A collaborative approach to developing sustainable behaviour change interventions for childhood obesity prevention: Development of the Choosing Healthy Eating for Infant Health (CHERISH) intervention and implementation strategy

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Objectives and Design. There is growing recognition of the need for effective behaviour change interventions to prevent chronic diseases that are feasible and sustainable and can be implemented within routine health care systems. Focusing on implementation from the outset of intervention development, and incorporating multiple stakeholder perspectives to achieve this, is therefore essential. This study explores the development of the Choosing Healthy Eating for Infant Health (CHERISH) childhood obesity prevention intervention and implementation strategy to improve infant feeding behaviours.

Methods. Five qualitative and quantitative evidence syntheses, two primary qualitative studies, and formal/informal consultations were conducted with practice, policy,

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research, and parent stakeholders. The Behaviour Change Wheel was used to guide the integration of findings.

Results. The CHERIsH intervention targets parent-level behaviour change and comprises (1) brief verbal messages and (2) trustworthy resources, to be delivered by health care professionals (HCPs) during routine infant vaccination visits. The implementation strategy targets HCP-level behaviour change and comprises (1) a local opinion leader, (2) incentivized training, (3) HCP resources and educational materials, (4) electronic delivery prompts, (5) awareness-raising across all primary care HCPs, and (6) local technical support.

Conclusions. This study provides a rigorous example of the development of an evidence-based intervention aimed at improving parental infant feeding behaviours, alongside an evidence-based behaviour change strategy to facilitate implementation and sustainability in primary care. This approach demonstrates how to systematically incorporate multiple stakeholder perspectives with existing literature and move from multiple evidence sources to clearly specified intervention components for both the intervention and implementation strategy.

Statement of Contribution

What is already known?

- Incorporating insights from practice, policy, and public/patient stakeholders plays a key role in developing behaviour change interventions that are feasible and sustainable and can be implemented within routine health care systems. However, there are limited examples that provide in-depth guidance of how to do this using a systematic approach.

What this study adds?

- This study describes an innovative use of the Behaviour Change Wheel to integrate multiple sources of evidence collected from practice, policy, research, and parent stakeholders to concurrently develop an evidence-based intervention to improve parental infant feeding behaviours and an implementation strategy to facilitate sustainable delivery by health care professionals in routine primary care

There is growing recognition of the need for effective evidence-based behaviour change interventions to prevent chronic diseases that are feasible and sustainable and can be implemented within routine health care systems (Brown & Beardslee, 2016; Leslie *et al.*, 2016; Walugembe, Sibbald, Le Ber, & Kothari, 2019). It has been frequently stated that it can take up to 17 years for research evidence to become embedded within routine clinical practice (Grant, Green, & Mason, 2003; Green, Ottoson, García, & Hiatt, 2009; Morris, Wooding, & Grant, 2011; Power *et al.*, 2019), with many positing that this time-lag is compounded by a traditional step-wise approach from intervention development and feasibility testing, to efficacy and effectiveness evaluations, before finally moving to implementation (Brownson, Jacobs, Tabak, Hoehner, & Stamatakis, 2013; Curran, Bauer, Mittman, Pyne, & Stetler, 2012; Glasgow, Lichtenstein, & Marcus, 2003). As such, it is of vital importance for interventions to be developed with a focus on implementation, and the multiple levels of behaviours required to facilitate implementation and intervention delivery, from the outset (Brownson *et al.*, 2013; Chambers & Norton, 2016; Pluye, Potvin, & Denis, 2004; Schell *et al.*, 2013). Incorporating insights from a variety of stakeholders including practice, policy, and

patient/public enables several levels of behavioural factors influencing implementation to be considered, and has been consistently acknowledged as one of the most important aspects in developing sustainable public health interventions (Iwelunmor *et al.*, 2016; Proctor *et al.*, 2015; Schell *et al.*, 2013; Stevens *et al.*, 2017). However, incorporating multiple stakeholder perspectives within intervention development is not straightforward (Cottrell *et al.*, 2014; Deverka *et al.*, 2012). Few examples exist which explicitly detail how to integrate the perspectives of different stakeholders with existing evidence regarding intervention effectiveness and implementability, using a systematic and theoretically informed approach (Walugembe *et al.*, 2019).

Incorporating stakeholder insights for developing sustainable interventions to prevent chronic diseases such as childhood obesity could be particularly beneficial. Childhood obesity is an urgent global concern with serious health, economic, and social implications both for the individual and the wider health system. Infancy and early childhood represent an optimal window to establish healthy behaviours and prevent the later development of childhood obesity and other chronic diseases (SafeFood, 2018; Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008; Waters *et al.*, 2011). In particular, ensuring optimum infant nutrition is vital, as a number of potentially modifiable infant feeding behaviours have been shown to predict later development of childhood overweight and obesity (Pluymen *et al.*, 2018; Wang *et al.*, 2016; Woo Baidal *et al.*, 2016). These behaviours include the initiation and duration of breastfeeding as well as the introduction of solid foods (i.e., complementary feeding) (Birch & Doub, 2014; Hurley, Cross, & Hughes, 2011; Patro-Gólab *et al.*, 2016; Pearce & Langley-Evans, 2013; Pluymen *et al.*, 2018; Wang *et al.*, 2016). International guidance from the World Health Organisation (WHO) recommends exclusive breastfeeding for the first six months of life, with complementary feeding (i.e., the introduction of nutritionally adequate and appropriate solid foods) from six months onwards (World Health Organisation, 2002). Despite these recommendations, a substantial proportion of infants worldwide are introduced to solid foods before four months (Barrera, Hamner, Perrine, & Scanlon, 2018; Clayton, Li, Perrine, & Scanlon, 2013; Inoue & Binns, 2014; Schiess *et al.*, 2010). Additionally, infants are commonly introduced to inappropriate foods that are high in energy, saturated fats, salt, and refined sugars or contain insufficient micronutrients (Inoue & Binns, 2014; Tarrant, Younger, Sheridan-Pereira, White, & Kearney, 2010).

Childhood obesity prevention interventions delivered by health care professionals (HCPs) in primary care settings have been identified as particularly promising (Clayton *et al.*, 2013; Matvienko-Sikar *et al.*, 2018; McPherson, Mirkin, Heatherley, & Homer, 2012). This is because primary care HCPs are a trusted source of information for parents (Bourgeois, Brauer, Simpson, Kim, & Haines, 2016; Horodyski *et al.*, 2007), and come into regular contact with parents during early infancy, such as during routine vaccination visits. However, the existing evidence for the effectiveness of infant feeding interventions to prevent childhood obesity, including those delivered by HCPs in health care contexts, is inconsistent (Blake-Lamb *et al.*, 2016; Graziose, Downs, O'Brien, & Fanzo, 2017; Hesketh & Campbell, 2010; Laws *et al.*, 2014; Matvienko-Sikar *et al.*, 2018; Redsell, Edmonds, Swift, & *et al.*, 2016). Several systematic reviews have previously demonstrated variable effects of infant feeding interventions on both feeding and weight outcomes (Blake-Lamb *et al.*, 2016; Graziose *et al.*, 2017; Hesketh & Campbell, 2010; Laws *et al.*, 2014; Matvienko-Sikar *et al.*, 2018; Redsell *et al.*, 2016). However, these reviews identified a number of methodological flaws and quality issues within existing interventions, including poor application or use of behaviour change theory (Hesketh & Campbell, 2010; Matvienko-Sikar *et al.*, 2019; Redsell *et al.*, 2016), a

lack of systematic approach to intervention development (Graziose *et al.*, 2017), significant heterogeneity in outcome measurement and reporting (Laws *et al.*, 2014; Matvienko-Sikar *et al.*, 2018), and an insufficient focus on the internal and external validity of the intervention (e.g., intervention fidelity delivery and adherence) (Redsell *et al.*, 2016; Toomey *et al.*, 2018). Overall, the findings of these reviews suggested that multi-component interventions underpinned by theory that incorporate a responsive feeding focus may have the most potential to impact on feeding and weight outcomes (Blake-Lamb *et al.*, 2016; Graziose *et al.*, 2017; Hesketh & Campbell, 2010; Laws *et al.*, 2014; Matvienko-Sikar *et al.*, 2018; Redsell *et al.*, 2016). The reviews also highlighted a limited focus on implementation and long-term sustainability, and a need for future research to develop multi-level behaviour change interventions that target beyond the individual/family level alone, and that can be embedded into routine service delivery (Blake-Lamb *et al.*, 2016; Graziose *et al.*, 2017; Laws *et al.*, 2014; Redsell *et al.*, 2016; Waters *et al.*, 2011). As such, there is a clear need to develop evidence-based behaviour change interventions that integrate research evidence with multiple stakeholder views and contextual information to facilitate implementation and sustainability within existing health care settings.

The aim of this study was to systematically develop an evidence-based intervention to improve parental infant feeding behaviours, and a concurrent evidence-based implementation strategy targeting HCP behaviours to support and sustain intervention delivery during routine vaccination visits. The Behaviour Change Wheel (BCW) intervention development framework (Michie, van Stralen, & West, 2011) was used to structure this approach and to incorporate evidence and insights from practice, policy, and parents.

Methods

Intervention context

In Ireland, vaccinations are delivered at five standardized time-points (2, 4, 6, 12, and 13 months) within the Health Service Executive (HSE) National Healthy Childhood Programme, a free universal child health service that is available from pregnancy through to adolescence ('HSE Healthy Childhood Programme,'). The Nurture Programme is a recently established quality improvement initiative within the National Healthy Childhood Programme that aims to support, empower, and educate parents and practitioners on a variety of infant health and well-being topics, including nutrition ('HSE Nurture Programme – Infant Health and Wellbeing,').

Sources of evidence

The Choosing Healthy Eating for Infant Health (CHERISH) team comprises researchers with expertise in a variety of areas including childhood obesity, population/public health, infant nutrition, developmental psychology, epidemiology, health psychology, health promotion, health services research, behaviour change, primary care, health economics, and implementation science (ET, KMS, JMS, SMH, PK, ED, JH, CH, CHe, MH, CK, JOH, MQ, TH, MB). We (the CHERISH team) conducted five evidence syntheses and two primary qualitative studies with HCPs and parents, as well as formal and informal consultations with policy, practice, and researcher stakeholders (full details of sources in Table 1). We combined findings from these sources in an iterative process to inform each step of the BCW framework and guide final decision-making made by our interdisciplinary research team.

Table 1. CHERIsH sources of evidence for intervention development

Source code: Source title (reference)	Type of activity	Overview of source aims and findings	Behaviour Change Wheel phase(s) and step(s) informed
SR1: 'Effects of health care professional delivered early feeding interventions on feeding practices and dietary intake: A systematic review' (Matvienko-Sikar <i>et al.</i> , 2018)	Systematic review	<ul style="list-style-type: none"> • Aimed to evaluate the effects of health care professional (HCP) delivered infant feeding interventions, delivered in the first two years postpartum on parental feeding practices, dietary intake, and weight outcomes for children. • 10 trials of interventions demonstrated inconsistent effects on feeding practices, dietary intake, and weight outcomes. Findings showed some reductions in pressure to eat and infant consumption of non-core beverages. • Responsive feeding-based interventions demonstrated greater improvements in feeding approaches, and weight outcomes 	Phase 1: Steps 2, 3, 4 Phase 2: Step 5 Phase 3: Step 8
SR2: 'Intervention Fidelity Within Trials of Infant Feeding Behavioural Interventions to Prevent Childhood Obesity: A Systematic Review' (Toomey <i>et al.</i> , 2018)	Systematic review	<ul style="list-style-type: none"> • Aimed to explore the use and/or reporting of strategies to enhance and assess intervention fidelity within 10 trials (identified in SR1) of HCP-delivered infant feeding interventions, using the National Institutes of Health Behaviour Change Consortium (Borrelli <i>et al.</i>, 2005) fidelity checklist. • Average use/reporting of fidelity strategies was moderate • Highlighted the need to improve reporting of intervention fidelity strategies and ensure focus on HCP-level behaviour change. 	Phase 1: Steps 2, 4 Phase 2: Step 5 Phase 3: Step 8

Continued

Table 1. (Continued)

Source code: Source title (reference)	Type of activity	Overview of source aims and findings	Behaviour Change Wheel phase(s) and step(s) informed
SR3: 'Behaviour Change Techniques and Theory Use in Healthcare Professional-Delivered Early Feeding Interventions to Prevent Childhood Obesity: A Systematic Review' (Matvienko-Sikar et al., 2019)	Systematic review	<ul style="list-style-type: none"> • Aimed to evaluate the use of behaviour change techniques and psychological theory in HCP-delivered infant feeding interventions for children ≤ 2 years. • 12 trials were examined using the Behaviour Change Technique (BCT) Taxonomy v1 (Michie et al., 2013) and the Theory Coding Scheme (Michie & Prestwich, 2010). • Theory use was poor; most commonly used theories were social cognitive theory (SCT) ($n = 4$ studies) and responsive feeding ($n = 4$). Studies that incorporated theory in intervention development and evaluation demonstrated better child weight outcomes. • Highlighted need for adequate integration of theory in intervention development, and identified BCTs that had been used in more effective interventions. 	Phase 1: Steps 3, 4 Phase 2: Step 5 Phase 3: Steps 7, 8
QES1: 'Parental experiences and perceptions of infant complementary feeding: a qualitative evidence synthesis' (Matvienko-Sikar et al., 2018)	Qualitative evidence synthesis	<ul style="list-style-type: none"> • Aimed to explore parents' perceptions and experiences of infant feeding and complementary feeding recommendations. • 25 qualitative studies included • Four key themes were identified: 1) 'Guidelines and advice' related to the variety and inconsistencies between sources of feeding information, 2) 'Stage of weaning' related to infant feeding as a process 	Phase 1: Steps 2, 3, 4 Phase 2: Step 5 Phase 3: Steps 7, 8

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Table 1. (Continued)

Source code: Source title (reference)	Type of activity	Overview of source aims and findings	Behaviour Change Wheel phase(s) and step(s) informed
		<p>involving different stages, 3) 'Knowing and trying' related to parents' feeding approaches being based on instinct, prior experience or trial and error, and 4) 'Daily life' related to problematic cost and time constraints for parents.</p> <ul style="list-style-type: none"> • Emphasized the importance of considering infant feeding as a changing process over time, and the need for clear, consistent information from trusted sources. 	
QES2: 'Health-care professional and parental views and experiences of implementing infant feeding interventions: a qualitative evidence synthesis' (E. Toomey, M. Byrne, C. Houghton, C. Kelly, K. Matvienko-Sikar, J. Mc Sharry, M. Queally, E. Doherty, C. Hayes, M. Hennessy, S. McHugh, P.M. Kearney, & C. Heary on behalf of the Choosing Healthy Eating for Infant Health [CHERISH] study team, in preparation)	Qualitative evidence synthesis	<ul style="list-style-type: none"> • Aimed to explore parents' and HCPs' views and experiences of participating in infant feeding interventions. • 13 qualitative studies included • Findings identified the importance of positive relationships between parents and HCPs and a supportive intervention environment. Issues with capacity (time and resources) and unclear roles and responsibilities negatively influenced implementation of the intervention by HCPs; for parents, a focus on practical elements and sustainability beyond the intervention was important to facilitate participation. • Highlighted the importance of positive communication between HCP and parents and identified a number of key barriers and enablers to participating in infant 	Phase 1: Steps 2, 4 Phase 2: Step 5 Phase 3: Step 8

Continued

Table 1. (Continued)

Source code: Source title (reference)	Type of activity	Overview of source aims and findings	Behaviour Change Wheel phase(s) and step(s) informed
FG: 'Experience and perceptions of infant feeding and delivery of an infant feeding intervention in primary care in Ireland' (C. Flannery, K. Matvienko-Sikar, E. Toomey, C. Kelly, M. Byrne, C. Heary, S. McHugh, & M. Hennessy, in preparation)	Qualitative focus groups	<p>feeding interventions for both parents and HCPs.</p> <ul style="list-style-type: none"> • Aimed to explore views on engaging in healthy infant feeding practices, participation in infant feeding interventions and opinions of proposed intervention • Six focus groups with 30 parents (mothers and fathers) • Findings identified that importance of clear and consistent messages, and practical guidance and support delivered at the right time, and the importance of trustworthiness of the intervention and associated resources, and relationships with HCPs • Parents have different preferences in terms of the format of intervention and information delivery, but were mostly positive about the potential for using the vaccination visits as a potential time-point 	Phase 1: Steps 2, 3, 4 Phase 2: Step 5 Phase 3: Steps 7, 8
QI: 'Exploring infant feeding interventions in primary care with healthcare professionals: a qualitative interview study', (E. Toomey, M. Byrne, C. Houghton, C. Kelly, K. Matvienko-Sikar, J. McSharry, M. Queally, E. Doherty, C. Hayes, M. Hennessy, S. McHugh, P.M. Kearney, & C. Heary on behalf of the Choosing Healthy Eating for Infant Health [CHERISH] study team, in preparation)	Qualitative semi-structured interviews	<ul style="list-style-type: none"> • Aimed to explore HCP views on addressing infant feeding in primary care, and the potential barriers and enablers to the use of brief vaccination visits as a time-point for intervention delivery • 21 semi-structured interviews with primary care HCPs (5 practice nurses, 7 general practitioners, 3 public health nurses, 3 community dieticians, and 3 community medical officers) 	Phase 1: Steps 2, 3, 4 Phase 2: Step 5 Phase 3: Steps 7, 8

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Table 1. (Continued)

Source code: Source title (reference)	Type of activity	Overview of source aims and findings	Behaviour Change Wheel phase(s) and step(s) informed
IC: Informal consultations with local and national infant feeding policy and practice representatives	Informal consultations	<ul style="list-style-type: none"> Highlighted importance of consistency regarding infant feeding messages, trustworthy resources for both parents and HCPs, and a need to support practical skill development for parents Barriers included a lack of time/capacity, resources, insufficient clarity regarding HCP roles and potential parent/child stress at the time of vaccinations Enablers included the importance of the topic, good relationships between parents and primary care HCPs, and the fact that children presenting for vaccination visits are typically medically well Vaccination visits were found to be potentially feasible if those barriers and enablers were taken into consideration 	Phase 1: Steps 2, 3 Phase 2: Step 5 Phase 3: Steps 7, 8
		<ul style="list-style-type: none"> Aimed to provide insight and information about the intervention context from a policy and practice perspective Separate informal consultations were held with policy representatives from the Health Service Executive National Healthy Childhood Programme (3 face-to-face meetings and ongoing email/telephone contact) and a practice-based general practitioner (TH) (6 face-to-face meetings and ongoing telephone contacts) 	

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Table 1. (Continued)

Source code: Source title (reference)	Type of activity	Overview of source aims and findings	Behaviour Change Wheel phase(s) and step(s) informed
ISC: International steering committee expert meeting	International steering committee meeting	<ul style="list-style-type: none"> • Provided guidance around what resources and opportunities existed both locally and nationally that could be used to operationalize intervention components, for example, a parent and child health website (www.mychild.ie), online infant feeding training modules for HCPs, and a number of infant health brief messages developed for healthcare contact points • Aimed to get international expert input and guidance into the intervention development, particularly around the operationalization and mode of delivery of intervention components • Two-day meeting with international steering committee (participants included 10 members of the immediate CHERISH interdisciplinary research team, two minute-keepers, and 21 representatives from a variety of policy, practice, and funding backgrounds including primary care ($n = 4$), nursing ($n = 2$), medical ($n = 4$), health psychology ($n = 4$), public health ($n = 8$), health economics ($n = 2$), nutrition ($n = 5$), maternal and child health ($n = 8$), childhood obesity ($n = 6$), epidemiology ($n = 3$), and implementation science ($n = 4$)). Representatives had been identified from the list of 	Phase 3: Step 8

Continued

Table 1. (Continued)

Source code: Source title (reference)	Type of activity	Overview of source aims and findings	Behaviour Change Wheel phase(s) and step(s) informed
		<p>original project application collaborators and also through word of mouth or existing networks. Local practice and national policy representatives (IC) were also present.</p> <ul style="list-style-type: none"> • Three recommendations were made regarding: 1) the involvement of primary care HCPs beyond those who would be delivering the intervention, 2) the need for HCP training, and 3) the degree of flexibility/ tailoring permitted regarding intervention content 	

SR = systematic review, QES = qualitative evidence synthesis, FG = focus groups, QI = qualitative interviews, IC = informal consultations, ISC = international steering committee, HCP = health care professional.

Applying the behaviour change wheel approach

The BCW approach (Michie, Atkins, & West, 2014) outlines three phases with eight specific steps across these phases.

Phase 1: Understanding the behaviour

Phase 1 comprises the following: Step 1 (defining the problem in behavioural terms), Step 2 (selecting the target behaviour(s)), Step 3 (specifying the target behaviour(s)), and Step 4 (identifying what needs to change). Specifically, this phase involves identifying components of the target behaviour (*who, what, where, when, and how often*) to be addressed through the intervention using the COM-B (Capability, Opportunity, Motivation-Behaviour) model. The COM-B model recognizes that for a person to change their behaviour, they must have the physical and psychological capability, social and physical opportunity, and reflective and automatic motivation (Michie *et al.*, 2011).

We used existing data regarding current infant feeding practices and introduction of solid foods (Bennett, 2017; Castro, Kearney, & Layte, 2015; safefood, 2018; Tarrant *et al.*, 2010) to understand and define the problem in behavioural terms. Selection and specification of the parental behaviours relevant to improving infant feeding, as well as the HCP behaviours needed to facilitate these behaviours in the intended primary care vaccination visit setting, were achieved by exploring national and international infant feeding recommendations (Fewtrell *et al.*, 2017; Food Safety Authority of Ireland, 2011; Health Service Executive, 2016; Healthy Ireland, 2015; World Health Organisation, 2002)

in conjunction with findings from our evidence sources (Table 1). Our informal consultations with local and national infant feeding policy and practice representatives provided valuable insight in terms of which particular behaviours might be best to target within the current Irish primary care context.

Specific barriers and enablers to the targeted parent-level behaviours and HCP/practice-level behaviours were extracted from our parent focus groups (FG) and HCP interviews (QI) and subsequently triangulated with findings of the evidence syntheses (SR1, SR2, SR3, QES1, QES2) by two authors. One author conducted initial coding, with 100% of this coding double-checked and verified separately by a second author. Specifically, parent-level barriers/enablers were coded according to the COM-B by KMS and HCP-level barriers/enablers were coded by ET, with each analysis verified by the other coder.

Phase 2: Identify intervention options

Phase 2 applies the BCW framework guidance (Michie *et al.*, 2014) to choose potential intervention options based on the findings of Phase 1. Specifically, Step 5 identifies intervention functions or the ‘broad categories of means by which an intervention can change behaviour’ (Michie *et al.*, 2014) (e.g., Education, Training), which map onto the relevant COM-B components identified in Phase 1. Where multiple options for intervention functions exist, the APEASE (Affordability, Practicability, Effectiveness/cost-effectiveness, Acceptability, Side effects/Safety, Equity) criteria (Michie *et al.*, 2014) can be used to determine the most appropriate option. Step 6 involves identifying specific policy-related areas to target (Michie *et al.*, 2011). This project focused on parent and practitioner-level change, and changing policy was deemed outside of the scope; therefore, this step was not included within our project.

For Step 5, two authors used a template to facilitate application of the APEASE criteria in a standardized manner for both the parent behaviours and the targeted HCP behaviours (File S1). Using information from four of our evidence syntheses (QES1, QES2, SR1, SR3) and qualitative data collection with parents and HCPs (QI, FG), ET and KMS collectively applied the APEASE criteria to each BCW intervention function via consensus discussion, with rationale for each decision documented on the template. Functions that met all APEASE criteria were included.

Phase 3: Identify content and implementation options

Phase 3 involves explicit identification of the intervention content in terms of behaviour change techniques (BCTs) (Step 7). BCTs are observable, replicable, and irreducible active ingredients of an intervention designed to change behaviour, and are listed and defined within the BCT Taxonomy v1 (BCTTv1) (Michie *et al.*, 2013). Finally, Step 8 involves operationalizing each BCT, that is, translating the BCT from its taxonomy definition into a concrete application of what it would look like within an intervention.

To inform the selection of final BCTs, using a similar process as outlined for identifying intervention functions, two authors (ET, KMS) collectively applied the APEASE criteria to each possible BCT via consensus discussion. Guided by the findings of our evidence syntheses (SR1, SR2, SR3, QES1, QES2) and qualitative data collection with parents and HCPs (FG, QI), we (ET, KMS) brainstormed potential intervention components and modes of delivery. We then presented the options to our international expert steering committee, practice, and policy representatives for feedback to guide final decision-

making by the CHERIsH team. Key recommendations arising from the international steering committee were documented and subsequently reviewed by the CHERIsH team at a follow-up meeting. As with each previous step of the process, consensus was reached on the finalized intervention and implementation strategy via discussion within the CHERIsH study team.

Results

Phase 1: Understanding the behaviour

Step 1: Define the problem in behavioural terms

As outlined in the introduction, a substantial proportion of infants internationally are introduced to inappropriate foods before the recommended time (Castro *et al.*, 2015; Inoue & Binns, 2014; O'Donovan *et al.*, 2015; Tarrant *et al.*, 2010). We therefore defined the problem in behavioural terms as the practice of suboptimal infant feeding behaviours by parents of infants aged 0–2.

Step 2: Selecting the target behaviour(s)

A number of specific parental behaviours relevant to the broader target of improving healthy infant feeding behaviours were identified from existing infant feeding recommendations (Food Safety Authority of Ireland, 2011; Healthy Ireland, 2015; World Health Organisation, 2002), which included guidance on maternal nutrition and physical activity-related behaviours before and during pregnancy, breastfeeding, and formula-feeding behaviours, as well as the timing of introduction of solid foods, the types and stages of solid foods introduced, and the ways in which parents feed their babies in response to infant cues (i.e., responsive feeding). Although several behaviours were relevant to our area of interest, we decided to focus predominantly on the introduction and provision of solid foods to children aged between 0 and 2, and in particular to select three core behaviours relating to (1) the timing of solid food introduction, (2) progression through the stages and textures of solid foods, and (3) responsive feeding behaviours. This decision was influenced by findings from our evidence sources (Table 1). Specifically, our systematic review of effectiveness (SR1) identified that interventions based on responsive feeding theory demonstrated greater improvements in feeding approaches and weight outcomes. Our qualitative data collection (FG, QI) also reinforced the importance of developing parental skills such as responding to infant cues. In addition, our qualitative evidence synthesis of parents' experiences of complementary feeding (QES1) and our focus groups (FG) both emphasized the importance of considering infant feeding as a changing process over time involving different stages.

In terms of selecting HCP behaviours for our implementation strategy, the findings of our systematic review of intervention fidelity (SR2) identified the importance of an explicit focus on HCP training and behaviour change within these types of interventions. In addition, our interviews with health care professionals (QI) and our qualitative evidence synthesis of parents' and HCPs' perspectives of infant feeding interventions (QES2) emphasized issues relating to capacity and resources for HCPs. Drawing on this evidence, in conjunction with informal consultations with our policy and practice-based representatives, we decided to select the provision of guideline-based information and support for the introduction of solid foods in primary care by HCPs involved in the vaccination visits as the HCP-level behavioural target.

Step 3: Specifying the target behaviour(s)

We specified our parent-level behaviours to be that parents (*who*) would (1) wait until as close to 26 weeks as possible to introduce solids and not before 17 weeks, (2) feed nutritious and developmentally appropriate foods, and (3) respond appropriately to the infant's hunger and satiety cues (*what*) each and every time they fed their infant (*when, where, and how often*). This specification was informed by integrating national and international guidelines (Fewtrell *et al.*, 2017; Food Safety Authority of Ireland, 2011; Health Service Executive, 2016; Healthy Ireland, 2015; World Health Organisation, 2002) with findings from our qualitative evidence synthesis of parents' views of infant feeding (QES1), our systematic reviews of effectiveness (SR1) and behaviour change theory and techniques (SR3) and our focus groups with parents (FG) in conjunction with consultation with the policy representatives.

For the HCP-level behaviour, that is, the provision of guideline-based information and support for introduction of solid foods at vaccination visits, our HCP interviews (QI), in addition to our informal policy and practice consultations, provided us with the contextual knowledge needed to identify the specifics of this behaviour. For example, both sources informed us that vaccinations in Ireland are typically delivered by practice nurses, but may occasionally be delivered by general practitioners in certain circumstances. Our interviews with HCPs also informed us that potentially the most acceptable time to deliver information alongside vaccination visits would be before the vaccine itself was administered. We therefore specified our HCP-level behaviour to be that practice nurses and/or general practitioners (*who*) would provide guideline-based information and support for introduction of solid foods (*what*) just before the delivery of vaccinations (*when*) in the practice vaccination room (*where*), at the 2-, 4-, 6-, 12-, and 13-month vaccination visits (*how often*).

Step 4: Identify what needs to change

The identified barriers and enablers to the target behaviours and to conducting the intervention within vaccination visits, analysed according to the COM-B model, are presented in Table 2.

Phase 2: Identify intervention options**Step 5: Identify intervention functions**

All nine BCW intervention functions were potentially relevant to the COM-B components identified in Step 4 for both the parent behaviour and the targeted HCP behaviour. By using our evidence sources to inform how we applied the APEASE criteria, we selected three intervention functions (Education, Environmental restructuring, and Persuasion) to address the parent-level targeted behaviour. For example, 'Education' was identified as relevant within four of our evidence syntheses (QES1, QES2, SR1, SR3) and our qualitative data collection with parents and HCPs (QI, FG). Using the information gleaned from these studies, we deemed the provision of education for parents to be Affordable, Practicable, potentially Effective and Cost-effective, Acceptable, Safe, and Equitable. In a similar manner, we selected Training, Education, Environmental restructuring, Persuasion, Incentivization, and Modelling as the intervention functions to address the HCP-level targeted behaviour (Table 2). The APEASE criteria ratings and the rationale for each intervention function selected for both the intervention and implementation strategy are provided in File S1.

Table 2. Mapping of COM-B components to selected intervention functions and BCTs

BCW Step 1-3	BCW Step 4		COM-B component identified	BCW Step 5 Intervention functions selected	BCW Step 7 BCTs selected
	Target behaviour	Barriers and enablers identified (sources)			
Parents to adhere to guideline-based early infant feeding practices between 0-2 years: <ul style="list-style-type: none"> Wait until as close to 26 weeks as possible to introduce solids (not before 17 weeks); Feed nutritious and developmentally suitable foods; Respond appropriately to child's hunger and satiety cues 	Enabler <ul style="list-style-type: none"> Focusing on practical skills including responsive feeding (responding to infant cues, feeding behaviours) (QES1, QES2, SR1, SR3, QI, FG) 	Enabler <ul style="list-style-type: none"> Focusing on practical skills including responsive feeding (responding to infant cues, feeding behaviours) (QES1, QES2, SR1, SR3, QI, FG) 	Capability: Physical ^a	Education	4.1 Instruction on how to perform the behaviour
	Barriers <ul style="list-style-type: none"> Conflicting information and lack of consistent messages regarding infant feeding (QES1, FG, QI, QES2) Lack of trustworthy resources regarding infant feeding (FG, QI) Misconceptions and lack of knowledge regarding infant feeding (QES1, FG) 	Barriers <ul style="list-style-type: none"> Conflicting information and lack of consistent messages regarding infant feeding (QES1, FG, QI, QES2) Lack of trustworthy resources regarding infant feeding (FG, QI) Misconceptions and lack of knowledge regarding infant feeding (QES1, FG) 	Capability: Psychological ^b	Education	5.3 Information about social and environmental consequences 5.1 Information about health consequences 7.1 Prompts, cues
	Enablers <ul style="list-style-type: none"> Focus on practical information including responsive feeding (responding to infant cues, feeding behaviours) (QES1, QES2, SR1, SR3, QI, FG) Awareness of infant feeding as a changing process – appropriate timing of intervention (QES1, QES2, FG) 	Enablers <ul style="list-style-type: none"> Focus on practical information including responsive feeding (responding to infant cues, feeding behaviours) (QES1, QES2, SR1, SR3, QI, FG) Awareness of infant feeding as a changing process – appropriate timing of intervention (QES1, QES2, FG) 	Opportunity: Social ^c	Environmental Restructuring	12.5 Adding objects to the environment 7.1 Prompts/cues

Continued

Table 2. (Continued)

BCW Step 1-3	BCW Step 4		COM-B component identified	BCW Step 5 Intervention functions selected	BCW Step 7
	Barriers and enablers identified (sources)				
Target behaviour	Barrier		Opportunity: Physical ^d	Environmental Restructuring	12.1 Restructuring the physical environment
	<ul style="list-style-type: none">Time and cost restraints (FG, QES1)				
	Enabler				
	<ul style="list-style-type: none">Availability of suitable, trustworthy resources in variety of formats (FG, QES1)				
	Barrier/Enabler				
	<ul style="list-style-type: none">Parents prior positive or negative experience of infant feeding influencing their behaviours (QES1, FG)				
	Barrier				
	<ul style="list-style-type: none">Mothers engaging in behaviours irrespective of guidelines based on ‘maternal instinct’ (QES1, FG)				
	Enablers				
	<ul style="list-style-type: none">Support around stressful aspects of feeding and promotion of awareness that feeding can be enjoyable (QES1, FG)				
<ul style="list-style-type: none">Trusting, positive, and non-judgemental relationships between HCPs & parents (QES1, QES2, QI, FG)		Motivation: Automatic ^f	Persuasion Environmental restructuring	5.3 Information about social and environmental consequences 5.1 Information about health consequences 9.1 Credible source 9.1 Credible source 5.3 Information about social and environmental consequences 5.1 Information about health consequences 12.5 Adding objects to the environment 7.1 Prompts/cues 12.1 Restructuring the physical environment	

Continued

Table 2. (Continued)

BCW Step 1-3	BCW Step 4		BCW Step 5 Intervention functions selected	BCW Step 7
	Barriers and enablers identified (sources)	COM-B component identified		
Target behaviour				BCTs selected
HCPs to provide guideline-based information and support regarding infant feeding and introduction of solid foods (0-2 years) in primary care during vaccination visits at 2, 4, 6, 12, 13 months	<p>Barrier</p> <ul style="list-style-type: none"> Increasing complexity of vaccination visits due to recent changes in vaccination visit schedule (QI) <p>Enabler</p> <ul style="list-style-type: none"> Clear, consistent messages regarding infant feeding (QI, QES2) 	<p>Capability: Psychological</p>	<p>Education Training</p>	<p>5.3 Information about social and environmental consequences</p> <p>5.1 Information about health consequences</p> <p>7.1 Prompts, cues</p> <p>6.1 Demonstration of the behaviour</p> <p>4.1 Instruction on how to perform the behaviour</p> <p>8.1 Behavioural practice/rehearsal</p> <p>12.5 Adding objects to the environment</p> <p>7.1 Prompts/cues</p> <p>12.1 Restructuring the physical environment</p> <p>12.1 Restructuring the social environment</p> <p>6.1 Demonstration of the behaviour</p> <p>4.1 Instruction on how to perform the behaviour</p> <p>8.1 Behavioural practice/rehearsal</p> <p>5.3 Information about social and environmental consequences</p> <p>5.1 Information about health consequences</p>
	<p>Barrier</p> <ul style="list-style-type: none"> Lack of time, capacity, and funding for addressing infant feeding (QI, QES2) Lack of suitable, trustworthy resources, and training for primary care HCPs (QI, QES2, SR2) 	<p>Opportunity: Physical</p>	<p>Training Environmental restructuring</p>	
	<p>Barriers</p> <ul style="list-style-type: none"> Competing priorities of infant feeding within core GP/PN role/responsibilities (QI) Lack of clarity regarding HCP roles (QES2) 	<p>Motivation: Reflective</p>	<p>Education Persuasion Incentivization</p>	

Continued

Table 2. (Continued)

BCW Step 1-3	BCW Step 4		BCW Step 5 Intervention functions selected	BCW Step 7 BCTs selected
	Barriers and enablers identified (sources)	COM-B component identified		
Target behaviour				
	Barrier/Enabler <ul style="list-style-type: none">Potential parental or child stress/anxiety due to vaccination but attendance at clinic for non-medical issue (QI)	Motivation: Automatic	Environmental restructuring Persuasion Incentivization Training Modelling	7.1 Prompts, cues 9.1 Credible source 12.5 Adding objects to the environment 7.1 Prompts/cues 12.1 Restructuring the physical environment 12.1 Restructuring the social environment 6.1 Demonstration of the behaviour 4.1 Instruction on how to perform the behaviour 8.1 Behavioural practice/rehearsal 5.3 Information about social and environmental consequences 5.1 Information about health consequences 9.1 Credible source

BCW = Behaviour Change Wheel.

^aPhysical Capability refers to the physical ability to engage in a behaviour, for example, physical skills/strength.; ^bPsychological Capability refers to the ability to engage in the necessary mental processes needed for the behaviour, for example, knowledge/understanding.; ^cSocial Opportunity refers to the social environment and the interpersonal influences, social cues, and cultural norms that influence the way we think about things, for example, social norms.; ^dPhysical Opportunity refers to the opportunities afforded by the physical environment, for example, time, resources, affordability.; ^eReflective Motivation refers to conscious reflective processes involving plans (self-conscious intentions) and evaluations, for example, goals.; ^fAutomatic Motivation refers to automatic processes involving emotional reactions, wants and needs, impulses, and reflex responses, for example, habits.

Table 3. Operationalization of selected BCTs and modes of delivery within CHERIsH intervention

BCT selected in Step 7	Operationalization of BCTs and modes of delivery within CHERIsH
Parent behaviour ^a Instruction on how to perform behaviour (4.1)	<ul style="list-style-type: none"> • HCP to advise parents on how to perform the behaviour using brief verbal messages tailored for each vaccination time-point (2, 4, 6, 12, and 13 months) <ul style="list-style-type: none"> ◦ Brief verbal messages to be developed using existing HSE National Healthy Childhood Programme (NHCP)/Nurture resources to ensure message consistency ◦ Brief verbal messages to be delivered in non-judgemental and positive communication style, and in consideration of differing individual parent needs • HCP to provide parent with intervention resources (CHERIsH leaflet, signposting to child health website, magnet with reminder of verbal messages and infant bib signposting to child health website) which provide further reinforcement regarding how to perform behaviour <ul style="list-style-type: none"> ◦ Parent intervention resources to be developed using existing HSE National Healthy Childhood Programme (NHCP)/Nurture resources to ensure message consistency
Information about health consequences (5.1)	<ul style="list-style-type: none"> • HCP to provide parent with CHERIsH leaflet and child health website (parent intervention resources) which will emphasize health consequences of healthy infant feeding behaviours including long-term health benefits
Information about social and environmental consequences (5.3)	<ul style="list-style-type: none"> • HCP to provide parent with CHERIsH leaflet and child health website (parent intervention resources) which will emphasize social and environmental consequences of healthy infant feeding behaviours including long-term cost and other benefits
Adding objects to the environment (12.5)	<ul style="list-style-type: none"> • HCP to provide parent with parent intervention resources including a fridge magnet and an infant bib with reminder to provide further reinforcement regarding how to perform behaviour
Restructuring the physical environment (12.1)	<ul style="list-style-type: none"> • HCP to provide parent with parent intervention resources including a fridge magnet and an infant bib with reminder to provide further reinforcement regarding how to perform behaviour
Credible source (9.1)	<ul style="list-style-type: none"> • HCP and intervention resources to emphasize credibility and trustworthiness of intervention and associated resources both verbally and through use of HSE National Healthy Childhood Programme logos and branding
Prompts, cues (7.1)	<ul style="list-style-type: none"> • HCP to provide parent with magnet with reminder of verbal messages and infant bib signposting to child health website (parent intervention resources) which will act as prompt/cue for the behaviour
HCP behaviour ^b Credible source (9.1)	<ul style="list-style-type: none"> • CHERIsH researchers to deliver HCP training alongside senior primary care dietician from the NHCP Nurture team and to emphasize credibility and trustworthiness of training providers (e.g., explicit mention of provider credentials and intervention funding) and evidence-based intervention resources (e.g., HSE Nurture website) <ul style="list-style-type: none"> ◦ HCP training to be embedded within existing clinic CPD training schedule

Continued

Table 3. (Continued)

BCT selected in Step 7	Operationalization of BCTs and modes of delivery within CHERIsH
Information about social and environmental consequences (5.3)	<ul style="list-style-type: none"> o HCP training to be developed using existing HSE National Healthy Childhood Programme (NHCP)/Nurture resources to ensure message consistency • HCP training to highlight importance of the HCP as credible source for parents and for the importance of non-judgemental trusting relationships and communication between parent and HCPs • Local practitioner representative (TH) to be used as local opinion leader to provide ongoing verbal support for the behaviour and influence other HCPs to deliver intervention • HCP training and training resources (PowerPoint slides and HCP training manual) to emphasize (verbally and written) health, social, and environmental consequences of healthy infant feeding behaviours including long-term cost and social/environmental benefits • HCPs to also be provided with parent intervention resources (CHERIsH leaflet and child health website), which will emphasize social and environmental consequences of healthy infant feeding behaviours including long-term cost and other benefits
Information about health consequences (5.1)	<ul style="list-style-type: none"> • HCP training and training resources to emphasize (verbally and written) health, social, and environmental consequences of healthy infant feeding behaviours including long-term health benefits • HCPs to also be provided with parent intervention resources, which will emphasize health consequences of healthy infant feeding behaviours including long-term health benefits
Instruction on how to perform behaviour (4.1)	<ul style="list-style-type: none"> • HCP training to advise HCPs on what verbal messages to provide at each time-point and how to do this in addition to provision of parent intervention resources
Demonstration of the behaviour (6.1) Behavioural practice/ rehearsal (8.1)	<ul style="list-style-type: none"> • HCP training to provide HCPs with an observable example of how to deliver brief verbal messages and intervention resources • HCP training to prompt HCPs to practice delivery of verbal messages and intervention materials during the training, in order to increase habit and skill
Adding objects to the environment (12.5)	<ul style="list-style-type: none"> • HCPs to be provided with training resources and CHERIsH poster with verbal messages on it for vaccination rooms as well as parent intervention resources to facilitate performance of the behaviour
Restructuring the physical environment (12.1)	<ul style="list-style-type: none"> • Automated computerized prompts to be used to remind HCP to deliver intervention at vaccination visits • CHERIsH poster with verbal messages on it to be given to HCPs to put up in vaccination rooms
Restructuring the social environment (12.2)	<ul style="list-style-type: none"> • Local primary care HCPs (e.g., PHNs, dieticians) beyond those delivering the intervention (GPs, PNs) to be made aware of the CHERIsH intervention to ensure clarity and consistency across HCP roles and intervention message • On-site study administrator to provide ongoing technical support and assistance for HCPs via to facilitate delivery of intervention

Continued

Table 3. (Continued)

BCT selected in Step 7	Operationalization of BCTs and modes of delivery within CHERIsH
Prompts/cues (7.1)	<ul style="list-style-type: none"> • Automated computerized prompts to be used to remind HCP to deliver intervention at vaccination visits • CHERIsH poster with verbal messages on it to be given to HCPs to put up in vaccination rooms to remind HCP to deliver intervention at vaccination visits

NHCP = National Healthy Childhood Programme.

^aParent behaviour = Parents to adhere to guideline-based early infant feeding practices between 0 and 2 years – Wait until as close to 26 weeks as possible to introduce solids (not before 17 weeks); Feed nutritious and developmentally suitable foods; Respond appropriately to child's hunger and satiety cues.;

^bHCP behaviour = GPs/PNs to provide guideline-based information and support regarding infant feeding and introduction of solid foods (0-2 years) in primary care during vaccination visits at 2, 4, 6, 12, 13 months.

Phase 3: Identify content and implementation options

Step 7: Identify BCTS

Using the BCW guidance (Michie *et al.*, 2011), 11 potential BCTs were linked with intervention functions for the parent-level behaviour, and 15 potential BCTs were linked with the HCP-level behaviour (for full list of BCTs identified see File S3). For the parent-level behaviour, we judged seven BCTs to meet the APEASE criteria that were selected for the intervention. For the HCP-level behaviour, we selected 10 BCTs, which met the APEASE criteria. Selected BCTs for both parent and HCP-level behaviours are provided in Table 2. Full details regarding the application of the APEASE criteria and rationale for decision-making regarding selection of BCTs are provided in File S2.

Step 8: Identify mode of delivery

Lastly, we integrated information from our evidence syntheses (SR1, SR2, SR3, QES1, QES2) and qualitative data collection (FG, QI) with recommendations from our practice and policy representatives (IC) and our international expert steering group (ISC). This guided our final decision-making on the operationalization and modes of delivery of BCTs within the CHERIsH intervention and implementation strategy. Full details are provided in Table 3.

For example, our informal consultations with policy representatives (IC) identified a number of existing resources that had been recently developed by the National Healthy Childhood Programme. These included a list of brief evidence-based infant feeding messages linked to all health service contact points between the ages of 0 and 2 (including vaccination visits) to ensure consistency of messages across health care providers, a child health website ('HSE MyChild.ie,'), and a number of online training modules for HCPs in relation to infant feeding. We decided to use content from these resources within our intervention to operationalize some of the BCTs identified in Step 7. For instance, we decided that the BCT 'Instruction on how to perform the behaviour' would be operationalized by having HCPs deliver brief infant feeding messages to parents on how to

Figure 1. Logic model of the finalized intervention. Numbers on arrows represent BCTs used to target specific mechanisms – these BCT numbers are explained in Tables 2 and 3; HCPs = health care professionals; BCT = behaviour change technique

perform the behaviour (e.g., responding to infant cues) at each vaccination time-point, in addition to signposting them to the child health website, which provided further information, resources, and reinforcement of the verbal messages. The exact wording and mode of delivery of the brief messages were informed by the findings of our systematic reviews of effectiveness (SR1) and theory use (SR3), our qualitative evidence syntheses (QES1, QES2), and qualitative data collection (FG, QI) in consultation with the practice and policy representatives (IC) to ensure alignment with existing National Healthy Childhood Programme messages. Likewise, we used content from existing National Healthy Childhood Programme training modules for HCPs relevant to our intervention to develop training and resources for HCPs as part of our implementation strategy, with the mode of delivery informed by findings of our systematic review of fidelity (SR2), qualitative evidence synthesis of HCP experiences of infant feeding interventions (QES2), and HCP interviews (QI).

The international steering committee expert meeting (ISC) identified three main recommendations for further consideration in finalizing the intervention components and mode of delivery. These related to (1) the involvement of primary care HCPs beyond the practice nurses and general practitioners who would be delivering the intervention, (2) the need for augmented HCP training beyond the existing National Healthy Childhood Programme online modules, and (3) the degree of flexibility/tailoring permitted regarding the brief verbal messages. We reviewed these issues during a subsequent CHERIsH team meeting and decided to (1) ensure that all primary care and community-based HCPs within the relevant area were made aware of the intervention, (2) develop a group-based face-to-face training for HCPs utilizing the content from the existing online modules, and (3) ensure that the core intervention messages were kept consistent, but that the training would facilitate HCPs to deliver them in a flexible manner.

The finalized CHERIsH intervention and implementation strategy

In brief, the finalized CHERIsH parent-level intervention consists of (1) verbally delivered brief infant feeding messages and (2) provision of additional infant feeding resources including an information leaflet, a magnet, an infant bib, and signposting to the National Healthy Childhood Programme child health information website. The intervention is to be delivered by the HCP providing the vaccination (i.e., practice nurse or GP) at the 2-, 4-, 6-, 12- and 13-month vaccination visits, just before the delivery of the vaccination. The finalized HCP-level implementation strategy to support delivery of the parent-level intervention consists of (1) A local opinion leader, (2) Incentivized HCP training, (3) Distribution of supporting HCP resources and educational materials, (4) Electronic delivery prompts for HCPs, (5) Awareness raising across all HCPs within the clinical practice and local primary care community, and (6) Provision of local technical support and assistance. Further details of the finalized intervention and implementation strategy including the brief messages and leaflet content are provided in File S3, and described using the TIDieR checklist in File S4. Figure 1 depicts the logic model for the intervention as recommended by Davidoff, Dixon-Woods, Leviton, and Michie (2015) to articulate and graphically represent the intervention structures, processes, and contextual factors intended to achieve the targeted aims and objectives.

Discussion

This study provides a unique example of the development of an empirically-based brief intervention aimed at improving parental infant feeding behaviours to prevent childhood obesity, alongside the concurrent development of an implementation strategy to support and sustain intervention delivery by HCPs within routine primary care settings. The study describes the use of the Behaviour Change Wheel approach to comprehensively and systematically integrate multiple sources of evidence to incorporate perspectives from policy, practice, research, and parent stakeholders.

It has been estimated that only approximately 14% of health care research gets implemented into practice (Gitlin, 2013; Green *et al.*, 2009). As such, an earlier focus on sustainability, and development of interventions that are designed to be implementable and put into practice on a larger scale is warranted (Brownson *et al.*, 2013; Curran *et al.*, 2012; Glasgow *et al.*, 2003). In order to do this, it is important to explicitly consider behavioural changes needed across multiple levels, and in particular, those of the HCPs needed to deliver interventions in health care settings. However, despite the importance of this, many interventions do not consider the broader implementation requirements from the outset, nor the specific HCP behaviours needed to facilitate the behaviour change at patient/individual level (Brownson *et al.*, 2013; Toomey *et al.*, 2018). A key strength of our study is its explicit focus on the behaviour change needed at a HCP level, and the strategies required to enable this, in order to facilitate the delivery of the intervention to parents. If the intervention proves to be feasible and effective, the development of a multi-faceted implementation strategy to be tested alongside the intervention itself provides us with a thorough, evidence-based strategy that will enable the translation of research findings into practice more rapidly.

The development of the CHERIsH intervention and implementation strategy was informed by a substantial number and variety of sources from multiple perspectives. This enabled a comprehensive approach to intervention development; however, integrating the findings from each of the sources was complicated, as was disentangling evidence

from particular sources to determine exactly where they contributed. This process was further complicated by the fact that sources were often conducted in parallel due to time constraints, with findings combined iteratively throughout the course of the intervention development. However, the breadth and depth of sources used has resulted in an intervention and implementation strategy that is based on existing international evidence, but is also cognizant of local stakeholder needs and in alignment with national programmes and policy. The use of international experts from a variety of disciplines was also an important step and enabled us to develop an intervention that is informed by international learning and best practice; such that while developed in an Irish context, this study has broader international relevance. A CHERIsH patient and public involvement (PPI) group was also established and is described in the feasibility study protocol (Matvienko-Sikar *et al.*, 2019). The purpose of this group was to advise on study design and data collection procedures including study questionnaires. This decision was taken to avoid overburdening the PPI group and minimize duplication of effort across the PPI group and parent focus groups detailed in this study, as these focus groups specifically explored parents' opinions of the proposed intervention to incorporate parent perspectives within the intervention development. However, it is acknowledged that the finalized intervention may have benefitted further from additional insights from the PPI group.

The Behaviour Change Wheel was used within this study to guide the development of both the parent-level intervention and the implementation strategy targeting HCP behaviour change in a thorough, transparent, and systematic way (Michie *et al.*, 2011). Use of the BCW also enabled us to make the programme theory underlying both aspects of our intervention explicit, by facilitating our development of a logic model linking specific intervention components to study outcomes, via the intended mechanisms of change. While several other implementation frameworks or models could have been used to develop the HCP-level implementation strategy (Nilsen, 2015), the BCW was specifically developed to improve the design and implementation of evidence-based practice (Michie *et al.*, 2011) and has previously been used to develop implementation strategies to support the delivery of patient-level interventions (Gould *et al.*, 2017; Mc Sharry, Murphy, & Byrne, 2016; Sinnott *et al.*, 2015). However, examples of studies that have used the Behaviour Change Wheel approach with this amount of evidence sources from such varied perspectives are rare; our study showcases the transparent and systematic development of a thorough and extremely comprehensive evidence-based intervention and associated implementation strategy. The transparency of this process will enable better testing of hypothesized causal pathways and facilitate future replication and/or refinement of the developed intervention.

Implications for future research

Childhood overweight and obesity is an extremely challenging public health issue, the aetiology of which is influenced by a complex interplay of multiple genetic, environmental, and lifestyle factors (Lytle, 2009; Sahoo *et al.*, 2015). While there are a large number of factors which impact childhood obesity, the CHERIsH intervention provides an example of an evidence-based approach towards addressing one of these factors, and if successful will contribute an important piece to the overall puzzle. The next stages of this research are to evaluate the acceptability and feasibility of both the parent intervention and the HCP implementation strategy in a feasibility study (Matvienko-Sikar *et al.*, 2019). This will facilitate the refinement of the intervention and its implementation strategy, and

inform the next stages of the CHERIsH study, which will explore the effectiveness of both aspects.

Conclusions

This study provides a rigorous example of the development of an implementation strategy to facilitate HCP behaviour change, to support the implementation of an intervention aimed at improving parental adherence to recommended infant feeding behaviours. In addition, this study provides a unique example of integrating multiple different sources of evidence to guide the use of the BCW approach for multi-level behaviour change. As such, the transparency of the processes detailed in this paper will be of significant value for other researchers looking to accelerate findings into practice by planning for implementation from the outset, in a comprehensive and systematic manner.

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Conflicts of interest

All authors declare no conflict of interest.

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Author contribution

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Data availability statement

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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Supporting Information

The following supporting information may be found in the online edition of the article:

File S1. Selection of intervention functions.

File S2. Selection of behaviour change techniques (BCTs).

File S3. Finalised CHERISH parent-level intervention and HCP implementation strategy.

File S4. Description of the finalised intervention and implementation strategy using the TiDieR checklist.