ORIGINAL RESEARCH

Measuring and modelling body mass index among a cohort of urban children living with disadvantage

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Abstract

Aim. To report on baseline outcomes of body mass index, eating habits and physical activity of a cohort of urban disadvantaged children from a longitudinal evaluation of a school based, health promoting initiative.

Background. The healthy schools programme was developed for implementation in schools located in disadvantaged areas of Dublin, Ireland.

Design. A prospective, cohort study design was implemented.

Method. A 3-year longitudinal evaluation was conducted in five intervention and two comparison schools between 2009–2011. Data were collected on each participating child to determine their eating habits, levels of physical activity and body mass index at year 1 (baseline), year 2 and year 3. Independent *t*-tests were used to compare mean values, chi-square and Fishers exact tests were used to compare proportions at baseline.

Results. Participation rates were over 50%. Older children reported eating on average more fruit and vegetables than younger children; breakfast was often eaten on the way to, or in school and in one age group 16.7% of intervention children reported they did not eat breakfast that day. Levels of physical activity varied with over 70% of younger children stating they never played a sport. In intervention schools over one quarter of all children were either overweight or obese. A comparison was conducted between the proportion of 9-year olds overweight and obese in our disadvantaged cohort and a national random sample of 8500 9-year olds and no important differences were observed.

Conclusion. Baseline results indicate that body mass index rates particularly among pre adolescent, urban disadvantaged girls are of concern.

Keywords: body mass index, child obesity, children's nursing, disadvantage, measuring BMI, school, urban

Introduction

Childhood obesity has increased dramatically worldwide (Cole *et al.* 2000, Griffin *et al.* 2007, Pedrosa *et al.* 2009) and is now considered an important global public health problem (Department of Health & Children 2005). It is estimated that 10% of the world's school-aged children are overweight and a quarter of these fall into the obese category [International Obesity Task Force (IOTF) 2002, Lobstein *et al.* 2004]. Current trends also show that childhood obesity rates are significantly higher in developed countries (Lobstein *et al.* 2004, Pedrosa *et al.* 2009) and are related to sedentary leisure time (Liou *et al.* 2010).

Background

Globally, childhood obesity is on the increase at an alarming rate and in Ireland alone the number of overweight adolescents has increased threefold since the early 1990s (Griffin *et al.* 2007). Obesity in childhood is a multisystem disease caused by various factors such as diet, physical activity, genetics and family factors (Ebbeling *et al.* 2002). To date much research has been conducted in the arena of this childhood pandemic and the extent to how it can potentially affect children's lives has been well documented.

Childhood obesity can have significant detrimental consequences on a child's health and well-being throughout their life. It is estimated that in Europe over 20,000 obese children have type 2 diabetes and more than 400,000 have impaired glucose tolerance (Jackson-Leach & Lobstein 2006). Figures like these indicate that childhood obesity has indeed reached pandemic proportions and the impact that this will have on European children, families and health services will be immense. Childhood obesity has been found to follow children into adulthood thereby emerging as a lifelong obstacle. A systematic review conducted by Singh *et al.* (2008) conclusively found that overweight children are at least twice as probable to become overweight adults in comparison to normal weight children. Another systematic review by Arenz *et al.* (2004) found that how children are fed in infancy influences the likelihood of obesity in childhood. The review found that breast-fed infants have a significantly reduced risk of developing obesity in childhood.

A study conducted in the Republic of Ireland and Northern Ireland by Whelton *et al.* (2007) found that the overall prevalence of overweight and obesity was higher among girls than that in boys in both jurisdictions. The study also revealed that in the Republic of Ireland the highest prevalence of overweight was among young teenage girls (13 years) and alarmingly, obesity among 7-year-old girls.

In the longitudinal Growing Up in Ireland study (Department of Health & Children 2009) findings from the 9-year-old cohort demonstrate a clear relationship between parental weight status and rates of childhood obesity. The study revealed that in households where both parents were overweight, 24% of children were overweight and 9% were obese. In households where one parent was overweight, 16% of children were overweight and 4% were obese. Finally in households where neither parent was overweight, 10% of children were overweight and 1% obese.

Although our knowledge of the global impact childhood obesity has on public health has increased, there still exists a deficit of international epidemiological information on the disease (Jansen *et al.* 2005) and the implications of the disease for nursing practice (Brown *et al.* 2007). Excess body weight is now recognized as the most prevalent childhood disease in Europe (Department of Health & Children 2005) and for this reason it is essential to establish whether or not Irish trends are following a similar pattern of escalation (Barron *et al.* 2009).

Body Mass Index (BMI) is the most common method of establishing the amount of fat that an individual is carrying. Although BMI is widely used in the adult population and it is internationally recognized that 30 kg/m² and above is indicative of obesity; in childhood BMI changes significantly with age and therefore must be assessed in terms of the age and gender of the child. Estimation of BMI values in children depends on comparison with population reference data and BMI cut-off points are established by taking age and gender into consideration. Obesity assessment in the paediatric population is complicated by a lack of consensus on the criteria for classifying a child as being overweight or obese. The study reported in this article uses the age and gender-specific cut-off measurements as provided by the International Obesity Task Force (IOTF) (Cole *et al.* 2000).

The study

Aim

The aim of the study was to give baseline results from a longitudinal comparative evaluation of a healthy schools initiative focusing specifically on three of the seven targeted child health and well-being outcomes. The three child health and well-being outcomes relate specifically to children's physical development and they are:

- Children demonstrate age-appropriate physical development.
- Children are physically fit.
- Children eat healthily.

Design

The healthy schools programme draws on a 'whole school approach' to health promotion in schools (Lahiff 2008). This approach is based on the guiding principles of the Ottawa Charter for Health Promotion (World Health Organisation 1986) and the more recent Vilnius Resolution in 2009. For this reason the overall study was also based on a whole school approach including children, teachers, parents/guardians and other school related personnel. The overall study utilized a mixed methods approach to data collection to evaluate all seven child health and well-being outcomes. This article, however, focuses on three aspects of the data, healthy eating, levels of physical activity and children's BMI data. To measure the three outcomes that relate to the children's physical well-being, health data were collected in term two of year one 2009 (baseline), term two of year two 2010 and again in term two of year three 2011.

Sample

The study was carried out in seven schools all located in RAPID (Revitalising Areas by Planning Investment and Development) areas of Dublin, Republic of Ireland. The sample frame comprised of five intervention schools where a healthy schools programme was piloted and two comparison schools without the programme. All children from junior infants (4 years old) to fifth class (12 years old) were invited to take part in the study.

The class teacher of every class in participating schools was employed as a gatekeeper to protect the interests of potential participants and also to ensure voluntary participation. The teachers facilitated the distribution of sealed information packs to each child in their class. The sealed information pack contained an information sheet detailing the study and a consent form. The teachers asked the children to give the packs to their parent/guardian and also showed the children a box where they could return the consent forms. Specific inclusion and exclusion criteria were drafted by the research team to help guide the sampling process.

The inclusion criteria for participation in the study were:

- Children from junior infants (4 years) to fifth class (12 years) of academic year 2008/09 will be eligible for participation.
- Parent/Guardian must consent to their child taking part.
- The child must be willing to take part on the day of measurement.

The exclusion criteria for the study were:

- Parents/Guardians who do not consent to their child taking part.
- The child who does not wish to take part on the day of measurement.
- Children who are in sixth class (12 years) as they will not be in the school next year for follow-up
- Children who are in fifth class (11 years) at baseline will be excluded from the 2-year follow-up.

In preparation for the study the research team met with the school principals to agree procedures for the research and also to answer any questions. This was an invaluable process as it enabled the research team to run the study smoothly while ensuring as little disruption as possible to the children, the teachers and daily school life. The research team provided each school with posters detailing the study, its aims and objectives. These posters were displayed in the schools so that children, parents/guardians and teachers could familiarize themselves with the study. The children's nurse on the research team also visited each class in each school annually 1 month prior to the commencement of measurement. These visits helped to build a rapport with the children which was important as the children's nurse would be working closely with the children for the purpose of obtaining their BMI measurements.

Data collection

The Health Related Behaviour Questionnaire or HRBQ (Balding 2002), an extensive health enquiry instrument was used to measure healthy eating and physical activity. Pupils aged 7–11 anonymously completed the questionnaire in school, for younger children parents completed the questions. The HRBQ has previously been used in the UK to evaluate a nationwide Healthy Schools initiative (e.g. The Students Health Education Unit 2007).

For the BMI measurements children were weighed on digital scales (SECA 875 digital flat scale) in their stockings and all heavy outdoor clothing was removed. Digital scales have been found to be most accurate for weighing children (Gerner *et al.* 2006). Height was recorded using a SECA Leicester portable height measure (SE001) which was stabilized against a wall. Children were not stretched but positioned in the Frankfurt plane and a weighted headboard was not used. Waist circumference was recorded by measuring the midpoint between the top of the iliac crest and the last rib. BMI was calculated by dividing the individual's weight in kilograms by their height in metres squared (weight in kg/height in m² = BMI) (See supporting information Data S1 in the online version of the article in Wiley Online Library).

Ethical considerations

The relevant institutional ethics committee approved the study.

Consent

Informed consent was obtained from the child's parent/guardian prior to data collection. Kodish (2005) specifies that when conducting research involving children, informed consent essentially comprises of parental permission and the assent of the individual child. For this reason the assent of each participating child was confirmed on the day of data collection.

Study protocol

A protocol for data collection was developed by the research team. This protocol included the visits to the schools by the children's nurse on the team as mentioned earlier. These visits helped to establish a positive rapport with the children which is an essential element of conducting research involving children (Scott 2003). The protocol also ensured that consistency was maintained throughout the longitudinal study and also that ethical principles were maintained at all times.

Child protection

The research team underwent Health Service Executive, child protection training in preparation for conducting research with children. Each member of the research team also underwent personal vetting with An Garda Síochána (Irish police force) prior to the study.

Child development

The study sample comprised of children of various ages from 6–12 years. This was a crucial factor in the study because children of various ages have different levels of understanding. To ensure that ethical principles were upheld for all children the research team incorporated into the study protocol, the acknowledgement of the various ages of the children. Age-appropriate language and play were integrated into the process of data collection. Specific time was set aside prior to the commencement of each individual measurement to ensure that the child assented to being measured. As active participants in the research process feedback was provided for each participating child in an age-appropriate manner and all children were praised and thanked individually for giving their time and taking part in the study.

Data protection

Each child was allocated a personal identification code for the duration of the longitudinal study. All data was stored

safely and securely in accordance to the Data Protection Act (Ireland) (1988).

Data analysis

The null hypothesis was that the Healthy Schools Programme does not change eating habits, levels of physical activity and BMI outcome, the alternative hypothesis was that the Programme improves these outcomes. At baseline the null hypothesis was that there was no difference between the intervention and the comparison school, the alternative was that there was a difference. Further hypotheses for analysis were, there is no difference between proportions of male participants and female participants in each of the BMI categories and there is no association between proportion in each BMI category and age. Independent t-tests were used to compare mean values, Chi squared tests were used to test for independence between gender and BMI category and between age group and BMI category.

Validity and reliability

BMI that is widely used in the adult population has become recently recommended for use in children and adolescents. It must be remembered, however, that the assessment of weight status and body fat in the younger population is more complex. This is due to the nature of a child's growth and development and therefore it must be assessed in terms of the age and the gender of the child. Estimation of BMI values in children depends on comparison with population reference data and BMI cut-off points are established by taking age and gender into consideration. Currently in Ireland no standards exist for assessing Irish children (Department of Health & Children 2005), however, recent studies have used the age and gender-specific cut-off measurements from the International Obesity Task Force (Department of Health & Children 2005, 2009). Measurements were obtained by a children's nurse who received training in child anthropometry prior to the study commencement. The margin of error for measurement was significantly reduced as one individual measured the children throughout the study period. High quality standardized measuring equipment was used to record data.

Results

A total of 537 children (266 boys and 361 girls) took part in year 1 (baseline) of the BMI study ranging in ages from 4–12 years old. These children represented over 50% of all children attending the seven schools. The mean age of the

266 boys was 8.33 years with a 95% confidence interval of [8.10, 8.57]. The corresponding mean age of the 271 girls was 8.10 years with a 95% confidence interval of [7.86, 8.35]. Analysis of the overall BMI by type of school, comparison or intervention, revealed no statistically significant differences in the distribution of the BMI's between school types ($\chi^2 = 3.46$, d.f. = 2, $P = 0.178$).

The Cole international cut-off values, recommended by the IOTF indicated that the overall prevalence of children who were overweight was 101 of which 39 were boys and 62 were girls. The rate of being overweight in the sample was 18.8% with boys accounting for 7.26% of the total and girls accounting for 11.54% of the total. The percentage of the boys who were overweight (Ow) was 14.7% and of the girls it was 22.9%.

The overall number of children who were obese (Ob) was 60. A total of 32 of these were boys representing 5.95% of the total population and 12.03% of the boys. A total of 27 of these were girls representing 5.02% of the total population and 9.96% of the girls.

There were 161 children (30% of the sample) who fell into the overweight (Ow) or obese (Ob) categories. This number can be broken down by gender into 90 for the girls and 71 for the boys. The number of boys who were obese or overweight was similar at 39 and 32, respectively, whereas over twice as many girls were overweight, compared with the numbers who fell into the obesity category. The percentage of girls who were overweight or obese (Ow/Ob) was 33.2% as compared with the boys at 26.7%. Full details of all the proportions overweight or/and obese or both are provided in Table 1.

An independent-samples *t*-test was conducted to compare the mean BMI scores of the boys and girls. There was no statistically significant difference in the BMI scores between the boys (mean = 18.24, SD = 3.41) and the girls (mean = 18.02, SD = 2.97) with a *t* value of 0.796

(d.f. = 535) and a *P* value of 0.426. The BMI scores were also compared for each age group and the error plot seen in Figure 1 shows clearly, that the average BMI scores are increasing for the entire sample with age.

The error plot in Figure 1 suggests that there is a relationship between BMI scores and age. This association was explored using the Pearson product-moment correlation coefficient. The correlation coefficient ($r = 0.35$, $P < 0.005$) indicates a medium positive linear correlation between BMI score and age, using Cohen's (1988) that a medium correlation ranges from 0.30–0.49. A linear regression model was used to measure the effect of each year's increase of age on BMI for the cohort and subgroups. A 1 year increase in age resulted in an increase of 0.55 in the average BMI score in the entire cohort. This increase was lower (0.37) in the normal/underweight group but a good deal higher in the overweight and obese groups indicating increases of 0.83 and 1.10 in the BMI scores for each year increase in age.

Figure 1 Average BMI scores with confidence intervals per age group.

Table 1 Sample sizes by gender & age with numbers underweight & normal (Uw/N), overweight (Ow), obese (Ob), obese & overweight (Ow/Ob).

Age	Males				Females				Totals			
	Uw/N	Ow	Ob	Ow/Ob	Uw/N	Ow	Ob	Uw/Ob	Uw/N	Ow	Ob	Ow/Ob
4	2	0	0	0	–	–	–	–	2	0	0	0
5	21	2	3	5	29	7	6	13	50	9	9	18
6	23	3	2	5	22	5	4	9	45	8	6	14
7	31	3	3	6	23	11	5	16	54	14	8	22
8	17	10	4	14	24	6	3	9	41	16	7	23
9	46	5	8	13	25	10	5	15	71	15	13	28
10	27	9	8	17	31	14	3	17	58	23	11	34
11	25	7	3	10	23	8	2	10	48	15	5	20
12	3	0	1	1	4	1	0	1	7	1	1	2
Totals	195	39	32	71	181	62	28	90	376	101	60	161

In 2008/2009 a major longitudinal study was undertaken in Ireland called 'Growing up in Ireland', which followed the development over a 3-year period of infants and 9-year olds nationwide. The sample size for the 9-year olds was 8500 and the IOTF recommended Cole measures were also used allowing a comparison of the proportions in each BMI category with the 9-year olds in the present study. In the 'Growing up in Ireland' study 26% of 9-year olds were found to be overweight or obese. A z test was used to compare the two studies ($P_1 = 0.26$, $n_1 = 8500$) and ($P_2 = 0.283$, $n_2 = 99$) and the resulting z value of 0.51 indicated that there was no important difference between the results observed in our study of urban disadvantaged children and that of the national random sample obtained in the Growing Up in Ireland study.

Analysis of the results from the Health Related Behaviour Questionnaire (HRBQ) revealed that there was no important difference between the number of fruit and vegetables eaten by children in the intervention and comparison schools. However, the number of pieces of fruit and vegetable eaten by younger children was lower (on average two pieces a day) than that eaten by older children (on average four pieces a day). An analysis of children's breakfast eating habits revealed no important difference between intervention and comparison schools but the proportion of children who did not eat breakfast that day was lowest among younger children and increased with older children. Details of breakfast eating habits are provided in Table 2.

Levels of engagement in physical activity outside of school activities were measured and although no significant differences were observed between intervention and comparison schools the level of activity varied considerably by both class group and nature of activity. Encouragingly almost 50% of older children played a sport 3 or more days a week but a proportion ranging from 14% in intervention schools to 17% in comparison schools never played sports outside of school. Details of all physical activities are provided in Table 3.

Discussion

The baseline null hypothesis in this study was that there was no difference between outcomes in the comparison and intervention urban disadvantaged schools. The alternative null hypothesis was that there was a difference. No differences between comparison and intervention schools were observed in BMI, healthy eating habits and levels of physical activity.

A more detailed analysis of BMI using the International Task force on Obesity (IOTF) Guidelines for Childhood Overweight and Obesity, found that there were more obese

boys than girls but significantly more overweight girls than boys (Table 1). It also showed that from age 7 years onwards as age increases so too does BMI in both boys and girls (Figure 1).

All research studies demonstrate particular strengths and weaknesses in their design and it is important that these are made explicit on study presentation. An important strength of this study article is that it details how measurements were planned and obtained for a cohort of urban disadvantaged children. This article also details how these children were active participants in the research process and also how the research team ensured that the experience was a positive experience for participating children. An additional strength of the study is that one measurer recorded all the measurements which significantly reduced the margin of error that could be associated with multiple measurers, while at the same time ensured consistency of the study research protocol. A further strength of this study is the repeat measurement of the same children over several years as this helped to determine the increase of overweight/obesity with age. A possible weakness of the study is that in the results there is no differentiation between normal weight and underweight. In this particular population of disadvantaged children underweight status may be an important factor in the population and underweight status was highlighted by participating schools as being a possible issue.

In the UK and Ireland, previous studies using the IOTF classification found prevalence of obesity to be between 21–27% in both boys and girls (Stamatakis 2004, McMaster *et al.* 2005, Barron *et al.* 2009). Barron *et al.* (2009) compare their results with a previous study (Whelton *et al.* 2007) and suggest that overweight/obesity levels in children are stabilizing in Ireland. However, in this study of children aged 4–12 years, 33.2% of girls and 26.7% of boys were either overweight or obese (Table 1) showing an increase. Kelleher *et al.* (2003) identified that in Ireland, levels of obesity in adults are higher in lower socioeconomic groups. However, this study shows no difference between schools in a disadvantaged area and comparison schools in all child age groups. Similar results are presented in the Growing up in Ireland study for 8500, 9-year olds, which was a nationwide, random sample study. Thus, it is of concern that overweight/obesity is presenting as an increasing national problem among all socioeconomic groups. The rate of overweight and obesity in girls is particularly worrying in this study as BMI in both genders increases with age. Ruxton (2004) identifies that obesity increases with age and is a major risk to girls especially during adolescence. The levels of overweight and obesity among children in this study strengthens the need to address this early to deal with

Table 2 Breakfast eating habits among the cohort of urban disadvantaged children in intervention and comparison schools across three class groupings.

Did you eat breakfast this morning	Junior and senior infants* Age 4–7 years		First and second class† Age 6–9 years		Third, fourth, fifth class‡ Age 8–12 years		Total
	I	C	I	C	I	C	
No	3.1%	0%	16.7%	8.1%	11.7%	12.5%	51
	3	0	16	3	21	8	
Yes, at home	89.6%	91.3%	47.9%	62.2%	60.3%	68.8%	328
	86	21	46	23	108	44	
Yes, on the way to school	0%	0%	11.5%	2.7%	4.5%	4.7%	23
	0	0	11	1	8	3	
Yes, at school	5.2%	8.7%	5.2%	5.4%	6.7%	6.2%	30
	5	2	5	2	12	4	
Yes, at home and on the way to school	0%	0%	5.2%	8.1%	4.5%	1.6%	17
	0	0	5	3	8	1	
Yes, at home and at school	2.1%	0%	7.3%	10.8%	9.5%	4.7%	33
	2	0	7	4	17	3	
Yes, on the way and at school	0%	0%	1%	2.7%	0%	0%	2
	0	0	1	1	0	0	
Yes, at home, on the way to school and at school	0%	0%	5.2%	0%	2.8%	1.6%	11
	0	0	5	0	5	1	
Total	96	23	96	37	179	64	495

*Fishers exact = 1.123, Exact sig = 0.875. †Fishers exact = 7.907, Exact sig = 0.308. ‡Fishers exact = 2.82, Exact sig = 0.848.

current and future public health issues. It is particularly of concern for the educational and health professionals that deal with children on a regular basis.

The Irish government recognized the growing problem in Ireland and set up The National Taskforce on Obesity (Department of Health & Children 2005) which dealt with both adults and children. Recommendations were made in the areas of high level government, education sector, social and community sectors, health sector, food commodities, production and supply and physical environment which recognizes that a multi-sectored approach is needed to address what appears to be a nationwide problem. The development of National Guidelines for Community Practitioners on Prevention and Management of Childhood Overweight and Obesity (McMaster *et al.* 2005) made further recommendations for the community management of obesity.

A recommendation of the National Taskforce (2005) was for all children through the school system to have a growth assessment for both underweight and overweight. It was suggested that these could be done at school entry (4–5) and at regular intervals (9–11 and 14–16 years) through the child's development. The findings of this study would suggest that the intervals for childhood measurement need to be more regular and before age nine, as at age nine quite a proportion of children are presenting as overweight or obese and this proportion increases with age. In addition, it

is identified that children go through periods of 'puppy fat' often before a growth spurt (Ruxton 2004). Thus, by having regular measurements these periods can be discounted and children who are at risk of overweight/obesity can be targeted. Schools are an ideal environment for health promotion programmes aimed at preventing overweight and obesity (McMaster *et al.* 2005). In these, parents and children could then be facilitated to make changes working with relevant healthcare professionals. Elsewhere, in terms of nursing and healthcare practice, systematic reviews have demonstrated that practitioners must be involved in well-constructed implementation and evaluation studies that build on the limited base of current evidence (Wofford 2008). The key choices for obesity treatment are diet, physical activity, lifestyle and behavioural changes (Ruxton 2004) all of which could be addressed in a school environment. The use of a whole school approach can be adopted in this.

To develop a national approach there is a need for regular data to be collected to compare with WHO (Barron *et al.* 2009). McMaster *et al.* (2005) outlined that a lack of universally accepted measurements means that defining prevalence rates continues to arise. If the recommendations above are to be implemented a standardized measurement needs to be utilized. This study advances this as the methods of measurements are detailed. Ruxton (2004) identifies that the sole use

Table 3 Levels of physical activity outside of school among a cohort of urban disadvantaged children in intervention and comparison schools across three class groupings.

Class groups Intervention comparison		Junior and senior infants*		First and second class [†]		Third, fourth, fifth class [‡]		
		Age 4–7 years		Age 6–9 years		Age 8–12 years		
		I	C	I	C	I	C	
Riding your bike	Never	24.2%	12%	23.2%	13.9%	26.0%	26.6%	
		24	3	22	5	47	17	
	34	6	25	14	63	21		
	41	16	48	17	71	26		
	Class groups Intervention comparison		Junior and senior infants [§]		First and second class [¶]		Third, fourth, fifth class ^{**}	
Age 4–7 years			Age 6–9 years		Age 8–12 years			
I			C	I	C	I	C	
Running	Never	4%	0.0%	14.3%	6.2%	6.7%	6.2%	
		4	0	13	2	12	4	
	15	1	22	14	51	19		
	80	24	56	16	115	41		
	Class groups Intervention comparison		Junior and senior infants ^{††}		First and second class ^{‡‡}		Third, fourth, fifth class ^{§§}	
Age 4–7 years			Age 6–9 years		Age 8–12 years			
I			C	I	C	I	C	
Dancing/Gymnastics	Never	44.4%	44%	35.5%	33.3%	36.8%	45.2%	
		44	11	33	11	64	28	
	28	11	25	11	44	20		
	27	3	35	10	66	14		
	Class groups Intervention comparison		Junior and senior infants ^{¶¶}		First and second class ^{***}		Third, fourth, fifth class ^{†††}	
Age 4–7 years			Age 6 to 9 years		Age 8–12 years			
I			C	I	C	I	C	
Going on walks	Never	15.2%	8.0%	18.3%	16.7%	14.9%	18.5%	
		15	2	17	6	27	12	
	37	8	32	17	77	25		
	47	15	44	13	77	28		

of BMI underestimates obesity and suggest that waist measurements may be more appropriate as they measure central obesity. Central obesity in particular is a risk factor for type 2 diabetes and heart disease. This study measures both BMI and waist circumference and calculates the data accordingly.

Conclusion

It was found that pre-teen girls are demonstrating significantly high BMI values. Findings also suggest that there is a relationship between BMI scores and age. To move for-

Table 3 (Continued).

Class groups Intervention comparison		Junior and senior infants ^{†††} Age 4–7 years		First and second class ^{§§§} Age 6–9 years		Third, fourth, fifth class ^{¶¶¶} Age 8–12 years	
		I	C	I	C	I	C
Swimming	Never	66.7%	60.0%	15.2%	28.6%	16.1%	23.4%
		66	15	14	10	28	15
	1–2 days a week	33.3%	40.0%	41.3%	31.4%	48.9%	54.7%
		33	10	38	11	85	35
	3 or more days a week	0%	0%	43.5%	40.0%	35.1%	21.9%
		0	0	40	14	61	14
Class groups Intervention comparison		Junior and senior infants ^{****} Age 4–7 years		First and second class ^{††††} Age 6–9 years		Third, fourth, fifth class ^{‡‡‡} Age 8–12 years	
		I	C	I	C	I	C
Playing with friends	Never	2.0%	0.0%	8.4%	10.3%	5.2%	1.6%
		2	0	8	3	9	1
	1–2 days a week	7.1%	4.0%	28.4%	24.1%	20.1%	20.3%
		7	1	27	7	35	13
	3 or more days a week	90.9%	96.0%	63.2%	65.5%	74.7%	78.1%
		90	24	60	19	130	50
Class groups Intervention comparison		Junior and senior infants ^{§§§§} Age 4–7 years		First and second class ^{¶¶¶¶} Age 6–9 years		Third, fourth, fifth class ^{*****} Age 8–12 years	
		I	C	I	C	I	C
Playing a sport	Never	72.7%	76.0%	25.8%	39.3%	14.0%	16.9%
		72	19	25	11	24	11
	1–2 days a week	19.2%	24.0%	25.8%	28.6%	36.8%	33.8%
		19	6	25	8	63	22
	3 or more days a week	8.1%	0.0%	48.5%	32.1%	49.1%	49.2%
		8	0	47	9	84	32

*Fishers exact = 3.921, Exact sig = 0.145. †Fishers exact = 2.439, Exact sig = 0.319. ‡Fishers exact = 0.107, Exact sig = 0.965. §Fishers exact = 2.661, Exact sig = 0.252. ¶Fishers exact = 4.540, Exact sig = 0.098. **Fishers exact = 0.069, Exact sig = 0.971. ††Fishers exact = 3.462, Exact sig = 0.193. ‡‡Fishers exact = 1.152, Exact sig = 0.586. §§Fishers exact = 4.973, Exact sig = 0.087. ¶¶Fishers exact = 1.313, Exact sig = 0.501. ***Fishers exact = 1.873, Exact sig = 0.376. †††Fishers exact = 0.640, Exact sig = 0.744. ‡‡‡Fishers exact = missing, Exact sig = 0.639. §§§Fishers exact = 3.011, Exact sig = 0.227. ¶¶¶Fishers exact = 4.382, Exact sig = 0.115. *****Fishers exact = 0.390, Exact sig = 1.000. ††††Fishers exact = 0.381, Exact sig = 0.848. ‡‡‡‡Fishers exact = 1.258, Exact sig = 0.586. §§§§Fishers exact = 1.943, Exact sig = 0.360. ¶¶¶¶Fishers exact = 2.788, Exact sig = 0.254. *****Fishers exact = 0.444, Exact sig = 0.814.

ward and find an effective solution to the worldwide public health problem of childhood obesity policy needs to be directed at children from an early age. From the findings of this study it is clear that Irish government policy needs to adopt a comprehensive national strategy towards combating childhood obesity and increasing the health and well-being of Irish children. It is also clear from existing research that the current worldwide childhood obesity pandemic is indeed a multi-factorial problem and therefore a successful national strategy needs to incorporate the various societal domains which influence children's

lives for example the home, the community and School. Additional research is needed to generate effective interventions for the management of childhood obesity. The implementation of effective interventions will not only enhance child health and well-being in childhood years but also follow through into adulthood also.

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What is already known about this topic

- Childhood obesity is currently a worldwide public health problem.
- Children who are obese in childhood are at greater risk of being obese in adulthood in comparison to their normal weight peers.
- Childhood obesity can adversely affect children's health and well-being throughout their life.

What this paper adds

- When carrying out research with children, particular thought needs to be given to the various areas of ethical concern.
- Utilization of a study protocol helps to maintain reliability and validity throughout the research process.
- Currently in the Republic of Ireland pre-teen disadvantaged, urban girls are demonstrating significantly high Body Mass Index values.

Implications for practice and/or policy

- Additional research is needed to generate interventions for the management of obesity.
- Interventions need to be targeted towards disadvantaged, urban children at various levels; in the home, in the community and at school.
- Nursing practice and school health policy makers need to be aware not only of the alarmingly high levels of overweight and obese children but also need to measure on an ongoing basis the changing levels of physical activity among children and children's daily eating habits.

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Conflict of interest

There is no conflict of interest.

Author contributions

All authors meet at least one of the following criteria (recommended by the ICMJE: http://www.icmje.org/ethical_1author.html) and have agreed on the final version:

- substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;
- drafting the article or revising it critically for important intellectual content.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Data S1. This supporting information file is a micro soft word document of additional information on how body mass index was measured within this study.

Please note: Wiley-Blackwell are not responsible for the content or functionality of any supporting materials supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.

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