burger (1 burger)	Beefburgers, chilled/frozen, fried - 60g	60g	Burger, beef, 98-99% beef, fried in vegetable oil
Pork: roast	There are no options for just roasted pork - but I chose the suggested portion size for pork of 120g	120g	Pork, hand, shoulder joint, roasted, lean and fat

Pork: chops	There are 4 options but all of them suggest a portion size of 120g - I chose: Pork loin chops	120g	Pork, loin chops, roasted, lean and fat
Pork: slices/steak/escalopes	There are no specific options for just this one - but I chose the suggested portion size for pork of 120g	120g	Pork, loin steaks, fried in corn oil, lean and fat
Lamb: roast	Lamb, leg, lean and fat, roast - 120g	120g	Lamb, leg, whole, roasted well done, lean and fat
Lamb: chops	Lamb, loin chops, grilled, lean - 60g	60g	Lamb, loin chops, grilled, lean
Lamb: stew	There are no specific options for just this one - but I chose the suggested portion size for cooked lamb of 120g	120g	Stew, Irish, made with lean lamb, homemade
Chicken portion OR other poultry e.g. turkey: roast	Turkey, light meat, roasted - 100g	100g	Turkey, light meat, roasted
Breaded chicken, chicken nuggets, chicken burger	There are no specific options for just this one - so I will be using Nutritics demographic average portion size - 140g	140g	Chicken breast in crumbs, chilled, fried
Bacon	There are 4 options but all of them suggest a portion size of 40g - I chose: Bacon rasher, streaky, fried	40g	

Ham	Two options in this one: Ham, canned or Ham, premium - I chose Ham, premium - 23 g	23g	Ham, premium
Corned beef	Corned beef, canned - 40g	40g	Corned beef, canned
Luncheon meats	Luncheon meat, canned - 40g	40g	Luncheon meat, canned
Sausages, Frankfurters (1 sausage)	N/A	47g	Frankfurter
Savoury pies (e.g. meat pie, pork pie, steak & kidney pie, sausage rolls)	Among all the options of pies the one chosen was: pork pie, individual - 140g	140g	Pork pie, individual
Heart, kidney	N/A	40g	Kidney, lamb, raw
Fish fried in batter, as in fish and chips	Cod in batter, fried in retail blend oil - 180g	180g	Cod, in batter, fried in rapeseed oil
Fish fried in bread crumbs	N/A	180g	Whiting, in crumbs, fried in blended oil
Oven baked/grilled fish (in bread crumbs OR batter)	N/A	120g	Salmon, farmed, flesh only, grilled
Fish fingers/fish cakes	Fish fingers, cod, frozen - 60g	60g	Fish fingers, cod, grilled/baked
Other white fish, fresh OR frozen (e.g. cod, haddock, plaice, sole, halibut, coli)	Haddock, grilled - 85g	85g	Haddock, flesh only, grilled
Oily fish (fresh) - (e.g. mackerel, kippers, tuna,	Tuna, raw - 120g	120g	

salmon, sardines, herring)			
Oily fish (canned) - (e.g. mackerel, kippers, tuna, salmon, sardines, herring)	Among all the options of oily canned fish the one chosen was: Tuna, canned in oil, drained - 45g	45g	Tuna, canned in sunflower oil, drained
Shellfish (e.g. crab, prawns, mussels)	Among all the options of shellfish the one chosen was: Mussels, boiled - 40g	40g	Mussels, purchased cooked

B. BREAD AND SAVOURY BISCUITS (One slice OR one biscuit)

Average use during your pregnancy	EPIC MANUAL	Agreement on calculation	Interpretation with 'menu' in Nutritics
White bread and rolls (including ciabatta and panini bread)	White bread, average - 30g	30g	Bread, white, average
Brown bread and rolls	Brown bread, average - 30g	30g	Bread, brown, average
Wholemeal bread and rolls	Wholemeal bread, average - 30g	30g	Bread, wholemeal, average
Cream crackers, cheese biscuits	Cream crackers - 7g	7g	Cream crackers
Crisp bread, e.g. Ryvita	Crispbread, rye	10g	Crispbread, rye
Pancakes, muffins, oatcakes	Among those three options the one chosen was: Muffins, American style, chocolate chip - 80g	80g	Muffins, American style, chocolate chip, homemade
Baguette	N/A	30g	Bread, white, French stick

C. CEREALS (One medium sized bowl)

Average use during your pregnancy	EPIC MANUAL	Agreement on calculation	Interpretation with 'menu' in Nutritics
Porridge, Readybrek	Among those two options the one chosen was: Porridge, made with water - 200g	200g	Porridge, made with milk and water

All Bran, Weetabix, Shredded Wheat	Among those options the one chosen was: Weetabix - 30g	30g	Breakfast cereal, wheat biscuits, Weetabix type, fortified
Branflakes, Bran Buds	N/A	30g	Breakfast cereal, bran type cereal, fortified
Cornflakes, Rice Krispies	N/A	30g	Breakfast cereal, cornflakes, unfortified
Muesli (e.g. Country Store, Alpen, sugar coated, Granola)	Muesli - 30g	30g	Breakfast cereal, crunchy/crispy muesli type cereal, with nuts, unfortified
Sugar Coated Cereals (e.g. Frosties, Crunchy Nut, Cornflakes, Crunchy Sugar Coated Muesli)	N/A	30g	Breakfast cereal, puffed wheat, honey coated, fortified

D. POTATOES, RICE AND PASTA (Medium serving - about a cupful)

Average use during your pregnancy	EPIC MANUAL	Agreement on calculation	Interpretation with 'menu' in Nutritics
Boiled, instant or jacket potatoes	Among its options: Old potatoes, baked, flesh only - 180g	180g	Potatoes, old, baked, flesh only
Mashed potatoes	Old potatoes, mashed with butter - 180g	180g	Potatoes, old, mashed with butter
Chips	Chips, straight cut, frozen, fried in corn oil - 180g	180g	Potato chips, straight cut, frozen, fried in corn oil
Roast potatoes	Roast potatoes (old) in corn oil -	200g	Potatoes, old, roasted in corn oil

	200g		
Potato Salad	Potato salad with mayonnaise - 112g	112g	Salad, potato, with mayonnaise
White rice	White rice, polished, boiled - 150g	150g	White rice, basmati, boiled
Brown rice	Brown rice, boiled - 150g	150g	Rice, brown, easy cook, boiled in unsalted water
White/yellow/green pastas (e.g. spaghetti, macaroni, noodles)	Pasta, plain, fresh, cooked - 230g	230g	Pasta, plain, fresh, boiled
Wholemeal pasta	Spaghetti, wholemeal, boiled	95g (dried)	Pasta, wholemeal, dried
Lasagne (meat based)	Lasagne - 450g	450g	Lasagne beef, homemade
Lasagne (vegetarian)	Lasagne - 450g	450g	Lasagne, vegetable, retail
Moussaka	Moussaka - 330g	330g	Moussaka, homemade
Pizza	Pizza, cheese and tomato recipe - 240g	240g	Pizza, cheese and tomato, retail
Macaroni Cheese	N/A	281g	Macaroni cheese, homemade

E. DAIRY PRODUCTS AND FATS

Average use during your pregnancy	EPIC MANUAL	Agreement on calculation	Interpretation with 'menu' in Nutritics
Cream (1 tablespoon)	Cream, Fresh, Single - 20g	20g	Cream, Fresh, Single
Full-fat yoghurt OR Greek- style Yoghurt (125g carton)	Greek- style Yoghurt - 125g	125g	Yogurt, Greek style, plain
Dairy desserts (125g carton)	N/A	125g	Desserts, dairy, chocolate
Cheddar cheese (medium serving)	Cheese, Cheddar, English - 40g	40g	Cheese, Cheddar, English
Low-fat cheddar cheese (medium serving OR 1 slice - 25g)	N/A	25g	Cheese, Cheddar type, half fat
Eggs as boiled, fried, scrambled, poached (1)	Eggs, Chicken, Whole Raw - 50g	50g	Eggs, chicken, whole, raw
Quiche (medium serving)	Among its two options, I chose: Quiche, Lorraine - 120g	120g	Quiche, Lorraine, homemade
Light salad cream OR light mayonnaise (1 tablespoon)	Salad Cream, Reduced Calorie - 15g	15g	Salad cream, reduced fat
Salad cream, mayonnaise (1 tablespoon)	Salad cream - 15g	15g	Salad cream
French dressing	Dressing, French - 15g	15g	Dressing, French
Other salad dressing	Dressing, Oil and Lemon - 15g	15g	Dressing, oil and lemon, homemade
Butter (1 teaspoon)	Butter - 4g	4g	Butter, salted

Light Butter e.g. Dawn light, Connacht Gold (teaspoon)	N/A	4g	Butter, spreadable, light (60% fat)
Sunflower margarine e.g. Flora (1 teaspoon)	Margarine - 4g	4g	Margarine, Flora Original
Low-fat margarine e.g. low- low (1 teaspoon)	Low Fat Spread - 4g	4g	Margarine, Low Low Original
Cholesterol lowering spreads e.g. Flora Pro Active, Dairy Gold Heart (1 teaspoon)	N/A	4g	Margarine, Flora Pro-active
Cream and vegetable oil spread e.g. Golden Pasture, Kerrymaid, Dairy Gold (1 teaspoon)	N/A	4g	Kerrymaid Dairy Spread
Olive oil spread e.g. Golden Olive (1 teaspoon)	N/A	4g	Margarine, Golden Vale Golden Olive

F. FRUIT (1 fruit OR medium serving)

Average use during your pregnancy	EPIC MANUAL	Agreement on calculation	Interpretation with 'menu' in Nutritics
Apples	Apples, eating, average raw - 100g	100g	Apples, eating, raw, flesh and skin
Pears	Pears, average, raw - 100g	100g	Pears, raw, flesh and skin
Oranges, Satsuma, mandarins	Oranges - 160g	160g	Oranges, flesh only
Grapefruit	Grapefruit, raw - 80g	80g	Grapefruit, raw, flesh only
Bananas	Bananas - 100g	100g	Bananas, flesh only
Grapes	Grapes, average - 100g	100g	Grapes, average

Melon	Melon, average - 175g	175g	Melon, flesh only, average
Peaches, plums	Peaches, raw - 110g	110g	Peaches, raw, flesh and skin
Apricots	Apricots, raw - 65g	65g	Apricots, raw, flesh and skin
Strawberries, raspberries, kiwi fruit	Among its options: Strawberry was chosen - 80g	80g	Strawberries, raw
Tinned fruit	Among its options: Fruit cocktail, canned in juice was chosen - 105g	105g	Fruit cocktail, canned in juice, whole contents
Dried fruit e.g. raisins	Raisins	30g	Raisins
Frozen fruit	N/A	53g	Raspberries, frozen

G. VEGETABLES fresh, frozen OR tinned (Medium serving – 2 tablespoons OR 4 dessert spoons)

Average use during your pregnancy	EPIC MANUAL	Agreement on calculation	Interpretation with 'menu' in Nutritics
Carrots	Among their options, the one chosen was: Carrots, old, boiled in unsalted water - 60g	60g	Carrots, old, boiled in unsalted water
Spinach	Spinach, boiled in unsalted water - 90g	90g	Spinach, mature, boiled in unsalted water
Broccoli, spring greens, kale	Among their options, the one chosen was: Broccoli, green,	90g	Broccoli, green, boiled in unsalted water

	boiled in unsalted water- 90g		
Brussel sprouts	Brussels sprouts, boiled in unsalted water - 90g	90g	Brussels sprouts, boiled in unsalted water
Cabbage	Cabbage, boiled in unsalted water, average - 90g	90g	Cabbage, average, boiled in unsalted water
Peas	Among their options, the one chosen was: Peas, frozen, boiled in unsalted water - 65g	65g	Peas, frozen, boiled in unsalted water
Green beans, broad beans, runner beans	Among their options, the one chosen was: Green beans/French beans, boiled in unsalted water - 90g	90g	Beans, green, boiled in unsalted water
Courgettes	Among their options, the one chosen was: Courgettes, fried in blended oil - 90g	90g	Courgette, fried in rapeseed oil
Cauliflower	Among their options, the one chosen was: Cauliflower, boiled in unsalted water - 90g	90g	Cauliflower, boiled in unsalted water
Parsnips, turnips	Among their options, the one chosen was: Parsnip, boiled in unsalted water - 65g	65g	Parsnip, boiled in unsalted water
Leeks	Among their options, the one chosen was: Leeks, boiled in unsalted water - 160g	160g	Leeks, boiled in unsalted water

Onions	Among its options, the one chosen was: Onions, raw - 90g	90g	Onions, raw
Garlic	Garlic, raw - 10g	10g	Garlic, raw
Mushrooms	Among its options, the one chosen was: Mushrooms, common raw - 44g	44g	Mushrooms, white, raw
Sweet peppers	Peppers, capsicum, green, raw - 160g	160g	Peppers, capsicum, green, raw
Beansprouts	Among its options, the one chosen was: Bean sprouts, mung, raw - 60g	60g	Beansprouts, mung, raw
Green salad, Lettuce	Lettuce, average, raw - 30g	30g	Lettuce, average, raw
Cucumber, celery	Cucumber, raw - 23g	23g	Cucumber, raw, flesh and skin
Tomatoes	Among its options, the one chosen was: Tomatoes, raw - 85g	85g	Tomatoes, standard, raw
Sweetcorn	Sweetcorn, kernels, raw - 60g	60g	Sweetcorn, kernels, raw
Beetroot	Beetroot, pickled, drained - 35g	35g	Beetroot, pickled, drained
Coleslaw	Among its options, the one chosen was: Coleslaw, with mayonnaise, retail - 45g	45g	Coleslaw, not low calorie, retail
Baked beans	Baked beans, canned in tomato sauce - 135g	135g	Baked beans, canned in tomato sauce

Dried lentils, beans, peas	Among its options, the one chosen was: Lentils, red, split, dried, boiled in unsalted water - 30g	30g	Lentils, red, split, dried, boiled in unsalted water
Tofu, soya meat, TVP, veggie burger	Among its options, the one chosen was: Tofu, soya bean, steamed, fried - 60g	60g	Tofu, soya bean, steamed, fried

H. SWEETS AND SNACKS (Medium serving)

Average use during your pregnancy	EPIC MANUAL	Agreement on calculation	Interpretation with 'menu' in Nutritics
Chocolate coated sweet biscuits e.g. digestive (1)	Among its options, the one chosen was: Digestive biscuits, chocolate - 20g	20g	Biscuits, digestive, half coated in chocolate
Plain sweet biscuits e.g. Marietta, Digestives, Rich Tea (1)	Among its options, the one chosen was: Digestive biscuits, plain - 13g	13g	Biscuits, digestive, plain
Cakes e.g. fruit, sponge	Among its options, the one chosen was: Muffins, American style, chocolate chip - 80g	80g	Muffins, American style, chocolate chip, homemade
Buns, pastries e.g. croissants, doughnuts	Among its options, the one chosen was: Doughnuts, jam - 75g	75g	Doughnuts, with jam
Fruit pies, tarts, crumbles	Among its options, the one chosen was: Mince pies,	48g	Mince pies, retail

	individual - 48g		
Sponge puddings	Sponge pudding - 170g	170g	Pudding, sponge, homemade
Milk puddings e.g. rice, custard, trifle	Among its options, the one chosen was: Rice pudding, canned- 200g	200g	Pudding, rice, canned
Ice cream, choc ices, Frozen desserts	Among its options, the one chosen was: Ice-cream, dairy, flavoured- 60g	60g	Ice cream, dairy, flavoured
Chocolates, single OR square	Among its options, the one chosen was: Twix- 50g	50g	Chocolate covered caramel and biscuit fingers
Sweets, toffees, mints	Among its options, the one chosen was: Toffees, mixed- 8g	8g	Toffees, mixed
Sugar added to tea, coffee, cereal (1 teaspoon)	Among its options, the one chosen was: Sugar, white - 5g	5g	Sugar, white
Sugar substitute e.g. Canderel added to tea, coffee, cereal (1 teaspoon)	N/A	1g	Sweetener, Canderel/Splenda tablet/powder
Crisps OR other packet snacks	Among its options, the one chosen was: Potato crisps - 40g	40g	Potato crisps, crinkle cut
Peanuts OR other nuts	Among its options, the one chosen was: Peanuts, roasted and salted - 40g	40g	Peanuts, roasted and salted

I. SOUPS, SAUCES AND SPREADS

Average use during your pregnancy	EPIC MANUAL	Agreement on calculation	Interpretation with 'menu' in Nutritics
Vegetable soups: homemade/fresh (1 bowl)	N/A	220g	Soup, vegetable, homemade
Vegetable soups: tinned/packet (1 bowl)	Vegetable soup, canned - 220g	220g	Soup, vegetable, canned
Meat OR cream soups: homemade/fresh (1 bowl)	N/A	220g	Soup, cream of vegetable, homemade
Meat OR cream soups: tinned/packet (1 bowl)	Chicken soup, cream of, canned - 220g	220g	Soup, chicken, cream of, canned
Sauces e.g. white sauce, cheese sauce (1 tablespoon)	Cheese sauce packet mix - 60g	60g	Sauce, cheese, packet mix, dry
Gravy (1 tablespoon)	Gravy instant granules, made up - 70g	70g	Gravy instant granules
Tomato based sauces e.g. pasta sauces	Chutney, Tomato - 15g	15g	Chutney, Tomato
Curry-type sauces	Curry sauce - 115g	115g	Sauce, fresh curry, Avonmore
Pickles, chutney (1 tablespoon)	Pickle, sweet - 15g	15g	Pickle, sweet
Marmite, Bovril (1 tablespoon)	Marmite - 9g	9g	Yeast extract
Jam, marmalade, honey, syrup (1 tablespoon)	Jam, fruit with edible seeds - 15g	15g	Jam, fruit with edible seeds
Peanut butter (1 teaspoon)	Peanut butter, smooth - 16g	16g	

J. DRINKS

Average use during your pregnancy	EPIC MANUAL	Agreement on calculation	Interpretation with 'menu' in Nutritics
Tea (cup)	Tea, black, infusion, average - 150g	150g	Tea, black, infusion, average
Coffee instant (cup)	Coffee, instant, made up with water - 150g	150g	Coffee, instant, made up with water
Coffee ground (cup)	N/A	150g	Coffee, infusion, strong
Coffee, decaffeinated (cup)	N/A	150g	Coffee, infusion, decaffeinated, average
Coffee whitener e.g. coffee-mate (teaspoon)	Coffee-mate - 5g	5g	Coffeemate, whitener powder
Cocoa, Hot Chocolate (cup)	Cocoa powder - 15g	15g	Cocoa powder
Horlicks, Ovaltine (cup)	Ovaltine powder - 20g	20g	Ovaltine, powder
Low calorie OR diet soft fizzy drinks (glass)	Diet cola - 330g	330g	Cola, diet
Fizzy Soft drinks e.g. Coca Cola (glass)	Cola - 330g	330g	Cola
Pure fruit drinks e.g. orange juice (small glass)	Orange juice, unsweetened - 200g	200g	Orange juice concentrate, unsweetened, commercial
Fruit squash (small glass)	Fruit drink/squash, concentrated, made up	200g	Fruit drink/squash, concentrated Robinsons

Appendix 4-23: Nutritics codebook

Nutritics Codebook

A. MEAT, FISH AND POULTRY									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Beef roast	4.3	8.6	17.1	51	86	120g	300	540	780
Beef: steak	3.9	7.7	15.4	46	77	108g	270	486	702
Beef: mince	3.6	7.1	14.3	43	71	100g	250	450	650
Beef: stew	11.8	23.6	47	141	236	330g	825	1.49	2.15
Beef burger (1 burger)	2.1	4.3	8.6	25.7	43	60g	150	270	390
Pork: roast	4.3	8.6	17.1	51	86	120g	300	540	780
Pork: chops	4.3	8.6	17.1	51	86	120g	300	540	780
Pork: slices/steak/escalopes	4.3	8.6	17.1	51	86	120g	300	540	780
Lamb: roast	4.3	8.6	17.1	51	86	120g	300	540	780
Lamb: chops	2.1	4.3	8.6	25.7	43	60g	150	270	390
Lamb: stew	4.3	8.6	17.1	51	86	120g	300	540	780
Chicken portion OR other poultry e.g. turkey: roast	3.6	7.1	14.3	43	71	100g	250	450	650
Breaded chicken, chicken nuggets, chicken burger	5	10	20	6	100	140g	350	630	910
Bacon	1.4	2.9	5.7	17.1	28.6	40g	100	180	260
Ham	0.82	1.6	3.3	9.9	16.4	23g	58	104	150
Corned beef	1.4	2.9	5.7	17.1	28.6	40g	100	180	260
Luncheon meats	1.4	2.9	5.7	17.1	28.6	40g	100	180	260

A. MEAT, FISH AND POULTRY									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Sausages, Frankfurters (1 sausage)	1.7	3.4	6.7	20.1	33.6	47g	118	212	306
Savoury pies (e.g. meat pie, pork pie, steak & kidney pie, sausage rolls)	5	10	20	6	100	140g	350	630	910
Heart, kidney	1.4	2.9	5.7	17.1	28.6	40g	100	180	260
Fish fried in batter, as in fish and chips	6.4	12.9	25.7	77	129	180g	450	810	1.17
Fish fried in bread crumbs	6.4	12.9	25.7	77	129	180g	450	810	1.17
Oven baked/grilled fish (in bread crumbs OR batter)	4.3	8.6	17.1	51	86	120g	300	540	780
Fish fingers/fish cakes	2.1	4.3	8.6	25.7	43	60g	150	270	390
Other white fish, fresh OR frozen (e.g. cod, haddock, plaice, sole, halibut, coli)	3	6.1	12.1	36.4	61	85g	213	383	553
Oily fish (fresh) - (e.g. mackerel, kippers, tuna, salmon, sardines, herring)	4.3	8.6	17.1	51	86	120g	300	540	780
Oily fish (canned) - (e.g. mackerel, kippers, tuna, salmon, sardines, herring)	1.6	3.2	6.4	19.3	32.1	45g	113	2.3	293
Shellfish (e.g. crab, prawns, mussels)	1.4	2.9	5.7	17.1	28.6	40g	100	180	260

Please check that you put a tick (✓) on every line

B. BREAD AND SAVOURY BISCUITS (One slice OR one biscuit)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
White bread and rolls (including ciabatta and panini bread)	1.1	2.1	4.3	12.9	21.4	30g	75	135	195
Brown bread and rolls	1.1	2.1	4.3	12.9	21.4	30g	75	135	195
Wholemeal bread and rolls	1.1	2.1	4.3	12.9	21.4	30g	75	135	195
Cream crackers, cheese biscuits	0.25	0.5	1	3	5	7g	17.5	31.5	46
Crisp bread, e.g. Ryvita	0.36	0.71	1.4	4.3	7.1	10g	25	45	65
Pancakes, muffins, oatcakes	2.9	5.7	11.4	34.3	57	80g	200	360	520
Baguette	1.1	2.1	4.3	12.9	21.4	30g	75	135	195

Please check that you put a tick (✓) on every line

C. CEREALS (One medium sized bowl)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Porridge, Readybrek	7.1	14.3	28.6	86	143	200g	500	900	1.3
All Bran, Weetabix, Shredded Wheat	1.1	2.1	4.3	12.9	21.4	30g	75	135	195
Branflakes, Bran Buds	1.1	2.1	4.3	12.9	21.4	30g	75	135	195
Cornflakes, Rice Krispies	1.1	2.1	4.3	12.9	21.4	30g	75	135	195
Muesli (e.g. Country Store, Alpen, sugar	1.1	2.1	4.3	12.9	21.4	30g	75	135	195

C. CEREALS (One medium sized bowl)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
coated, Granola)									
Sugar Coated Cereals (e.g. Frosties, Crunchy Nut Cornflakes, Crunchy Sugar Coated Muesli)	1.1	2.1	4.3	12.9	21.4	30g	75	135	195

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Please check that you put a tick (✓) on every line

D. POTATOES, RICE AND PASTA (Medium serving – about a cupful)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Boiled, instant or jacket potatoes	6.4	12.9	25.7	77	129	180g	450	810	1.17
Mashed potatoes	6.4	12.9	25.7	77	129	180g	450	810	1.17
Chips	6.4	12.9	25.7	77	129	180g	450	810	1.17
Roast potatoes	7.1	14.3	28.6	86	143	200g	500	900	1.3
Potato Salad	4	8	16	48	80	112g	280	504	728
White rice	5.4	10.7	21.4	64	107	150g	375	675	960
Brown rice	5.4	10.7	21.4	64	107	150g	375	675	960
White/yellow/green pastas (e.g. spaghetti,	8.2	16.4	32.9	99	164	230g	575	1.03	1.5

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D. POTATOES, RICE AND PASTA (Medium serving – about a cupful)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
macaroni, noodles)									
Wholemeal pasta	3.4	6.8	13.6	41	68	95g	238	428	618
Lasagne (meat based)	16.1	32.1	64	193	321	450g	1.13	2.02	2.92
Lasagne (vegetarian)	16.1	32.1	64	193	321	450g	1.13	2.02	2.92
Moussaka	11.8	23.6	47	141	236	330g	825	1.49	2.15
Pizza	8.6	17.1	34.3	103	171	240g	600	1.08	1.56
Macaroni Cheese	10	20.1	40	120	201	281g	703	1.26	1.83

Please check that you put a tick (✓) on every line

E. DAIRY PRODUCTS AND FATS									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Cream (1 tablespoon)	0.71	1.4	2.9	8.6	14.3	20g	50	90	130
Full-fat yoghurt OR Greek- style Yoghurt (125g carton)	4.5	8.9	17.9	54	89	125g	313	563	813
Dairy desserts (125g carton)	4.5	8.9	17.9	54	89	125g	313	563	813
Cheddar cheese (medium serving)	1.4	2.9	5.7	17.1	28.6	40g	100	180	260
Low-fat cheddar cheese (medium serving OR 1 slice - 25g)	0.89	1.8	3.6	10.7	17.9	25g	63	113	163

E. DAIRY PRODUCTS AND FATS									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Eggs as boiled, fried, scrambled, poached (1)	1.8	3.6	7.1	21.4	35.7	50g	125	225	325
Quiche (medium serving)	4.3	8.6	17.1	51	86	120g	300	540	780
Light salad cream OR light mayonnaise (1 tablespoon)	1.1	2.1	4.3	12.9	21.4	30g	75	135	195
Salad cream, mayonnaise (1 tablespoon)	1.1	2.1	4.3	12.9	21.4	30g	75	135	195
French dressing	0.54	1.1	2.1	6.4	10.7	15g	37.5	68	98
Other salad dressing	0.54	1.1	2.1	6.4	10.7	15g	37.5	68	98
The following on bread OR vegetables									
Butter (1 teaspoon)	0.14	0.29	0.57	1.7	2.9	4g	10	18	26
Light Butter e.g. Dawn light, Connacht Gold (teaspoon)	0.14	0.29	0.57	1.7	2.9	4g	10	18	26
Sunflower margarine e.g. Flora (1 teaspoon)	0.14	0.29	0.57	1.7	2.9	4g	10	18	26
Low-fat margarine e.g. low- low (1 teaspoon)	0.14	0.29	0.57	1.7	2.9	4g	10	18	26
Cholesterol lowering spreads e.g. Flora Pro Active, Dairy Gold Heart (1 teaspoon)	0.14	0.29	0.57	1.7	2.9	4g	10	18	26
Cream and vegetable oil spread e.g. Golden Pasture, Kerrymaid, Dairy Gold (1 teaspoon)	0.14	0.29	0.57	1.7	2.9	4g	10	18	26

E. DAIRY PRODUCTS AND FATS									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Olive oil spread e.g. Golden Olive (1 teaspoon)	0.14	0.29	0.57	1.7	2.9	4g	10	18	26

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Please check that you put a tick (✓) on every line

F. FRUIT (1 fruit OR medium serving)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Apples	3.6	7.1	14.3	43	71	100g	250	450	650
Pears	3.6	7.1	14.3	43	71	100g	250	450	650
Oranges, Satsuma, mandarins	5.7	11.4	22.9	69	114	160g	400	720	1.04
Grapefruit	2.9	5.7	11.4	34.3	57	80g	200	360	520
Bananas	3.6	7.1	14.3	43	71	100g	250	450	650
Grapes	3.6	7.1	14.3	43	71	100g	250	450	650
Melon	6.3	12.5	25	75	125	175g	438	788	1.14
Peaches, plums	3.9	7.9	15.7	47	79	110g	275	495	715
Apricots	2.3	4.6	9.3	27.9	46	65g	163	293	423
Strawberries, raspberries, kiwi fruit	2.9	5.7	11.4	34.3	57	80g	200	360	520
Tinned fruit	3.8	7.5	15	45	75	105g	263	473	683
Dried fruit e.g. raisins	1.1	2.1	4.3	12.9	21.4	30g	75	135	195
Frozen fruit	1.9	3.8	7.6	22.7	37.9	53g	133	239	345

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G. VEGETABLES Fresh, frozen OR tinned (Medium serving – 2 tablespoons OR 4 desert spoons)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Carrots	2.1	4.3	8.6	25.7	43	60g	150	270	390
Spinach	3.2	6.4	12.9	38.6	64	90g	225	405	585
Broccoli, spring greens, kale	3.2	6.4	12.9	38.6	64	90g	225	405	585
Brussel sprouts	3.2	6.4	12.9	38.6	64	90g	225	405	585
Cabbage	3.2	6.4	12.9	38.6	64	90g	225	405	585
Peas	2.3	4.6	9.3	27.9	46	65g	163	293	423
Green beans, broad beans, runner beans	3.2	6.4	12.9	38.6	64	90g	225	405	585
Courgettes	3.2	6.4	12.9	38.6	64	90g	225	405	585
Cauliflower	3.2	6.4	12.9	38.6	64	90g	225	405	585
Parsnips, turnips	2.3	4.6	9.3	27.9	46	65g	163	293	423
Leeks	5.7	11.4	22.9	69	114	160g	400	720	1.04
Onions	3.2	6.4	12.9	38.6	64	90g	225	405	585
Garlic	0.36	0.71	1.4	4.3	7.1	10g	25	45	65
Mushrooms	1.6	3.1	6.3	18.9	31.4	44g	110	198	286
Sweet peppers	5.7	11.4	22.9	69	114	160g	400	720	1.04
Beansprouts	2.1	4.3	8.6	25.7	43	60g	150	270	390
Green salad, Lettuce	1.1	2.1	4.3	12.9	21.4	30g	75	135	195
Cucumber, celery	0.82	1.6	3.3	9.9	16.4	23g	58	104	150
Tomatoes	3	6.1	12.1	36.4	61	85g	213	383	553
Sweetcorn	2.1	4.3	8.6	25.7	43	60g	150	270	390
Beetroot	1.3	2.5	5	15	25	35g	88	158	228
Coleslaw	1.6	3.2	6.4	19.3	32.1	45g	113	203	293
Baked beans	4.8	9.6	19.3	58	96	135g	338	608	878
Dried lentils, beans, peas	1.1	2.1	4.3	12.9	21.4	30g	75	135	195

G. VEGETABLES Fresh, frozen OR tinned (Medium serving – 2 tablespoons OR 4 desert spoons)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Tofu, soya meat, TVP, veggie burger	2.1	4.3	8.6	25.7	43	60g	150	270	390

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H. SWEETS AND SNACKS (Medium serving)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Chocolate coated sweet biscuits e.g. digestive (1)	0.71	1.4	2.9	8.6	14.3	20g	50	90	130
Plain sweet biscuits e.g. Marietta, Digestives, Rich Tea (1)	0.46	0.93	1.9	5.6	9.3	13g	32.5	59	85
Cakes e.g. fruit, sponge	2.9	5.7	11.4	34.3	57	80g	200	360	520
Buns, pastries e.g. croissants, doughnuts	2.7	5.4	10.7	32.1	54	75g	188	338	488
Fruit pies, tarts, crumbles	1.7	3.4	6.9	20.6	34.3	48g	120	216	312
Sponge puddings	6.1	12.1	24.3	73	121	170g	425	765	1.1
Milk puddings e.g. rice, custard, trifle	7.1	14.3	28.6	86	143	200g	500	900	1.3
Ice cream, choc ices, Frozen desserts	2.1	4.3	8.6	25.7	43	60g	150	270	390
Chocolates, single OR square	1.8	3.6	7.1	21.4	35.7	50g	125	225	325
Sweets, toffees, mints	0.29	0.57	1.1	3.4	5.7	8g	20	36	52
Sugar added to tea, coffee, cereal (1	0.18	0.36	0.71	2.1	3.6	5g	12.5	22.5	32.5

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H. SWEETS AND SNACKS (Medium serving)									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
teaspoon)									
Sugar substitute e.g. Canderel added to tea, coffee, cereal (1 teaspoon)	0.04	0.07	0.14	3	5	1g	2.5	4.5	6.5
Crisps OR other packet snacks	1.4	2.9	5.7	17.1	28.6	40g	100	180	260
Peanuts OR other nuts	1.4	2.9	5.7	17.1	28.6	40g	100	180	260

I. SOUPS, SAUCES AND SPREADS									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Vegetable soups: homemade/fresh (1 bowl)	7.9	15.7	31.4	94	157	220g	550	990	1.43
Vegetable soups: tinned/packet (1 bowl)	7.9	15.7	31.4	94	157	220g	550	990	1.43
Meat OR cream soups: homemade/fresh (1 bowl)	7.9	15.7	31.4	94	157	220g	550	990	1.43
Meat OR cream soups: tinned/packet (1 bowl)	7.9	15.7	31.4	94	157	220g	550	990	1.43
Sauces e.g. white sauce, cheese sauce,	2.1	4.3	8.6	25.7	43	60g	150	270	390
gravy	2.5	5	10	30	50	70g	175	315	455
Tomato based sauces e.g. pasta	0.54	1.1	2.1	6.4	10.7	15g	37.5	68	98

I. SOUPS, SAUCES AND SPREADS									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
saucers									
Curry-type sauces	4.1	8.2	16.4	49	82	115g	288	518	748
Pickles, chutney (1 tablespoon)	0.54	1.1	2.1	6.4	10.7	15g	37.5	68	98
Marmite, Bovril (1 tablespoon)	0.32	0.64	1.3	3.9	6.4	9g	22.5	41	59
Jam, marmalade, honey, syrup (1 tablespoon)	0.54	1.1	2.1	6.4	10.7	15g	37.5	68	98
Peanut butter (1 teaspoon)	0.57	1.1	2.3	6.9	11.4	16g	40	72	104

J. DRINKS									
Average use during your pregnancy	Never or less than 1 a month	1-3 a month	1 a week	2-4 a week	5-6 a week	1 a day	2-3 a day	4-5 a day	6 or 7 a day
Tea (cup)	5.4	10.7	21.4	64	107	150g	375	675	960
Coffee instant (cup)	5.4	10.7	21.4	64	107	150g	375	675	960
Coffee ground (cup)	5.4	10.7	21.4	64	107	150g	375	675	960
Coffee, decaffeinated (cup)	5.4	10.7	21.4	64	107	150g	375	675	960
Coffee whitener e.g. coffee-mate (teaspoon)	0.18	0.36	0.71	2.1	3.6	5g	12.5	22.5	32.5
Cocoa, Hot Chocolate (cup)	0.54	1.1	2.1	6.4	10.7	15g	37.5	68	98

Horlicks, Ovaltine (cup)	0.71	1.4	2.9	8.6	14.3	20g	50	90	130	7
Low calorie OR diet soft fizzy drinks (glass)	11.8	23.6	47	141	236	330g	825	1.49	2.15	8
Fizzy Soft drinks e.g. Cocoa Cola (glass)	11.8	23.6	47	141	236	330g	825	1.49	2.15	9
Pure fruit drinks e.g. orange juice (small glass)	7.1	14.3	28.6	86	143	200g	500	900	1.3	10
Fruit squash (small glass)	7.1	14.3	28.6	86	143	200g	500	900	1.3	11

Appendix 4-24: Management of variables

The variables used in this PhD study analysis were in several formats. This appendix details how the original variables were transformed, recoded and prepared for analysis

Socio-demographic variables:

Age: “What is your date of birth?” - Survey 1

Age of participants was calculated based on the date of birth and due date: ages ranged from 18 to 48 years (mean age = 32 years). Then, divided into three groups of age: up to 29 years, from 30 to 34 (used as a reference category) and 35 or more years.

Relationship status: “Are you currently” – Survey 1

Original variable	Recoded variable
Married	Married or living with partner (used as a reference category)
Divorced or separated	In a relationship - not living with partner
Widowed	Single
Single	
Living with partner	
In a relationship - not living together	
Other	

Education level: “What is the highest qualification you have completed” – Survey 1

Original variable	New variable
No formal qualifications	Junior cert or less
Primary or first school	Leaving Cert/Vocational
Lower secondary	Primary degree/PG Cert (used as a reference category)
Junior/Intermediate/Group certificate ‘O’ levels/ GCSE, NCVA Foundation certificate, basic skills training certificate, or equivalent	MSc/PhD
Upper secondary Leaving certificate – 5 applied and vocational programmes, ‘A’ levels, NCVA level 1 certificate, or equivalent	
Completed apprenticeship, NCVA level 2/3 certificate, 6 Teagasc certificate, Diploma, or equivalent	
Both Upper secondary and Technical or Vocational qualification	
National certificate, Diploma NCEA / 8 Institute of Technology or equivalent, Nursing Diploma	
Primary degree Third level Bachelor degree	
Professional qualification of degree status at least	
Postgraduate certificate or diploma	
Postgraduate degree Masters	
Doctorate PhD	

Employment status: “How would you describe your current employment status” – Survey 1

Original variable	New variable
Full-time paid work	Full time paid work (used as a reference category)
Part-time paid work	Part-time paid work
Casual paid work	Casual paid work
Looking for first job	
Unemployed	
Student or pupil	
Looking after home/family	
Unable to work due to sickness/disability	
Unpaid voluntary work	
Others (Please describe)	

Country of birth: “Which country were you born in?” – Survey 1

Participants provided their country of birth in an open-ended question and then a dichotomous variable was created: Irish (used as a reference category) or non-Irish.

Type of care

In order to measure the socio-economic level, the focus was to analyse whether participants had private or public health insurance (not what they used).

Original variable	New variable
Private care (private health insurance)	Private health insurance
Semi-private care (private health insurance)	Public care (used as a reference category)
Public care (but has private health insurance)	
Public care	
Missing	

Health behaviours before pregnancy:

Survey 1:

“During the last 12 months BEFORE your pregnancy did you experience any of the following?”

Not able to lose weight

Labelled as “Difficulties in losing weight”

Original variable	New variable
Never	No (used as a reference category)
Rarely	Yes
Occasionally	
Often	

Not able to put on weight

Labelled as “Difficulties in putting on weight”

Original variable	New variable
Never	No (used as a reference category)
Rarely	Yes
Occasionally	
Often	

Mental health variables before pregnancy:

Survey 1:

“During the last 12 months BEFORE your pregnancy did you experience any of the following?”

Feeling depressed, low mood or sad (lasting two weeks or more):

Labeled as “Depression episodes before pregnancy”

Original variable	New variable
Never	No (used as a reference category)
Rarely	Yes
Occasionally	
Often	

Intense anxiety (such as panic attacks):

Labelled as Anxiety episodes (panic attacks) before pregnancy

Original variable	New variable
Never	No (used as a reference category)
Rarely	Yes
Occasionally	
Often	

Eating disorders (anorexia or bulimia)

“Have you ever had any of the following conditions?”

Labelled as “History of eating disorders before pregnancy

Original variable	New variable
Yes, as a child (up to age 17yrs)	No (used as a reference category)
Yes, as an adult (since age 18yrs)	Yes
No, never	
Not sure	

Physical activity and social behaviour changes during pregnancy:

Survey 1A:

As previously mentioned, physical activity during pregnancy was explored based on two variable: walking and moderate exercise during pregnancy.

Estimate total time walking during the last week

“What do you estimate was the total time you spent walking in this way LAST WEEK”

Labelled as “walking time during pregnancy”

So, the estimated time answered by participants were converted in minutes to compare with the guidelines/recommendations of 150minutes per week.

Three categories were created: No walking during pregnancy, <150 minutes of walking during pregnancy and ≥ 150 minutes of walking during pregnancy (used as a reference category).

Moderate physical activity during pregnancy

“What do you estimate is the total time you spend doing these activities LAST WEEK?” Labelled as “moderate physical activity during pregnancy”

So, just as above, the estimated time answered by participants were converted in minutes to compare with the guidelines/recommendations of 150minutes per week.

Three categories were created: No moderate physical activity during pregnancy, <150 minutes of moderate physical activity during pregnancy and ≥ 150 minutes of moderate physical activity during pregnancy (used as a reference category).

Survey 1:

Smoking cigarettes

“About cigarettes, which of the following best describes you:”

Labelled as “smoking behaviour”

Original variable	New variable
I smoke regularly now – about the same as before finding out I was pregnant	Never/stopped (used as a reference category)
I smoke regularly now – but I have cut down since I found out I was pregnant	Stopped smoking during pregnancy
I smoke more now than I used to before I found out I was pregnant	Still smoking
I smoke once in a while	
I stopped smoking when I found out I was pregnant	
I used to smoke but stopped before I got pregnant and I don't smoke cigarettes now	
I have never smoked cigarettes	

Drinking alcohol

“About alcohol, which of the following best describes you”

Labelled as “drinking behaviour”

Original variable	New variable
I drink alcohol regularly now – about the same as before finding out I was pregnant	Never/stopped (used as a reference category)
I drink alcohol regularly now – but I have cut down since I found out I was pregnant	Stopped drinking during pregnancy
I drink alcohol more now than I used to before I found out I was pregnant	Still drinking
I drink alcohol once in a while	
I stopped drinking alcohol when I found out I was pregnant	
I used to drink alcohol but stopped before I got pregnant and I don't drink alcohol now	
I have never drank alcohol	

Mental health variables during pregnancy:

Survey 1:

“Since the start of your pregnancy, have you experienced any of the following”

Feeling depressed, low mood or sad (lasting two weeks or more):

Labelled as “Depression episodes before pregnancy”

Original variable	New variable
Never	No (used as a reference category)
Rarely	Yes
Occasionally	
Often	

Intense anxiety (such as panic attacks):

Labelled as Anxiety episodes (panic attacks) before pregnancy

Original variable	New variable
Never	No (used as a reference category)
Rarely	Yes
Occasionally	
Often	

Relationship problems with your partner/spouse:

Labelled as Relationship problems with your partner/spouse during pregnancy

Original variable	New variable
Never	No (used as a reference category)
Rarely	Yes
Occasionally	
Often	

Pregnancy, birth and neonatal variables:

Hospital dataset (and Survey 2 when consent to access hospital database was not given):

Length of gestation

Length of gestation was calculated based on date baby was born due date. Findings (in number of weeks) were dichotomised into preterm (<37 weeks of gestation) and term (used as a reference category).

Mode of birth

For mode of birth, two different databases were used. First was the hospital database and then Survey 2 (“How was your baby born?”) - Labeled as “mode of birth”

Original variable – Survey 2	New variable
Vaginal birth	Spontaneous vaginal birth (used as a reference category)
Vaginal breech (bottom first) birth	Instrumental vaginal birth
Birth assisted with forceps (with no rotation of your baby’s head)	Caesarean section
Birth assisted with rotation forceps (to turn your baby’s head into the correct position for the birth)	
Vacuum extraction or ventouse (with no rotation of your baby’s head)	
Vacuum extraction or ventouse (with rotation of your baby’s head)	
Birth assisted with vacuum AND forceps	
Doctor rotated your baby’s head manually using his/her hands (to turn your baby’s head into the correction position for the birth)	
Caesarean section after unsuccessful attempt to deliver your baby using forceps or vacuum extraction	
Caesarean section (no other procedure used first)	

Infant’s weight at birth

For infant’s weight at birth, two different databases were also used. First was the hospital database and then Survey 2 (“How was your baby born?”) - Labeled as “What weight was your baby?”.

Answers could be both in pounds/ounces and kilograms. For those ones that were answered in pounds/ounces, it was converted to kilograms and then divided into two categories: < 4 kilos (used as a reference category) and ≥ 4 kilos.

Postpartum variables:

Survey 2:

Depression

“SINCE THE BIRTH, have you felt depressed for two weeks or longer?”

Original variable	New variable
Yes, and I still feel depressed	No (used as a reference category)
Yes, I felt depressed a while ago, but I feel better now	Yes
No	

Anxiety

“SINCE THE BIRTH, have you experienced intense anxiety or panic attacks?”

Original variable	New variable
Never	No (used as a reference category)
Rarely	Yes
Occasionally	
Often	

Appendix 4-25: Validation of AHEI-P in Ireland Email Cover Letter



Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

Dear ,

Re. Content validation of the Alternate Healthy Eating Index for Pregnancy (AHEI-P) adapted for use in Ireland Nutrition and Physical Activity study The Maternal health and Maternal Morbidity in Ireland (MAMMI) study

Many thanks for offering to help me by telling me what you think about this adapted tool, I really appreciate it. My name is Jamile Marchi and I am a final-year PhD student in the School of Nursing and Midwifery, Trinity College Dublin researching ***Diet and physical activity*** in first-time mothers before and during pregnancy and outcomes for women.

The '***Diet and Physical Activity survey***' (as part of the Nutrition and Physical Activity study) of the MAMMI study was offered to women recruited from the Coombe Women and Infants University Hospital, when they were between 30 and 36 weeks pregnant. The survey content was validated by experts.

Among other questions, the 'Diet and Physical Activity survey' contains a Food Frequency Questionnaire (FFQ) to collect women's usual diet since they became pregnant. I am using the Alternate Healthy Eating Index for Pregnancy (AHEI-P) index to assess dietary quality. The AHEI-P was originally developed from the AHEI and adapted for use in pregnancy with the inclusion and exclusion of some components. However, I have adapted the AHEI-P (an American-validated tool) for use in Ireland by including, combining or excluding some components and this is why I value your opinion on its appropriateness, I have attached a document showing the original AHEI-P and the changes that I made.

Please, feel free to write as little or as much as you want, and write down anything that does not make sense to you.

Again, I am really grateful for your time and efforts. Thank you so much for your support.

Kindest Regards

Jamile Marchi

Appendix 4-26: Validation of the AHEI-P in Ireland Protocol sent to experts

The original Alternate Healthy Eating Index for Pregnancy (AHEI-P)

Alternate Healthy Eating Index for Pregnancy (AHEI-P)		
Component	Minimum Score (0)	Maximum score (10)
Vegetables (servings/day)	0	≥5
Fruit (servings/day)	0	≥4
Ratio white meat/red meat	0	≥4
Fibre (g/day)	0	≥25
Trans fats	≥4% RDA	≤0.5% RDA
Ratio Polyunsaturated/saturated	≤0.01	≥1
Calcium (mg)	0	≥1,200
Folate (ug)	0	≥600
Iron (mg)	0	≥27

The AHEI-P has nine components and each component can be scored from 0-10 points according to how far the intake of each component is from the maximum score. For example, women who eat five or more portions of vegetables will get the maximum score of 10 points for this component, and when fruit intake is less than five portions, values are calculated according to an equation. The same calculations are used for all nine components, then totalled so that an individual will receive a diet quality score between 0-90 points. The cut-off scores (for the total score) are: poor quality diet (score <45 points); diet needs Improvement (score = 45-72 points) and high quality diet (score >72 points).

Changes made to the AHEI-P used in my data analysis – The AHEI-P in Ireland

Component	Minimum Score (0)	Maximum score (10) (20)*	NEW AHEIP for Ireland
Fruits and vegetables (servings/day)*	0	≥5	Fruits and vegetables combined: portion size: 5 portions
Ratio white meat/red meat	0	≥4	Unchanged
Fiber (g/day)	0	≥25	Unchanged
Trans fats	≥4% RDA	≤0.5% RDA	Unchanged
Ratio Polyunsaturated/ saturated	≤0.01	≥1	Unchanged
Calcium (mg)	0	≥1,000 (was ≥1,200)	Lowered
Folate (ug)	0	≥400 (was ≥600)	Lowered
Iron (mg)	0	≥16 (was ≥27)	Lowered

Participants' dietary intake was measured by a validated Food Frequency Questionnaire (FFQ) and entered into Nutritics V.3.7 dietary software, so that the food intake could be converted into nutrient measures.

Appropriateness of the AHEI-P in Ireland (Items that were adapted)			
Item	1. This adaption IS APPROPRIATE	2 This adaption IS NOT APPROPRIATE	Comment if you wish, please.
1) Fruits and vegetables: were combined as one component only as the Irish recommendation for fruits and vegetables is "five to seven portions per day" (New Irish food pyramid)			
2) Scoring of the component 'fruits and vegetables': because 'fruits and vegetables' are now combined, this component can receive a maximum score of 20 points. This replaces the original maximum score of 10 point for each (a maximum of 10 points for fruit and a maximum of 10 points for vegetables)			
3) Calcium: in order to score the maximum point (10) participants needed an intake of at least 1000 mg (PRI's EFSA) instead of the American recommendation (≥ 1200 mg)			
4) Folate: in order to score the maximum points (10) participants needed an intake of at least 400 ug (following the recommendations for pregnant women in Ireland) instead of the American recommendations (≥ 600 ug)			
5) Iron: in order to score the maximum points (10) participants needed an intake of at least 16 mg (PRI's, EFSA) instead of the American one (≥ 27)			

6) In order to calculate portion of fruits and vegetables, both discrete portions and disaggregate portions (as in composite foods) were taken into consideration (dried fruits, smoothies, vegetable soups and juices). Dried fruits (30g as one portion), fruit juices (150 ml as one portion), fruits in general (80g as one portion). Same for vegetables in general (80g counts as one portion), vegetables soup (counts as one portion: 350ml) and vegetable dishes (20% of the total intake in grams will be counted as vegetable content)			

The table below is regarding the items that were not adapted for an Irish context, please, comment if you wish.

Appropriateness of the AHEI-P in Ireland (Items that were NOT adapted)			
Item	1. This item IS APPROPRIATE	2 IS this NOT APPROPRIATE	Comment if you wish, please.
Ratio white meat/red meat			
Fibre (g/day)			
Trans fats			
Ratio Polyunsaturated/saturated			

Appendix 4-27: Summary of experts' comments on two of the items modified on the AHEI-P

Appropriateness of the AHEI-P in Ireland (Items that were adapted)	
Item	General comments
1. Fruits and vegetables: were combined as one component only as the Irish recommendation for fruits and vegetables is “five to seven portions per day” (New Irish food pyramid)	<u>Comment Expert 1</u> - If your FFQ has separate fruit and vegetable items I would keep the scores separate for your index. You will be able to learn more from the relative contribution of fruit and vegetable intake to your overall score. The intent of the Irish guidelines is that there should be at least 3 portions of fruit and at least 2 portions of vegetables per day. <u>Comment Expert 3 and 4</u> - The amendment above implies that the target is still just 5 portions? <u>Comment Expert 5</u> - Considering this is in the food pyramid this is appropriate but wonder will the balance of veg to fruit be lost as a signal within the overall score. For example, if someone has 3+ portions of fruit and little or no veg, they will score relatively high for this item. I recognize this is a challenge of using the pyramid and hopefully, the fibre item might help with looking at this aspect.
2. Scoring of the component ‘fruits and vegetables’: because ‘fruits and vegetables’ are now combined, this component can receive a maximum score of 20 points. This replaces the original maximum score of 10 points for each (a maximum of 10 points for fruit and a maximum of 10 points for vegetables)	<u>Comment Expert 1</u> - As per the above: I would recommend the score for fruit and vegetables remains separate. <u>Comment Expert 2</u> - Given that this score is out of 20 now, and that ideally, 7 portions F&V would be consumed daily, I think that the score awarded must reflect lower consumption even if 5 portions per day are consumed i.e. a score of 7/d mixed F&V gets 20 but the scoring needs to reflect the total number of F&V consumed and the mix. <u>Comment Expert 5</u> - This is fine but my comment above does touch on this.

Appendix 4-28: List of food items in each food group – Dietary cluster analysis

White bread and rolls: All breads and rolls made from white flour including French stick, pita, cream crackers, naan bread, ciabatta and chapatti

Brown bread and rolls: All breads and rolls made with brown flour including Irish soda bread

Wholemeal/grain bread and rolls: All breads and rolls made from wholemeal/wholegrain flours including granary bread, rye bread and wholemeal crackers

White pasta and white rice: All white pasta, white rice, noodles and white flours

Wholemeal pasta, wholemeal rice, grains and whole-wheat/wholemeal flour: All wholemeal pasta, wholemeal rice, grains (couscous, quinoa, barley, buckwheat, bulgar wheat, cassava, tapioca) and whole-wheat/wholemeal flour

Refined breakfast cereals: Cornflakes, Rice Krispies, Crunchy Nut Cornflakes, Special K, Frosties, Cocopops, Start, Sugar Puffs, Cereal Bars

Wholegrain breakfast cereals: Branflakes, All-Bran, Wheat and Oat bran, Porridge, Oatflakes, Weetabix, Sultana Bran, Fruit'n Fibre, Cheerios, Ready Brek, Mueslis, Shredded Wheat

Biscuits/buns/pastries/cakes: All biscuits (digestives, Jaffa cakes), buns (hot cross buns, currant buns), cakes (sponge cake, etc.) and pastries (Danish pastries, croissants, etc.)

Cream/ice cream/deserts/puddings: All types of cream, ice cream and deserts and puddings (apple pies, cheesecakes, custard, milkshakes, trifle, banoffee pie, cre`me caramel, mousse)

Yoghurts: All yoghurts including full- and low-fat varieties from cow's/goat's milk

Cheese: All cheeses (cheddar, mozzarella, brie, camembert, cream cheese, goat's cheese, cheese spreads and processed cheeses)

Sugars and preserves: All sugar (white/brown); jams, honey, molasses, treacle, salt and vinegar

Confectionery: All sweets, chocolate, chocolate bars and chocolate spreads

Eggs and egg dishes: All eggs (chickens/duck/quail) and egg dishes (omelette, quiche, etc.)

Butter/full-fat spreads: All butter and spreads that contain .40 % fat

Lower-fat spreads: All spreads that contain 40 % fat or less

Oils: All oils (vegetable oils, olive oil, coconut oil, etc.)

Potatoes: All boiled/baked/mashed potatoes including sweet potato, yam and plantain

Chips: All fried/roasted/chipped potatoes including potato wedges, potato cakes, potato fritters, potato waffles, hash browns, potato croquettes

Beans/lentils/pulses: All high-protein vegetables including beans, bean products (tofu), lentils, pulses (peas, sweet corn)

Other vegetables: All root vegetables (carrots, parsnips) and green leafy vegetables

Fruit: All kinds of fruit (fresh/canned/dried)

Fruit juice: All kinds of fruit juice, freshly squeezed or bottled

White fish and shellfish **White fish and shellfish:** (cod, haddock, plaice, whiting, canned tuna, crab, mussels, etc.), also includes products like fish pate and fish paste

Oily fish: Oily fish (salmon, trout, mackerel, eel, kipper, sardines, fresh tuna, swordfish, anchovies, herring, etc.)

White meat: White meats (chicken, turkey, pork, pheasant, mutton, pigeon)

Red meat: Red meats (beef, lamb, deer, duck, goose, rabbit)

Other meat/meat products: Processed meats (bacon, ham, sausages, pudding); offal (liver and liver pate); meat products (nuggets, kebabs, burgers) and meat pies

Savoury snacks: Savoury snacks such as potato crisps, popcorn, nuts, seeds, pretzels

Sauces, herbs, spices: Herbs (fresh and dried), spices, sauces and dressings (white sauces, pasta sauces, gravy, chutneys, relish)

Soup: Soups, broths and consommés

Savouries: Savoury dishes (Indian and Chinese dishes, savoury pancakes, stews, casseroles, shepherd's pie, etc.)

Low-energy beverages: Includes tea, coffee, sugar free cordials and diet fizzy drinks

High-energy beverages: Includes non-diet fizzy drinks, fruit squashes/cordials, hot chocolate, malted drinks made from milk, etc.

Appendix 4-29: Cluster food groups – Median and mean

Variables	Group 1						Group 2						P-value
	n	Min	Max	Mean	Median	Standard Deviation	n	Min	Max	Mean	Median	Standard Deviation	
White bread and rolls	164	0.0	10.1	2.5	1.9	2.2	393	0.0	9.6	1.1	0.7	1.3	0.000
Brown bread and rolls	164	0.0	8.2	0.9	0.4	1.3	393	0.0	13.8	1.2	0.5	1.7	0.000
Wholemeal/grain bread and rolls	164	0.0	10.4	1.1	0.5	1.5	393	0.0	13.1	1.7	1.2	2.1	0.040
White pasta and rice	164	1.1	35.4	4.5	3.5	3.6	393	0.0	18.5	3.8	3.0	2.5	0.000
Wholemeal pasta and rice	164	0.0	10.9	1.5	0.9	1.5	393	0.0	17.7	2.9	2.0	2.6	0.013
Refined breakfast cereal	164	0.0	22.0	1.4	0.4	2.3	393	0.0	6.9	0.5	0.2	0.8	0.000
Wholegrain breakfast cereal	164	0.0	11.9	2.7	2.4	1.9	393	0.0	27.2	4.3	4.1	2.9	0.000
Biscuits/buns/pastries/cakes	164	0.0	23.6	5.9	4.9	3.9	393	1.3	25.2	5.4	4.1	3.7	0.113
Cream/Ice cream/desert and pudding	164	0.5	10.9	3.3	2.9	1.7	393	0.3	16.6	3.4	2.9	1.8	0.628
Yoghurt	164	0.0	7.5	1.3	0.6	1.5	393	0.0	16.0	2.8	2.6	2.8	0.000
Cheese	164	0.0	8.5	2.1	1.5	1.7	393	0.0	19.5	3.1	2.9	2.6	0.000
Sugar and preserves	164	0.1	8.8	1.0	0.6	1.2	393	0.0	5.9	0.7	0.5	0.8	0.002
Confectionery	164	0.1	40.9	5.2	4.6	4.7	393	0.0	26.1	4.7	3.8	4.4	0.285
Eggs/Egg dishes	164	0.0	6.1	1.4	1.2	0.8	393	0.0	21.6	2.1	1.8	1.9	0.000
Butter/full fat spread	164	0.0	9.4	1.3	0.9	1.4	393	0.0	6.6	0.9	0.7	1.0	0.001
Lower fat spread	164	0.0	1.9	0.1	0.1	0.2	393	0.0	2.9	0.2	0.1	0.3	0.190
Oils	164	0.0	0.8	0.1	0.0	0.1	393	0.0	2.9	0.1	0.0	0.3	0.037

Potatoes	164	0.8	15.9	4.5	4.1	2.5	393	0.0	12.6	3.6	3.2	2.0	0.000
Potatoes chips	164	0.5	15.4	4.7	3.3	3.2	393	0.0	10.7	1.9	1.7	1.2	0.000
Beans, lentils and pulses	164	0.2	7.0	1.4	1.1	0.9	393	0.1	8.3	1.7	1.4	1.2	0.001
Other vegetables	164	1.7	9.8	3.9	3.7	1.4	393	1.9	16.0	5.6	5.2	2.0	0.000
Fruits	164	0.0	18.6	5.1	4.6	3.1	393	1.0	31.3	9.1	8.2	4.7	0.000
Fruit juices	164	0.0	36.5	7.3	6.0	6.6	393	0.0	28.1	4.3	2.2	4.7	0.000
White fish and shellfish	164	0.0	1.1	0.2	0.2	0.2	393	0.0	2.0	0.4	0.3	0.3	0.000
Oily fish	164	0.0	10.4	2.9	2.6	1.4	393	0.0	17.8	3.6	3.3	1.9	0.000
White meat	164	0.0	26.6	6.0	5.6	3.1	393	0.0	19.9	5.0	4.7	2.4	0.000
Red meat	164	0.0	9.5	3.7	3.3	1.8	393	0.0	12.0	3.9	3.5	1.8	0.347
Other meat/meat products	164	0.0	17.1	4.0	3.5	2.1	393	0.0	12.7	3.3	3.0	1.7	0.000
Savoury snacks	164	0.2	17.8	4.6	3.7	3.6	393	0.7	35.6	4.8	3.4	4.1	0.563
Sauces, herbs and spices	164	0.5	14.4	3.7	2.9	2.3	393	0.1	13.1	3.5	3.1	1.8	0.286
Soup	164	0.0	9.3	1.5	1.2	1.1	393	0.0	18.7	2.2	1.5	1.8	0.000
Savouries	164	2.3	22.6	6.8	6.2	3.1	393	0.0	24.8	6.2	5.9	2.2	0.025
Low-energy beverages	164	0.0	0.3	0.1	0.1	0.1	393	0.0	0.6	0.1	0.1	0.1	0.001
High-energy beverages	164	0.3	29.7	3.5	2.2	4.0	393	0.0	16.0	1.5	0.8	1.8	0.000

Appendix 5-1: Qualification breakdown of participants from the ‘Diet and dietary patterns during pregnancy in nulliparous women in Ireland’ study

Characteristics	<i>n</i>	%
<i>Highest qualification level (n=553)</i>		
No formal qualifications	1	0.2
Lower secondary	1	0.2
Junior Certificate/ O levels/ General Certificate of Secondary Education (GCSE), National Council for Vocational Awards/National Foundation Certificate (NCVA)	8	1.4
Upper secondary Leaving Certificate - applied and vocation programmes, A Levels, National Foundation Certificate (NCVA) level 1	34	6.1
Completed apprenticeship, National Foundation Certificate (NCVA) level 2/3, Teagasc certificate, diploma or equivalent	25	4.5
Both upper secondary and technical or vocational qualification	20	3.6
National certificate, National Certificate of Educational Achievement (diploma NCEA)/ Institute of Technology or equivalent, Nursing Diploma	34	6.1
Primary degree	114	20.4
Professional qualification of degree status	64	11.5
Postgraduate certificate or diploma	89	16.0
Postgraduate degree Masters	137	24.6
Doctorate PhD	26	4.7
Missing	4	0.7

Appendix 5-2: Type of maternity care service used (and whether holding private insurance or not)

Type of care	n	%
Type of care (n=537)		
Private care (private health insurance)	117	21.8
Semi-private care (private health insurance)	88	16.4
Public care (but had private health insurance)	117	21.8
Public care (no private health insurance)	215	40.0

Appendix 5-3: Tables section 5.4.2 Health, health perception and mental health before and during pregnancy

Table: Factors that would improve self-perceived health before pregnancy

Before pregnancy	n	%
To improve health (n=553)		
Less stress	265	47.9
Lose weight	155	28.0
More willpower	81	14.6
A different job	78	14.1
Less alcohol	76	13.7
More money	69	12.5
Less/stop smoking	55	9.9
Fewer changes in life	32	5.8
Less international/national pollution	31	5.6
Less local pollution	26	4.7
Employment	23	4.2
Regular doctor checks	20	3.6
Someone to talk to	18	3.3
Less time in smoky places	16	2.9
Better information about how to stay healthy	13	2.4
Better information about where to go for health care	8	1.4
Gain weight	6	1.1
"Easier to read" health information	4	0.7

Table: Before pregnancy self-perceived general health

Before pregnancy	n	%
Self-perceived health (n=552)		
Excellent	162	29.3
Very good	288	52.2
Good	82	14.9
Fair	14	2.5
Bad or very bad	6	1.1

Appendix 5-4: Pre-pregnancy Body Mass Index (BMI) and satisfaction with body image before and during pregnancy

Body mass index (BMI kg/m²) before pregnancy

Pre-pregnancy BMI	n	%
BMI Categories (n=542)		
Underweight (<18.5 kg/m ²)	20	3.7
Normal weight/Ideal (18.5-24.9 kg/m ²)	352	64.9
Overweight (25-29.9 kg/m ²)	122	22.5
Obese (≥30 kg/m ²)	48	8.9

Appendix 5-5: Tables from sections 5.4.4 Physical Activity before - during pregnancy and section 5.4.5 Alcohol intake and cigarette smoking before and during pregnancy

Table: Physical activity advice during pregnancy

Advice during pregnancy	n	%
On taking exercise (n=548)		
Yes	254	46.4
No	294	53.6

Table: Cigarette smoking and alcohol behaviours before and during pregnancy

Alcohol intake and cigarette smoking	n	%
Alcohol intake (n=551)		
Drink once in a while (still drinking alcohol)	38	6.9
Stopped drinking alcohol when pregnant	387	70.2
Never drank alcohol or stopped before pregnancy	126	22.9
Smoking behaviour (cigarettes) (n=550)		
Smoke regularly - about the same as before finding out about the pregnancy (still smoking)	21	3.8
Stopped smoking when finding out about the pregnancy	53	9.6
Never smoked or stopped smoking before pregnancy	476	86.6

Appendix 5-6: Nausea, vomiting, cravings and aversions during pregnancy

Nausea, vomiting, cravings and aversions during pregnancy		n	%
Nausea (n=557)			
	Yes	408	73.2
	No	149	26.8
Vomiting (n=557)			
	Yes	254	45.6
	No	303	54.4
Cravings (n=555)			
	Yes	309	55.7
	No	246	44.3
Aversion (n=552)			
	Yes	302	54.7
	No	250	45.3

Appendix 5-7: Tables from section 5.4.7 Advice on diet, dietary supplements and physical activity during pregnancy

Table: Dietary advice during pregnancy

Advice during pregnancy	n	%
On what to stop eating/drinking (n=553)		
Yes	395	71.4
No	158	28.6
On what to start eating/drinking (n=555)		
Yes	237	42.7
No	318	57.3
On dietary supplements (n=554)		
Yes	417	75.3
No	137	24.7
Would have liked more information about diet during pregnancy (n=553)		
Yes	224	40.5
No	329	59.5

Table: Source of dietary advice

Source of Advice	What to eat/not to eat (n=469)	Dietary supplement intake (n=417)
	n%	n%
General practitioner	253 (53.9)	295 (70.7)
Public Health Nurse	27 (5.8)	13 (3.1)
GP practice Nurse	38 (8.1)	29 (6.9)
Dietitian	71 (15.1)	20 (4.8)
Midwife	193 (41.2)	173 (41.2)
Mother	134 (28.6)	49 (11.7)
Internet	316 (67.4)	76 (18.1)

Appendix 5-8: Tables from section 5.4.9 Breastfeeding intention and section 5.4.10 Diet changes: before and during pregnancy

Table: Breastfeeding advice during pregnancy

Advice during pregnancy	n	%
On breastfeeding (n=553)		
Yes	355	64.2
No	198	35.8

Table: Type of diets followed before and during pregnancy

Type of diet	Before pregnancy (n=153)		During pregnancy (n=83)	
	n	%	n	%
Weight loss	79	51.6	0	0.0
Vegetarian	22	14.4	23	27.7
Vegan	8	5.2	2	2.4
Control diabetes	1	0.7	24	28.9
Gluten free	23	15.0	14	16.9
Cholesterol lowering	3	2.0	2	2.4

Table: Perceived quality of diet before pregnancy

Before pregnancy	n	%
Diet quality (n=555)		
Very healthy	49	8.8
Healthy	326	58.7
Fair	163	29.4
Not so good	14	2.5
Bad	2	0.4
Other	1	0.2

Table: Number of meals per week (intake), before and during pregnancy

Meals per week	Before pregnancy		During pregnancy	
	Breakfast (n=557)		Breakfast (n=552)	
	n	%	n	%
Every day	420	75.7	490	88.8
1-3 times a week	67	12.1	16	2.8
4-6 times a week	52	9.4	44	8.0
Never	16	2.9	2	0.4
	Morning snack (n=502)		Morning snack (n=512)	
	n	%	n	%
Every day	151	30.1	238	46.5
1-3 times a week	191	38	142	27.7
4-6 times a week	81	16.1	110	21.5
Never	79	15.7	22	4.3
	Lunch (n=552)		Lunch (n=550)	
	n	%	n	%
Every day	442	80.1	481	87.5
1-3 times a week	21	3.8	14	2.5
4-6 times a week	88	15.9	55	10
Never	1	0.2	0	0
	Afternoon snack (n=498)		Afternoon snack (n=515)	
	n	%	n	%
Every day	101	20.3	191	37.1
1-3 times a week	245	49.2	206	40
4-6 times a week	66	13.3	87	16.9
Never	86	17.3	31	6
	Dinner (n=554)		Dinner (n=550)	
	n	%	n	%
Every day	470	84.8	469	85.3
1-3 times a week	17	3.1	15	2.7
4-6 times a week	67	12.1	66	12
Never	0	0.0	0	0
	Night snack (n=500)		Night snack (n=557)	
	n	%	n	%
Every day	91	18.2	156	30.3
1-3 times a week	258	51.6	235	45.6
4-6 times a week	61	12.2	72	14
Never	90	18	52	10.1

Table: Self-reported changes in the frequency of consumption of food items/groups, from before to during pregnancy

Since pregnancy	Started		Same		More		Less		Stopped		Never	
	n	%	n	%	n	%	n	%	n	%	n	%
Milk, dairy products, cheese (n=553)	16	2.9	226	40.9	274	49.5	29	5.2	8	1.4	0	0.0
Bread, cereals (n=553)	12	2.2	269	48.6	251	45.4	18	3.3	1	0.2	2	0.4
Biscuits (n=549)	6	1.1	235	42.8	173	31.5	101	18.4	10	1.8	24	4.4
Fat (n=550)	1	0.2	339	61.6	99	18.0	97	17.6	3	0.5	11	2.0
Meat (n=554)	5	0.9	368	66.4	84	15.2	73	13.2	3	0.5	21	3.8
Fish (n=554)	7	1.3	242	43.7	157	28.3	96	17.3	10	1.8	42	7.6
Eggs (n=554)	3	0.5	298	53.8	122	22.0	106	19.1	11	2.0	14	2.5
Vegetables (n=553)	2	0.4	324	58.6	178	32.2	43	7.8	0	0.0	6	1.1
Fruits (n=553)	3	0.5	189	34.2	330	59.7	25	4.5	1	0.2	5	0.9
Chocolate (n=555)	1	0.2	203	36.6	223	40.2	106	19.1	16	2.9	6	1.1
Other sweets (n=547)	4	0.7	223	40.8	147	26.9	125	22.9	19	3.5	29	5.3
Coffee (n=555)	1	0.2	54	9.7	3	0.5	223	40.2	107	19.3	167	30.1
Tea (n=555)	8	1.4	184	33.2	36	6.5	250	45.0	20	3.6	57	10.3
Juice (n=553)	11	2.0	228	41.2	181	32.7	73	13.2	13	2.4	47	8.5
Soft drinks with sugar (n=553)	5	0.9	123	22.2	53	9.6	153	27.7	39	7.1	180	32.5
Sugar free soft drinks (n=552)	2	0.4	151	27.4	54	9.8	135	24.5	31	5.6	179	32.4
Water intake (n=555)	-	-	220	39.6	288	51.9	47	8.5	-	-	-	-

Appendix 5-9: Macronutrients adequacy according to the European Food and Safety Authority (2017) guidelines

Diet adequacy	Carbohydrates		Protein		Fat	
	n	%	n	%	n	%
Macronutrients adequacy (n=557)	(45-60%)		(12-20%)		(20-35%)	
Mean intake (Standard Deviation)	45.60% (5.56)		18.4% (2.84)		35% (4.24)	
Below recommendations	204	36.6	2	0.4	1	0.2
Meets recommendations	345	61.9	417	74.9	282	50.6
Above recommendations	8	1.4	138	24.8	274	49.2

Appendix 5-10: Cluster food groups – Median and mean:

Food groups (%E)	Group 1						Group 2						P-value
	n	Min	Max	Mean	Median	Standard Deviation	n	Min	Max	Mean	Median	Standard Deviation	
White bread and rolls	164	0.0	10.1	2.5	1.9	2.2	393	0.0	9.6	1.1	0.7	1.3	0.000
Brown bread and rolls	164	0.0	8.2	0.9	0.4	1.3	393	0.0	13.8	1.2	0.5	1.7	0.000
Wholemeal/grain bread and rolls	164	0.0	10.4	1.1	0.5	1.5	393	0.0	13.1	1.7	1.2	2.1	0.040
White pasta and rice	164	1.1	35.4	4.5	3.5	3.6	393	0.0	18.5	3.8	3.0	2.5	0.000
Wholemeal pasta and rice	164	0.0	10.9	1.5	0.9	1.5	393	0.0	17.7	2.9	2.0	2.6	0.013
Refined breakfast cereal	164	0.0	22.0	1.4	0.4	2.3	393	0.0	6.9	0.5	0.2	0.8	0.000
Wholegrain breakfast cereal	164	0.0	11.9	2.7	2.4	1.9	393	0.0	27.2	4.3	4.1	2.9	0.000
Biscuits/buns/pastries/cakes	164	0.0	23.6	5.9	4.9	3.9	393	1.3	25.2	5.4	4.1	3.7	0.113
Cream/Ice cream/desert and pudding	164	0.5	10.9	3.3	2.9	1.7	393	0.3	16.6	3.4	2.9	1.8	0.628
Yoghurt	164	0.0	7.5	1.3	0.6	1.5	393	0.0	16.0	2.8	2.6	2.8	0.000
Cheese	164	0.0	8.5	2.1	1.5	1.7	393	0.0	19.5	3.1	2.9	2.6	0.000
Sugar and preserves	164	0.1	8.8	1.0	0.6	1.2	393	0.0	5.9	0.7	0.5	0.8	0.002
Confectionery	164	0.1	40.9	5.2	4.6	4.7	393	0.0	26.1	4.7	3.8	4.4	0.285
Eggs/Egg dishes	164	0.0	6.1	1.4	1.2	0.8	393	0.0	21.6	2.1	1.8	1.9	0.000
Butter/full fat spread	164	0.0	9.4	1.3	0.9	1.4	393	0.0	6.6	0.9	0.7	1.0	0.001
Lower fat spread	164	0.0	1.9	0.1	0.1	0.2	393	0.0	2.9	0.2	0.1	0.3	0.190
Oils	164	0.0	0.8	0.1	0.0	0.1	393	0.0	2.9	0.1	0.0	0.3	0.037

Potatoes	164	0.8	15.9	4.5	4.1	2.5	393	0.0	12.6	3.6	3.2	2.0	0.000
Potatoes chips	164	0.5	15.4	4.7	3.3	3.2	393	0.0	10.7	1.9	1.7	1.2	0.000
Beans, lentils and pulses	164	0.2	7.0	1.4	1.1	0.9	393	0.1	8.3	1.7	1.4	1.2	0.001
Other vegetables	164	1.7	9.8	3.9	3.7	1.4	393	1.9	16.0	5.6	5.2	2.0	0.000
Fruits	164	0.0	18.6	5.1	4.6	3.1	393	1.0	31.3	9.1	8.2	4.7	0.000
Fruit juices	164	0.0	36.5	7.3	6.0	6.6	393	0.0	28.1	4.3	2.2	4.7	0.000
White fish and shellfish	164	0.0	1.1	0.2	0.2	0.2	393	0.0	2.0	0.4	0.3	0.3	0.000
Oily fish	164	0.0	10.4	2.9	2.6	1.4	393	0.0	17.8	3.6	3.3	1.9	0.000
White meat	164	0.0	26.6	6.0	5.6	3.1	393	0.0	19.9	5.0	4.7	2.4	0.000
Red meat	164	0.0	9.5	3.7	3.3	1.8	393	0.0	12.0	3.9	3.5	1.8	0.347
Other meat/meat products	164	0.0	17.1	4.0	3.5	2.1	393	0.0	12.7	3.3	3.0	1.7	0.000
Savoury snacks	164	0.2	17.8	4.6	3.7	3.6	393	0.7	35.6	4.8	3.4	4.1	0.563
Sauces, herbs and spices	164	0.5	14.4	3.7	2.9	2.3	393	0.1	13.1	3.5	3.1	1.8	0.286
Soup	164	0.0	9.3	1.5	1.2	1.1	393	0.0	18.7	2.2	1.5	1.8	0.000
Savouries	164	2.3	22.6	6.8	6.2	3.1	393	0.0	24.8	6.2	5.9	2.2	0.025
Low-energy beverages	164	0.0	0.3	0.1	0.1	0.1	393	0.0	0.6	0.1	0.1	0.1	0.001
High-energy beverages	164	0.3	29.7	3.5	2.2	4.0	393	0.0	16.0	1.5	0.8	1.8	0.000

Appendix 5-11: Tables from section 5.6 Part IV: Descriptive findings from pregnancy, birth, neonatal and postpartum outcome variables

Table: Comparison of average gestational weight gain by BMI group

BMI groups	Pre-pregnancy mean± SD	End of pregnancy mean± SD	Average GWG	Recommended values (IOM 2009)
Total sample (n=542)	65.3 ± 12.5	77.9 ± 14.4	12.6	
Underweight (<18.5 kg/m ²) (n=20)	50.0 ± 3.2	60.6 ± 6.2	10.6	12.5–18 kg
Normal weight/Ideal (18.5-24.9 kg/m ²) (n=351)	60.1 ± 6.1	73.8 ± 11.5	13.7	11.5–16 kg
Overweight (25-29.9 kg/m ²) (n=122)	72.9 ± 6.5	85.8 ± 12.7	12.9	7–11.5 kg
Obese (≥30 kg/m ²) (n=49)	91.1 ± 14.2	96.5 ± 13.4	5.4	5–9 kg

Table: Mode of birth

Mode of birth (n=556)	n	%
Spontaneous vaginal birth	197	35.5
Instrumental vaginal birth	174	31.3
Caesarean section - planned (elective)	53	9.5
Caesarean section - unplanned (emergency)	132	23.7

Table: Infant's weight at birth

Weight at birth (n=556)	n	%
<2.5 kg	22	4.0
2.5 to 4 kg	463	83.2
≥4 kg	71	12.8

Table: Source of breastfeeding advice

Source of advice	Breastfeeding (n=355)
	n%
General practitioner	71 (18.9)
Public Health Nurse	28 (7.5%)
GP practice Nurse	21 (5.6%)
Dietitian	3 (0.8%)
Midwife	220 (58.8%)
Mother	105 (28.1%)
Internet	156 (41.7%)

Appendix 5-12: Omnibus and Hosmer and Lemeshow tests

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Omnibus and Hosmer and Lemeshow tests

Pre-pregnancy predictors of dietary pattern/quality during pregnancy – multivariable analysis (Table 5-30). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
39.200	6	0.000	5.116	7	0.646

Omnibus and Hosmer and Lemeshow tests

Pregnancy predictors of dietary pattern/quality during pregnancy – multivariable analysis - amount of walking time per week (Table 5-32). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
25.665	4	0.000	1.067	3	0.785

Omnibus and Hosmer and Lemeshow tests

Pregnancy predictors of dietary pattern/quality during pregnancy – multivariable analysis – amount of moderate physical activity time per week (Table 5-34). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
24.645	4	0.000	1.293	3	0.731

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and socio-demographic/economic predictors of breastfeeding initiation – multivariable analysis (Table 5-39). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
92.622	7	0.000	8.153	8	0.419

Omnibus and Hosmer and Lemeshow tests

Diet pattern/quality during pregnancy and socio-demographic/economic predictors for exploring associations with breastfeeding at 3 months postpartum – multivariable analysis (Table 5-41). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
48.739	7	0.000	11.268	7	0.127

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and socio-behavioural changes predictors for exploring associations with breastfeeding at 3 months postpartum – multivariable analysis (Table 5-42). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
14.992	3	0.002	3.939	2	0.140

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and behaviour/attitude predictors for exploring associations with breastfeeding at 3 months postpartum – amount of walking time per week – multivariable analysis (Table 5-43). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
11.801	2	0.003	0.000	1	1.000

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and behaviour/attitude predictors for exploring associations with breastfeeding at 3 months postpartum – amount of moderate physical activity time per week – multivariable analysis (Table 5-44). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
13.869	2	0.001	0.000	1	1.000

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and postpartum mental health predictors for exploring associations with breastfeeding at 3 months postpartum – multivariable analysis (Table 5-45). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
25.839	3	0.000	1.979	3	0.577

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and final predictors for exploring breastfeeding at 3 months postpartum – amount of walking time per week – multivariable analysis (Table 5-46).

Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
65.693	8	0.000	6.395	8	0.604

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and final predictors for exploring breastfeeding at 3 months postpartum – amount of moderate physical activity time per week – multivariable analysis (Table 5-47). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
62.177	8	0.000	8.056	8	0.427

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Omnibus and Hosmer and Lemeshow tests

Pre-pregnancy socio-demographic/economic predictors of dietary patterns/quality during pregnancy – multivariable analysis (Table 5-51). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
71.004	10	0.000	8.489	7	0.291

Omnibus and Hosmer and Lemeshow tests

Pre-pregnancy behaviour predictors of dietary patterns/quality during pregnancy – multivariable analysis (Table 5-52). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
61.243	6	0.000	5.194	7	0.636

Omnibus and Hosmer and Lemeshow tests

Pre-pregnancy mental health predictors of dietary patterns/quality during pregnancy – multivariable analysis (Table 5-53). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
10.533	2	0.005	0.000	1	1

Omnibus and Hosmer and Lemeshow tests

Final pre-pregnancy predictors of dietary pattern/quality during pregnancy – multivariable analysis (Table 5-54). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
94.3888	10	0.000	3.450	8	0.903

Omnibus and Hosmer and Lemeshow tests

Pregnancy socio-behavioural predictors of dietary patterns/quality during pregnancy – amount of walking time per week – multivariable analysis (Table 5-56). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
51.482	6	0.000	2.917	6	0.819

Omnibus and Hosmer and Lemeshow tests

Pregnancy socio-behavioural predictors of dietary patterns/quality during pregnancy – amount of moderate physical activity time per week - multivariable analysis (Table 5-57). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
82.905	6	0.000	3.012	7	0.884

Omnibus and Hosmer and Lemeshow tests

Pregnancy behaviour/attitude predictors of dietary patterns/quality during pregnancy - multivariable analysis (Table 5-58). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
23.716	2	0.000	0.143	1	0.705

Omnibus and Hosmer and Lemeshow tests

Pregnancy mental health predictors of dietary patterns/quality during pregnancy - multivariable analysis (Table 5-59). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
9.320	2	0.009	0.000	1	1.000

Omnibus and Hosmer and Lemeshow tests

Final pregnancy predictors of dietary pattern/quality during pregnancy – amount of walking time per week - multivariable analysis (Table 5-60). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
103.595	12	0.000	2.326	8	0.969

Omnibus and Hosmer and Lemeshow tests

Pregnancy predictors of dietary pattern/quality during pregnancy – amount of moderate physical activity time per week - multivariable analysis (Table 5-61). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
122.420	12	0.000	3.990	8	0.858

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and socio-demographic/economic predictors for exploring breastfeeding initiation - multivariable analysis (Table 5-85). Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
94.854	5	0.000	1.594	6	0.953

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and socio-demographic/economic predictors for exploring breastfeeding at 3 months postpartum - multivariable analysis. Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
57.130	7	0.000	10.067	8	0.260

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and socio-behavioural changes predictors for exploring breastfeeding at 3 months postpartum - multivariable analysis. Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
32.908	3	0	0.033	2	0.984

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and behaviour/attitude predictors for exploring breastfeeding at 3 months postpartum – amount of walking time per week - multivariable analysis. Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
34.066	3	0	1.608	2	0.448

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and behaviour/attitude predictors for exploring breastfeeding at 3 months postpartum – amount of moderate physical activity time per week – multivariable analysis. Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
27.927	1	0.000	0.000	0	-

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and postpartum mental health predictors for exploring breastfeeding at 3 months postpartum – multivariable analysis. Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
46.414	4	0.000	1.570	5	0.905

Omnibus and Hosmer and Lemeshow tests

Dietary pattern/quality during pregnancy and final predictors for exploring breastfeeding at 3 months postpartum – multivariable analysis. Omnibus and Hosmer and Lemeshow tests.

Omnibus Tests of Model Coefficients			Hosmer and Lemeshow Test		
Chi-square	df	p-value	Chi-square	df	p-value
71.019	8	0.000	1.729	8	0.988

Appendix 5-13: Multivariable regression analysis models – sub-groups for Dietary pattern/quality multivariable regression analysis models for exploring associations with breastfeeding at 3 months postpartum – according to the AHEI-P (in Ireland)

The first logistic regression model containing the variables related to socio-demographic/economic factors. Participants aged up to 29 years (AOR 0.3, 95% CI 0.2-0.6, $p=0.000$), participants who were educated to Leaving certificate/vocational level (AOR 0.4, 95% CI 0.2-0.7, $p=0.002$), participants who were in the diet that needs improvement group (AOR 0.6, 95% CI 0.4-0.9, $p=0.047$) and non-Irish participants (AOR 0.6, 95% CI 0.4-0.9, $p=0.035$) were statistically significantly less likely to be breastfeeding at 3 months postpartum. There was no association between breastfeeding at 3 months postpartum and relationship status.

Appendix 5-14: Multivariable regression analysis models – sub-groups for pre-pregnancy and dietary pattern/quality multivariable regression analysis sub-models – according to Cluster analysis

The multivariable logistic regression model analysing the pre-pregnancy socio-demographic/economic variables. Pre-pregnancy socio-demographic/economic factors that were significantly associated with having a diet that needed improvement during pregnancy were: being aged up to 29 years (AOR 2.8, 95% CI 1.6-4.8, $p=0.000$), being single (AOR 2.6, 95% CI 1.2-5.7, $p=0.016$), having a Leaving Certificate/vocational level of education (AOR 2.6, 95% CI 1.5-4.4, $p=0.000$), and being overweight (AOR 2.1, 95% CI 1.2-3.3, $p=0.005$). There was no significant association between employment status or type of health insurance.

Pre-pregnancy socio-demographic predictors of dietary patterns/quality during pregnancy

Pre-pregnancy variables	Total n	Health conscious diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Age group	557	393	%	164	%				
Up to 29 years	103	47	45.6	56	54.4	0.000	2.8	1.6	4.8
30 to 34 years	257	202	78.6	55	21.4	1.0 (ref)			
35 years or more	197	144	73.1	53	26.9	0.272	1.3	0.8	2.1
Relationship status	554	390	%	164	%				
Married or living with partner	500	364	72.8	136	27.2	1.0 (ref)			
In a relationship - not living with partner	43	20	46.5	23	53.5	0.746	1.2	0.3	4.4
Single	11	6	54.5	5	45.5	0.016	2.6	1.2	5.7
Education level	553	390	%	163	%				
Junior Cert or less	10	6	60	4	40.0	0.842	1.2	0.3	5.2
Leaving Cert/Vocational	113	55	48.7	58	51.3	0.000	2.6	1.5	4.4
Primary degree/PG	267	199	74.5	68	25.5	1.0 (ref)			
MSc/PhD	163	130	79.8	33	20.2	0.523	0.8	0.5	1.4
Pre-pregnancy BMI	542	387	%	155	%				
Underweight	20	14	70	6	30.0	0.644	1.3	0.4	3.9
Ideal	354	276	78	78	22.0	1.0 (ref)			
Overweight	119	70	58.8	49	41.2	0.005	2.1	1.2	3.3
Obese	49	27	55.1	22	44.9	0.085	1.8	0.9	3.7

Below, the behaviour logistic regression model containing the pre-pregnancy behaviour variables. All pre-pregnancy behaviour variables showed statistically significant association with having a diet during pregnancy that needed improvement: not exercising before pregnancy (AOR 2.5, 95% CI 1.4-4.5, p=0.001), sometimes (AOR 2.1, 95% CI 1.2-3.6, p=0.008) or never reading food labels (AOR 4.8, 95% CI 2.4-9.7, p=0.000), not taking any dietary supplement before pregnancy (Adjusted OR 1.8, 95% CI 1.2-2.7, p=0.005), and being sometimes (AOR 2.0, 95% CI 1.2-3.1, p=0.004) or never satisfied with body image (AOR 2.9, 95% CI 1.2-6.6, p=0.015).

Pre-pregnancy behaviour predictors of dietary patterns/quality during pregnancy

Pre-pregnancy variables	Total n	Health conscious diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Exercise before pregnancy	552	390	%	162	%				
Yes	488	360	73.8	128	26.2	1.0 (ref)			
No	64	30	46.9	34	53.1	0.001	2.5	1.4	4.5
Reads food labels	557	393	%	164	%				
Yes, always	123	103	83.7	20	16.3	1.0 (ref)			
Yes, sometimes	361	256	70.9	105	29.1	0.008	2.1	1.2	3.6
No, never	73	34	46.6	39	53.4	0	4.8	2.4	9.7
Dietary supplement intake	554	391	%	163	%				
Yes	309	235	76.1	74	23.9	1.0 (ref)			
No	245	156	63.7	89	36.3	0.005	1.8	1.2	2.7
Body image satisfaction	554	390	%	164	%				
Yes, always	167	133	79.6	34	20.4	1.0 (ref)			
Yes, sometimes	354	237	66.9	117	33.1	0.004	2	1.2	3.1
No, never	33	20	60.6	13	39.4	0.015	2.9	1.2	6.6

Below, the mental health logistic regression model. The only variable statistically significantly associated with having a diet during pregnancy that needed improvement was being sometimes (AOR 1.9, 95% CI 1.2-3.0, p=0.004) or never (AOR 2.5, 95% CI 1.1-5.6, p=0.022) satisfied with body image.

Pre-pregnancy mental health predictors of dietary patterns/quality during pregnancy

Pre-pregnancy variables	Total n	Health conscious diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Body image satisfaction	554	390	%	164	%				
Yes, always	167	133	79.6	34	20.4	1.0 (ref)			
Yes, sometimes	354	237	66.9	117	33.1	0.004	1.9	1.2	3.0
No, never	33	20	60.6	13	39.4	0.022	2.5	1.1	5.6

Appendix 5-15: Multivariable regression analysis models – sub-groups for pregnancy and dietary pattern/quality multivariable regression analysis submodels – according to Cluster analysis

Below, the socio-behavioural changes logistic regression model containing the pregnancy socio-behaviour changes variables. The socio-behaviour variables significantly associated with having a diet during pregnancy that needed improvement were: still smoking during pregnancy (AOR 9.9, 95% CI 3.4-28.5, p=0.000), stopped drinking alcohol during pregnancy (AOR 2.1, 95% CI 1.2-3.4, p=0.007), walking for less <150 minutes (AOR 1.6, 95% CI 1.1-2.5, p=0.026) and not walking (AOR 4.0, 95% CI 2.1-7.6, p=0.000).

Pregnancy socio-behavioural predictors of dietary patterns/quality during pregnancy – amount of walking time per week

Pregnancy variables	Total n	Health conscious diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Smoking behaviour	550	387	%	163	%				
Never/stopped	476	351	73.7	125	26.3	1.0 (ref)			
Stopped smoking during pregnancy	53	31	58.5	22	41.5	0.079	1.7	0.9	3.2
Still smoking	21	5	23.8	16	76.2	0.000	9.9	3.4	28.5
Alcohol use (drinking behaviour)	551	389	%		%				
Never/stopped	126	101	80.2	25	19.8	1.0 (ref)			
Stopped drinking alcohol during pregnancy	387	259	66.9	128	33.1	0.007	2.1	1.2	3.4
Still drinking alcohol	38	29	76.3	9	23.7	0.927	1.1	0.4	2.7
Walking	552								
≥150 minutes	208	163	78.4	45	21.6	1.0 (ref)			
<150 minutes	285	198	69.5	87	30.5	0.026	1.6	1.1	2.5
None	59	28	47.5	31	52.5	0.000	4.0	2.1	7.6

Below, the socio-behavioural changes variables significantly associated with having a diet during pregnancy that needed improvement were: still smoking during pregnancy (AOR 9.1, 95% CI 3.0-27.6, p=0.000), stopped drinking alcohol during pregnancy (AOR 2.4, 95% CI 1.4-4.1, p=0.002), taking <150 minutes (AOR 2.7, 95% CI 1.2-6.1, p=0.017) and no moderate physical activity (AOR 8.3, 95% CI 3.4-18.4, p=0.000).

Pregnancy socio-behavioural predictors of dietary patterns/quality during pregnancy – amount of moderate physical activity time per week

Pregnancy variables	Total n	Health conscious diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
Smoking behaviour	550	387	%	163	%				
Never/stopped	476	351	73.7	125	26.3	1.0 (ref)			
Stopped smoking during pregnancy	53	31	58.5	22	41.5	0.233	1.5	0.8	2.9
Still smoking	21	5	23.8	16	76.2	0.000	9.1	3.0	27.6
Alcohol use	551	389	%	162	%				
Never/stopped	126	101	80.2	25	19.8	1.0 (ref)			
Stopped drinking alcohol during pregnancy	387	259	66.9	128	33.1	0.002	2.4	1.4	4.1
Still drinking alcohol	38	29	76.3	9	23.7	0.740	1.2	0.4	3.2
Moderate PA	545	388	%	157	%				
≥150 minutes	93	85	91.4	8	8.6	1.0 (ref)			
<150 minutes	215	170	79.1	45	20.9	0.017	2.7	1.2	6.1
None	237	133	56.1	104	43.9	0.000	8.3	3.4	18.4

Below, the logistic regression model containing the pregnancy behaviour/attitude variables. Factors significantly associated with having a diet during pregnancy that needed improvement were: vomiting during pregnancy (AOR 2.3, 95% CI 1.5-3.3, $p=0.000$) and not taking any dietary supplement during pregnancy (AOR 2.1, 95% CI 1.1-3.9, $p=0.018$). There was no association between experiencing nausea during pregnancy, or not receiving dietary advice and dietary pattern/quality during pregnancy, and having a diet during pregnancy that needed improvement.

Pregnancy behaviour/attitude predictors of dietary patterns/quality during pregnancy

Pregnancy variables	Total	Health conscious diet		Needs improvement diet		p-value	AOR	CI 95%	
		n	%	n	%			Lower	Upper
	Vomiting during pregnancy	557	393	%	164	%			
No	303	237	78.2	66	21.8	1.0 (ref)			
Yes	254	156	61.4	98	38.6	0.000	2.3	1.5	3.3
Dietary supplement intake during pregnancy	551	390	%	161	%				
Yes	520	377	72.5	143	27.5	1.0 (ref)			
No	31	13	41.9	18	58.1	0.018	2.1	1.1	3.9

Below, the mental health logistic regression model containing the pregnancy mental health variables. The only variable that showed a statistically significant association with having a diet during pregnancy that needed improvement was never being satisfied with body image during pregnancy (AOR 2.7, 95% CI 1.3-5.7, p=0.007).

Pregnancy mental health predictors of dietary patterns/quality during pregnancy									
Pregnancy variables	Total	Health conscious diet		Needs improvement diet		p-value	AOR	CI 95%	
	n	n	%	n	%			Lower	Upper
Body image satisfaction	550	388	%	162	%				
Yes, always	172	122	70.9	50	29.1	1.0 (ref)			
Yes, sometimes	342	249	72.8	93	27.2	0.668	0.9	0.6	1.4
No, never	36	17	47.2	19	52.8	0.007	2.7	1.3	5.7

Appendix 5-16: Multivariable regression analysis models – sub-groups for Dietary pattern/quality multivariable regression analysis models for exploring associations with breastfeeding at 3 months postpartum – according to cluster analysis

Below, the first multivariable logistic regression model containing the variables related to socio-demographic/economic factors. Participants aged up to 29 years (AOR 0.4, 95% CI 0.2-0.7, $p=0.003$), participants who were educated to Leaving Certificate/vocational level (AOR 0.5, 95% CI 0.3-0.8, $p=0.010$), participants who were in the diet during pregnancy group that needs improvement (AOR 0.4, 95% CI 0.3-0.7, $p=0.000$) and who were non-Irish (AOR 0.6, 95% CI 0.4-0.9, $p=0.041$) were statistically significantly less likely be breastfeeding at 3 months postpartum. There was no association between breastfeeding at 3 months postpartum and relationship status.

Dietary pattern/quality during pregnancy and socio-demographic/economic predictors for exploring breastfeeding at 3 months postpartum

Variables	Total n	Breastfeeding 3 months postpartum				p-value	AOR	CI 95%	
		Yes		No				Lower	Upper
		n	%	n	%				
Age group	464	297	%	167	%				
Up to 29 years	79	34	43	45	57	0.003	0.4	0.2	0.7
30 to 34 years	216	152	70.4	64	29.6	1.0 (ref)			
35 years or more	169	111	65.7	58	34.3	0.279	0.8	0.5	1.2
Education level	460	294	%	166	%				
Junior Cert or less	9	3	33.3	6	66.7	0.092	0.3	0.1	1.2
Leaving Cert/Vocational	79	32	40.5	47	59.5	0.010	0.5	0.3	0.8
Primary degree/PG	221	147	66.5	74	33.5	1.0 (ref)			
MSc/PhD	151	112	74.2	39	25.8	0.210	1.4	0.8	2.2
Diet (cluster)	464	297	%	167	%				
Health conscious	349	246	70.5	103	29.5	1.0 (ref)			
Needs improvement	115	51	44.3	64	55.7	0.000	0.4	0.3	0.7
Country of birth	459	294	%	165	%				
Ireland	112	81	72.3	31	27.7	1.0 (ref)			
Non-Irish	347	213	61.4	134	38.6	0.041	0.6	0.4	0.9

Below, the logistic regression model containing the variables related to socio-behavioural changes associated with diet would predict breastfeeding at 3 months postpartum. Participants less likely to be breastfeeding at 3 months postpartum were in the diet group that needs improvement (AOR 0.3, 95% CI 0.2-0.5, p=0.000) and who were still smoking during pregnancy (AOR 0.2, 95% CI 0.1-0.8, p=0.023). There was no association between breastfeeding at 3 months postpartum and drinking behaviour.

Dietary pattern/quality during pregnancy and socio-behavioural changes predictors for exploring breastfeeding at 3 months postpartum

Predictors for exploring breastfeeding at 6 months postpartum									
Variables	Total n	Breastfeeding 3 months postpartum				p-value	AOR	CI 95%	
		Yes		No				Lower	Upper
		n	%	n	%				
Diet (cluster)	464	297	%	167	%				
Health conscious diet	349	246	70.5	103	29.5	1.0 (ref)			
Needs improvement	115	51	44.3	64	55.7	0.000	0.3	0.2	0.5
Smoking behaviour	458	292	%	166	%				
Never/stopped	407	267	65.6	140	34.4	1.0 (ref)			
Stopped smoking during pregnancy	40	23	57.5	17	42.5	0.607	0.8	0.4	1.6
Still smoking	11	2	18.2	9	81.8	0.023	0.2	0.1	0.8

Below, the logistic regression model containing the behaviour/attitude variables that would predict breastfeeding at 3 months postpartum. As previously stated, two separate models were performed for time spent walking and for moderate physical activity per week. Participants significantly less likely to be breastfeeding at 3 months postpartum were: in the diet group that needs improvement (AOR 0.3, 95% CI 0.2-0.5, p=0.000) and not walking during pregnancy (AOR 0.4, 95% CI 0.2-0.8, p=0.008). There was no association between breastfeeding at 3 months postpartum and dietary supplement intake during pregnancy or dietary advice during pregnancy.

Dietary pattern/quality during pregnancy and behaviour/attitude predictors for exploring breastfeeding at 3 months postpartum – amount of walking time per week

Variables	Total n	Breastfeeding 3 months postpartum				p-value	AOR	CI 95%	
		Yes		No				Lower	Upper
		n	%	n	%				
Diet (cluster)	464	297	%	167	%				
Health conscious	349	246	70.5	103	29.5	1.0 (ref)			
Needs improvement	115	51	44.3	64	55.7	0.000	0.3	0.2	0.5
Walking	461	295	%	166	%				
≥150 minutes	179	126	70.4	53	29.6	1.0 (ref)			
<150 minutes	237	150	63.3	87	36.7	0.206	0.8	0.5	1.2
None	45	19	42.2	26	57.8	0.008	0.4	0.2	0.8

Below, the second behaviour/attitude model, time spent walking was replaced with the amount of moderate physical activity per week. Participants significantly less likely to be breastfeeding at 3 months postpartum were in the diet group that needs improvement (AOR 0.3, 95% CI 0.2-0.5, p=0.000).

Dietary pattern/quality during pregnancy and behaviour/attitude predictors for exploring breastfeeding at 3 months postpartum – amount of moderate physical activity time per week

Variables	Total n	Breastfeeding 3 months postpartum				p- value	AOR	CI 95%	
		Yes		No				Lower	Upper
		n	%	n	%				
Diet (cluster)	464	297	%	167	%				
Health conscious	349	246	70.5	103	29.5	1.0 (ref)			
Needs improvement	115	51	44.3	64	55.7	0.000	0.3	0.2	0.5

Below, the logistic regression model contained the postpartum mental health variables. Participants less likely to be breastfeeding at 3 months postpartum were in the diet group that needs improvement (AOR 0.3, 95% CI 0.2-0.5, p=0.000) and who experienced postpartum intense anxiety episodes (such as panic attacks) (AOR 0.5, 95% CI 0.3-0.9, p=0.042). Participants more likely to be breastfeeding at 3 months postpartum were those who were sometimes satisfied with body image (AOR 5.8, 95% CI 2.3-14.8, p=0.000). There was no association between breastfeeding at 3 months postpartum and postpartum depression episodes.

Dietary pattern/quality during pregnancy and postpartum mental health predictors for exploring breastfeeding at 3 months postpartum

Predictors for exploring breastfeeding at 3 months postpartum									
Variables	Total n	Breastfeeding 3 months postpartum				p-value	AOR	CI 95%	
		Yes		No				Lower	Upper
		n	%	n	%				
Diet (cluster)	464	297	%	167	%				
Health conscious	349	246	70.5	103	29.5	1.0 (ref)			
Needs improvement	115	51	44.3	64	55.7	0.000	0.3	0.2	0.5
Postpartum intense anxiety episodes (such as panic attacks)	455	289	%	166	%				
No	388	252	64.9	136	35.1	1.0 (ref)			
Yes	67	37	55.2	30	44.8	0.042	0.5	0.3	0.9
Body image satisfaction after birth	459	293	%	166	%				
Yes, always	56	50	89.3	6	10.7	1.0 (ref)			
Yes, sometimes	274	169	61.7	105	38.3	0.000	5.8	2.3	14.8
No, never	129	74	57.4	55	42.6	0.590	1.0	0.7	1.8

Appendix 6-1: Prevalence of smoking during pregnancy per country and in the different regions of the world

Region	Prevalence (%)
'Diet and dietary patterns during pregnancy in nulliparous women in Ireland' study	3.8%
Ireland	38.4% (95% CI 25.4-52.4)
Uruguay	29.7% (95% CI 16.6-44.8)
Bulgaria	29.4% (95% CI 26.6-32.2)
European region	8.1% (95% CI 4.0-12.2)
Region of the Americas	5.9% (95% CI 3.2-8.6)
Southeast Asian region	1.2% (95% CI 0.7-1.7)
Western Pacific region	1.2% (95% CI 0.0-3.7)
Eastern Mediterranean region	0.9% (95% CI 0.0-1.9)
African region	0.8% (95% CI 0.0-2.2)
Worldwide	1.7% (95% CI 0.0-4.5)

*adapted from ([Lange et al. 2018](#))

Appendix 7-1: Dissemination to date

Conference proceedings:

Marchi J, Begley C, Kearney J, Daly D. (2014) Food behaviours that contribute to risk factors during pregnancy in Ireland. The MAMMI Study - Nutrition study. Proceedings of the *15th Healthcare Interdisciplinary Research Conference & Student Colloquium. Health, Wellbeing and Innovation: Recent advances in research, practice and education*, Dublin, 4th-6th November 2014.

Marchi J, Berg M, Dencker A, Olander E, Begley C. (2015) Risks for the mother and baby associated with obesity in pregnancy: a systematic review of reviews. Proceedings of the *Hot Topic Conference 2015: Obesity & Pregnancy*, World Obesity Federation, London, 29th-30th October, 2015.

Marchi J, Berg M, Dencker A, Olander E, Begley C. (2015) Mother and baby risks associated with obesity in pregnancy: a systematic review of reviews. School of Nursing and Midwifery, Trinity College Dublin. Proceedings of the *16th Healthcare Interdisciplinary Research Conference (HIRC2015)*, Dublin, 4th-6th November 2015.

Marchi J, Begley C, Kearney J, Daly D. (2016) Developing a survey to assess diet and physical activity patterns in nulliparous women. Proceeding of the *3rd International Conference on Nutrition and Growth (N&G 2016)*, Vienna, 17th-19th March 2016.

Marchi J, Begley C, Kearney J, Daly D. (2016) Vitamin supplementation before and during pregnancy. The MAMMI Study - Nutrition and Physical Activity study. Proceedings of the *17th Healthcare Interdisciplinary Research Conference 2016*, Dublin, 10th November 2016.

Marchi J, Begley C, Kearney J, Daly D. (2016) The dietary and physical activity patterns of nulliparous women and outcomes for women and babies – the MAMMI study - Nutrition and Physical Activity study. Proceedings of the *Minding Mothers with Morbidities Conference*, Trinity College Dublin, Dublin, 8th November 2016.

Marchi J, Begley C, Kearney J, Daly D. (2018) Vitamin supplementation in nulliparous women before and during pregnancy. The MAMMI Study - Nutrition and Physical Activity study. Proceeding of the *5th International Conference on Nutrition and Growth (N&G 2018)*, Paris, 1st-3rd March 2018.