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Project Spraoi: A Strategy to Improve Nutrition and Increase Physical Activity in Primary School Children

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Lisa Delaney

Thesis submitted for the award of Masters of Science (MSc)

Department of Sport, Leisure and Childhood Studies

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Authors declaration

I (Lisa Delaney) hereby declare that this thesis is entirely my own work, and to the best of my knowledge does not breach any law of copyright, and was carried out in accordance with the requirements of Cork Institute of Technology's Regulations and Code of Practice.

Where contributions of others are involved every effort is made to indicate this clearly with due references to the literature and acknowledgement of collaborative research.

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Abstract

Introduction: Paediatric obesity has become a global epidemic with many countries developing strategies to help tackle its prevalence. School based physical activity (PA) and nutrition interventions have proven to play a promising role in tackling childhood obesity.

Background: Project Spraoi is an Irish primary school based intervention. The intervention was delivered to an intervention school to help enhance PA and nutritional behaviour amongst pupils. The intervention school was assigned an 'Energizer'; a trained PA and nutrition change agent who worked with the school to achieve the objectives. For evaluation purposes a control school was recruited.

Methodology: Pupils from the intervention and control school (boys n = 85, 51.5%, girls n = 80, 48.5%) aged 6 and 10 at enrolment, had their anthropometric and physiological measurements taken, completed a nutritional knowledge survey and a cardiovascular fitness test, and wore an accelerometer at baseline and near intervention end. Data from intervention school stakeholders was also obtained.

Results: Pupils receiving the intervention had a statistically significant improvement in blood pressure ($p = .000$) compared to pupils who did not receive the intervention ($p = .710$). Twenty six weeks later pupils from the intervention school also performed better in the fitness test near intervention end ($p = .000$) compared to baseline.

No statistically significant improvements in pupils' BMI or waist circumference were found. PA increased and sedentary time decreased in the intervention school however these findings were not statistically significant. Improvements in pupils' nutritional knowledge and behaviour across certain topics were also found.

Conclusion: This approach may be associated with health benefits however the trajectory of this change needs to be measured over a longer time period.

List of Abbreviations

APPLES	Active Programme Promoting Lifestyle in Schools
ASF	Active School Flag
Be Active ASAP	Be Active After School Activity Programme
BF	Body Fat
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
BP	Blood Pressure
BPH	Benign Prostatic Hyperplasia
BPM	Beats Per Minute
CDC	Centers for Disease Control and Prevention
CHANGE	Children's Health, Activity, Nutrition: Get Educated
CHF	Congestive Heart Failure
CIT	Cork Institute of Technology
CND	Coronary heart disease
COSI	Childhood Obesity Surveillance Initiative
CSEP	Canadian Society for Exercise Physiology
CSO	Central Statistics Office
CSPPA	The Children's Sport Participation and Physical Activity Study

CVD	Cardio Vascular Disease
DEIS	Delivering Equality of Opportunity in Schools
DES	Department of Education and Skills (Ireland)
DEXA	Dual Energy X-ray Absorptiometry
DHC	Department of Health and Children (Ireland)
DLW	Doubly-Labeled Water
DOH	Department of Health (Ireland)
DPAH	Diet Physical Activity and Health
EU	European Union
FAO	Food and Agriculture Organisation
FFQs	Food Frequency Questionnaires
FM	Fat Mass
FFM	Fat Free Mass
GUI	Growing Up in Ireland
HBSC	Health Behaviour in School Aged Children
HFCS	High Fructose Corn Syrup
HPU	Health Promotion Unit
HRB	Health Research Board
HSE	Health Service Executive

IASO	International Association for the Study on Obesity
IOTF	International Obesity Task Force
IHF	Irish Heart Foundation
INDI	Irish Nutrition and Dietetic Institute
ISCP	Irish Society of Chartered Physiotherapists
IUNA	Irish Universities Nutrition Alliance
LBM	Lean Body Mass
LMS	Lambda-Mu-Sigma
LUTS	Lower Urinary Tract Symptoms
MEND	Mind, Exercise, Nutrition…Do it
METs	Metabolic Equivalents
MI	Myocardial Infarction
MOU	Memorandum Of Understanding
MRI	Magnetic Resonance Imaging
MVPA	Moderate to Vigorous level of Physical Activity
NAFLD	Non-Alcoholic Fatty Liver Disease
NCCA	National Council for Curriculum and Assessment
NCHS	National Center for Health Statistics
NHANES	National Health And Nutrition Examination Surveys

NHPS	National Health Promotion Strategy
NI	Northern Ireland
NNSC	National Nutrition Surveillance Centre
NTFO	National Task Force on Obesity
NZ	New Zealand
OSA	Obstructive Sleep Apnoea
PA	Physical Activity
PE	Physical Education
PSQ	Project Spraoi Questionnaire
QMR	Quantitative Magnetic Resonance
QOL	Quality Of Life
RCT	Randomised Control Trial
RoI	Republic of Ireland
ROLO	Randomised cOntrol trial of LOw glycemic index
RPE	Rating of perceived exertion
SAGO	Special Action Group on Obesity
SES	Socio Economic Status
SKF	Skinfold Thickness
SLAN	Survey of Lifestyle, Attitudes and Nutrition

SPARK	Sports, Play, and Active Recreation for Kids
SPHE	Social, Personal and Health Education
SPSS	Statistical Package for Social Sciences
SSBs	Sugar Sweetened Beverages
TBW	Total Body Water
TTE	Total Energy Expenditure
UK	United Kingdom
US	United States
WDHB	Waikato District Health Board
WHO	World Health Organisation

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Chapter 1: Introduction

Obesity is a 'normal response by normal people to an abnormal environment', (The Lancet 2011, p. 741).

Overweight and obesity are defined as the sustained accumulation of excess body fat that contributes to multifaceted health issues (World Health Organisation (WHO), 2014a; Halfron et al., 2013; Griffiths et al., 2011; Craigie et al., 2011; Reilly et al., 2003; Ebbeling et al., 2002). In recent decades the world has seen an unprecedented rise in the prevalence of overweight and obesity resulting in a global epidemic (Kearns et al., 2014; Hu and Vasanti, 2010). This epidemic has infiltrated all populations and is recognised as one of the most significant public health issues of the twenty first century (WHO, 2010; Simmons and Wareham, 2006). It has become a global leading risk factor for mortality resulting in at least 3.4 million adult deaths worldwide each year with more deaths now being associated with overweight and obesity than underweight (WHO, 2014a; World Obesity, 2014).

Overweight and obesity are rapidly penetrating into childhood and are currently the most prevalent chronic conditions affecting the health of children and adolescents (Raychaudhuri and Sanyal, 2012; Craigie et al., 2011). Overweight children and adolescents are presenting with related medical conditions originally associated with adults and these conditions can track into adulthood (Craigie et al., 2001). Consequently this current generation of children are the first generation predicted to have a shorter lifespan than that of their parents (World Obesity, 2014).

The prevalence of this growing epidemic has been driven by vast, complex determinants. As a result epidemiological studies, monitoring, and prevention efforts have amplified within the last four decades to help tackle this issue with numerous strategies targeting early childhood (Gortmaker et al, 2011). Research indicates that school based interventions are effective in improving the overall health status of pupils and may preclude the progression of paediatric overweight and obesity (De Bourdeaudhuij et al., 2011; Gonzalez-Suarez et al., 2009).

1.1 Background of Project Spraoi

An Exercise and Health Research Cluster was established at Cork Institute of Technology (CIT) in May 2012 to form 'Project Spraoi'. Project Spraoi is a primary school based health promotion intervention which aims to (i) increase physical activity (PA), (ii) decrease sedentary time, and (iii) improve nutritional behaviour amongst primary school children in Cork. Project Spraoi was founded on a New Zealand based study Project Energize (Graham et al., 2008). Project Energize is a school based intervention that aims to improve the overall health status of children by delivering an intervention to primary schools (Rush et al., 2011; Graham et al., 2008). The Energize programme aims to facilitate positive change in children's behaviour towards PA and nutrition.

The Exercise and Health Research cluster in CIT consists of a group of exercise and health educators who were joined in early 2013 by three post graduate researchers who each had their own Project Spraoi research study. Whilst the researchers worked independently from each other, the data collected for each study was pooled to facilitate a large scale study that is beyond the scope of this document. For the purpose of this MA project the objectives were as follows;

Primary objective:

- To determine whether a school based health intervention, Project Spraoi, could increase physical activity, reduce sedentary time and improve nutritional behaviour in primary school pupils over one academic year.

Specific objectives:

- To deliver a multi-pronged health intervention involving the whole school community.
- To evaluate the impact of the intervention by comparing measures, gathered pre- and post-intervention, from pupils receiving the intervention with measures from pupils who have not received the intervention.
- To evaluate the process of the intervention by gathering data from school stakeholders.

1.2 Contribution to Research

To the best of the authors knowledge, when this project commenced there was no intervention in Ireland that simultaneously targeted more than two determinants of obesity in the primary school setting. In addition, whilst Irish primary schools have implemented a range of health promotion initiatives such as Bizzy Breaks, Be Active After School Activity Programme (Be Active ASAP) along with others, none of these have been subject to a systematic evaluation in Ireland.

Studies examining the impact of school based interventions have been inconsistent (Wang et al., 2013; Brown and Summerbell, 2009). It is hoped that the findings from this study will contribute to the existing body of research to help determine the impact of school based health interventions.

This research has the potential to generate new data. As stated earlier the data collected by the Project Spraoi research team can be combined to facilitate a large scale evaluation. The findings from this evaluation can provide contemporary findings on the prevalence of childhood obesity in Cork primary schools.

Findings from Project Spraoi will be compared against Project Energize to allow for international comparisons. The feasibility of applying the Project Energize methodological approach internationally can be assessed based on findings from this research. Based on these outcomes Project Energize could potentially become an international programme that can be tailored to further national settings.

Chapter 2: Literature Review

2.1 Introduction

According to a comprehensive report approximately 2.1 billion or almost one third of the world's population were overweight or obese in 2013 (Ng et al., 2014). Overweight and obesity are penetrating into childhood however exact prevalence estimates are difficult to determine due to the lack of a unified definition for paediatric obesity (Cole et al., 2000). Excess weight gain during childhood has been driven by the interplay of a wide variety of determinants with related medical comorbidities traditionally associated with adults now presenting in children (Raychaudhuri and Sanyal, 2012). Due to the vast increase in the prevalence of overweight and obesity many organisations and institutions are developing various strategies to help combat this emerging epidemic (WHO, 2014a).

As childhood obesity can track into adulthood (Gunnell et al., 1998) it is important to establish whether an early health promotion intervention can improve children's overall health status and prevent the progression of overweight and obesity. Recent studies indicate that multi-pronged health promotion interventions can help improve children's overall health (Rush et al., 2013; Ma and Frick, 2011; Seo and Sa, 2010; Brown and Summerbell, 2009, Flodmark et al., 2006).

This literature review will commence by defining adult and paediatric overweight and obesity followed by providing an insight into its prevalence and determinants. As this study aims to tackle PA, sedentary time and nutritional behaviour, the established guidelines for these determinants will be highlighted. In addition an insight into Ireland's recent PA, sedentary and nutritional behaviours will be discussed. The health consequences and financial burden associated with overweight and obesity will be outlined followed by the policies and strategies designed to tackle and monitor the progression of obesity. Finally methods available to measure body composition and monitor PA, sedentary and dietary behaviours will be discussed.

2.2 Defining overweight and obesity

Overweight and obesity are medical conditions described as the accumulation of excess adiposity as a result of prolonged positive calorific imbalance that may impair an individual's health (WHO, 2013; Craigie et al., 2011; Barlow, 2007; Kuczmarski and Flegal, 2000). The terms also identify ranges of weight that increase the likelihood of developing certain health complications (Centers for Disease Control and Prevention (CDC), 2012).

2.2.1 Defining adult overweight and obesity

There is a globally accepted definition for adult overweight and obesity using Body Mass Index (BMI) guidelines (WHO, 2014a). BMI outlines what is considered a healthy weight (CDC, 2012) and is defined as a person's weight in kilograms divided by the square of their height in metres (kg/m^2) (Cole et al., 1995). Adult overweight and obesity is defined as having a BMI $\geq 25kg/m^2$ and $\geq 30kg/m^2$ respectively (WHO, 2014a; World Obesity[1], 2014; CDC, 2012; Cole et al., 2000).

2.2.2 Defining childhood overweight and obesity

In contrast to the above there is no unified definition for paediatric overweight and obesity (Ebbeling et al., 2002; Cole et al., 2000). As BMI varies substantially by gender and age during childhood (Flegal and Ogden, 2011; Kuczmarski and Flegal, 2000), various gender and age specific references have been developed. A child's BMI value can be defined in terms of a percentile, Z-score or percent of median (de Onis and Blössner, 1997). A percentile is a value from 0 to 100; a Z-score expresses the anthropometric value as a number of a standard deviation score (SDS) or Z-score above or below the average BMI value (WHO, 2014g, Cole et al., 1995; de Onis and Blössner, 1997). Percentage of the median expresses a child's BMI value as a percentage of the expected value for the reference population (WHO, 2014g). Once a child's BMI percentile or Z-score has been calculated, this value can be checked against various thresholds (WHO, 2014g). Thresholds are derived from a reference population known as a child growth reference and are relative to a child's age and gender (CDC, 2011a; Flegal and Ogden, 2011; Cole et al., 1995).

[1] Formerly the International Association for the Study of Obesity (IASO)

Table 2.1 portrays the four thresholds currently used for defining paediatric overweight and obesity.

Table 2.1: Current thresholds for defining childhood overweight and obesity

	UK's 1990 BMI Growth Reference Chart	CDC 2000 Growth Reference Chart	WHO 2007 Growth Reference	International Obesity Task Force Growth Reference (IOTF)
Defined as:	Percentiles	Percentiles	Z-scores/SDS	BMI cut offs
Ages	0 - 23 years	2 – 20 years	5 - 19 years	2 – 18 years
Geographic area	United Kingdom	United States	Brazil, Ghana, India, Norway, Oman, US	Great Britain, Brazil, Hong Kong, the Netherlands, Singapore, US
Underweight	BMI < 2nd percentile	BMI ≤ 3rd and ≥ 5th percentile	BMI ≤ -3 to ≤ -2 SDS	BMI 16 (Thinness grade 3) cut-off BMI 17 (Thinness grade 2) cut-off BMI 18.5 (Thinness grade 1) cut-off
Overweight	BMI ≥ 85th percentile[2] BMI ≥ 91st percentile [3]	BMI ≥ 85th and <95th percentile	BMI > + 1SD and ≤ +2SDS	BMI ≥ 25th and < 30th cut-off point
Obese	BMI ≥ 95th percentile [4], BMI ≥ 98th percentile[5]	BMI ≥ 95th percentile	BMI > + 2SDS	BMI ≥ 30th cut-off point
Reference	(Cole et al., 1995)	(CDC, 2000)	(WHO, 2013c)	(IASO, 2013a)

2.2.2 (a) UK's 1990 Growth Reference

The UK's 1990 BMI Growth Reference (UK90) was developed based on collated and nationally representative UK data (Cole et al., 1995). It is the only available reference for weight adjusted height for assessing overweight and obesity for the UK population (Wright et al., 2002). The UK90 is considered as a valid reference (Rudolf et al., 2000) and has been

[2] For population monitoring
[3] For clinical assessment
[4] For population monitoring
[5] For clinical assessment

used in various studies (Heinen et al., 2014; Woods et al., 2010; Reilly and Dorosty, 1999) and in clinical settings (Wright et al., 2002). However further research is required to determine its validity in other geographical areas (Rudolf et al., 2000).

2.2.2 (b) CDC 2000 Growth Reference Chart

The CDC Growth Chart was developed from five nationally representative survey data sets (the National Health and Nutrition Examination Surveys) (Flegal and Ogden, 2011; Kuczmarski and Flegal, 2000). However during the development of this reference the CDC decided not to use the most recent data as children in the latest survey were heavier on average than children in previous surveys (Kuczmarski and Flegal, 2000). In addition this reference has not been endorsed for international use (Wang and Wang, 2002).

2.2.2 (c) WHO 2007 Growth Reference

The WHO and the IOTF references are the two current international references for defining childhood overweight and obesity (Wang and Lobstein, 2006).

The WHO 2007 Growth Reference is a reconstruction of the 1977 National Center for Health Statistics (NCHS) data and the WHO child growth standards sample data (WHO, 2014h). The development of this reference used the original NCHS sample (a non-obese sample) and supplemented the data from the WHO Child Growth Standards for under-fives (de Onis et al., 2007). In addition, during the development of the WHO Charts the data was trimmed in order to exclude heavier children (Flegal and Odgen, 2011).

2.2.2 (d) IOTF Growth Reference

The IOTF is now known as World Obesity/Policy and Prevention however the growth reference is still referred to as the IOTF Growth Reference (IOTF, 2013). The IOTF classification links adult and paediatric overweight and obesity as the reference is based on BMI centile curves that pass through the adult BMI cut-off points for overweight (≥ 25kg/m^2) and obesity (≥ 30kg/m^2) (IASO, 2013, Wang and Lobstein, 2006). The most recent available US growth survey data however, was excluded when constructing the reference as data which predated the rise in obesity was preferred (Wang and Wang, 2002).

Whilst there is a significant variation in the prevalence of overweight and obesity across the countries that made up this reference population, the development of this reference is based on large data sets (Wang and Wang, 2002).

Table 2.2 illustrates the variation in scores between gender and age using the IOTF cut-offs (IASO, 2013; IASO, 2004; Cole et al., 2000).

Table 2.2: IOTF BMI cut-offs for thinness, overweight and obesity in Children

T = Thinness **G = Grade** **OW = Overweight**		**TG 3**	**TG 2**	**TG 1**	**OW**	**Obese**	**Morbid Obesity**
BMI Cut-offs		16	17	18.5	**25**	**30**	35
Gender and age (years)	♂ 6	12.54	13.16	14.06	**17.52**	**19.76**	21.69
	♀ 6	12.34	12.96	13.85	**17.33**	**19.61**	21.61
	♂ 10	12.70	13.47	14.63	**19.80**	**23.96**	28.35
	♀ 10	12.63	13.40	14.58	**19.78**	**23.97**	28.36

Source: International Association for the Study of Obesity (2013) 'Extended International (IOTF) Body Mass Index Cut-Offs for Thinness, Overweight and Obesity in Children'.

The task of assessing the global prevalence of paediatric overweight and obesity has proved challenging due to the absence of a globally accepted definition (Cole et al., 2000). There is a consensus however, that children and adolescents with a BMI above the 85th and 95th percentile should be classified as overweight and obese respectively (Dietz and Bellizzi, 1999). The UK90 and CDC 2000 growth reference coincide with this recommendation. Irrespective of this consensus there is an urgent need for a unified definition for paediatric obesity (Cole et al., 2000) to accurately assess the global prevalence of childhood obesity and to allow for international and research comparisons.

2.3 Prevalence of overweight and obesity

Adult obesity has reached epidemic proportions and is rapidly penetrating into childhood (WHO, 2013b). As a result, rates of overweight and obesity amongst adults and children are increasing worldwide in all populations (Cole et al., 2000).

2.3.1 Adult overweight and obesity

In recent decades there has been an unpredicted rise in the prevalence of overweight and obesity resulting in a global epidemic (Kearns et al., 2014; Hu and Vasanti, 2010). Approximately 2.1 billion adults worldwide are currently classified as being overweight or obese (Ng et al., 2014).

A global comparison from all WHO regions (n = 192) was conducted in 2010 to determine the prevalence of overweight and obesity in individuals aged over fifteen years (WHO, 2011b). Nauru (located 42 kilometres south of the equator, to the northeast of New Guinea and the Solomon Islands) had the highest prevalence level in males (96.9%) and females (93%) (WHO, 2011b). Eritrea and Ethiopia (located in eastern Africa) had the lowest amongst males (3.5%) and females (3.7%) respectively (WHO, 2011b). China and the US followed by Brazil and Mexico experienced the largest overall increase within three decades (between 1980 and 2008) (Rodrigo, 2013, Stevens et al., 2012). In 2008 China and the US had the most overweight people (241 million and 158 million respectively) with over half of the world's obese population living in these two countries (Stevens et al., 2012).

In Europe sixty percent of adults (approximately 260 million) are currently overweight or obese (World Obesity, 2014). A systematic review of the prevalence of obesity in Europe found that overall, the prevalence is higher in the central, eastern, and southern regions of Europe and this can be partially due to variances in social economic conditions, lifestyle and nutritional factors (Berghöfer et al., 2008).

Within the EU Ireland has one of the highest prevalence levels (Irish Universities Nutrition Alliance (IUNA), 2011) however exact figures are inconsistent. The most recent representative data indicates that 37% of Irish adults aged 18 to 64 years are overweight (44% men, 31% women) and 24% are obese (26% men, 21% women) (Irish Universities Nutrition Alliance (IUNA), 2011). This is in accordance with findings from the Irish National Survey of Lifestyle, Attitudes and Nutrition (SLAN) (Department of Health and Children, 2008). However findings from the WHO 2010 comparison study implies that Ireland has a higher prevalence of overweight (53.9% men, 43.9% women) and obesity (11.7% men, 10.4% women) (WHO, 2011b) with another study reporting that 66% of men and 51% of

women over twenty years of age are classified as overweight or obese (Ng et al., 2014). The inconsistency of these findings could be due to variances in the methodological approaches used.

2.3.2 Paediatric overweight and obesity

Childhood obesity has gained global significance and is acknowledged as a global epidemic (WHO, 2013b). Its prevalence has significantly increased over the past three decades (WHO, 2010; Perry et al., 2009) however, as previously stated, exact prevalence estimates are difficult to determine (Cole et al., 2000). In addition, it is difficult to determine trends of obesity in children across different ages, as researchers analysing data from wide age ranges usually combine the data to produce single prevalence estimates (Reilly, 2005a).

In 2010 the IOTF globally estimated that up to two hundred million school-aged children were overweight, of this figure forty to fifty million were classified as obese (IOTF, 2010). In 2012 more than forty million children under five years of age were classified as being overweight or obese (WHO, 2014a). In the EU over 20% of school aged children (one in every six) are currently overweight (World Obesity, 2014) whilst 5% (one in every twenty) are obese (Emilio et al., 2010). The levels of childhood obesity are significantly higher in Ireland when compared against France, Sweden and Germany but are considerably less compared to Italy, Greece and Spain (Layte and McCrory, 2011).

The WHO Regional Office for Europe established the Childhood Obesity Surveillance Initiative (COSI) in twenty one countries to routinely measure trends in overweight and obesity in primary school children aged six to nine years (WHO, 2014c). The first data collection took place in the 2007/08 academic school year with thirteen countries (including Ireland) participating in the initiative (WHO, 2014c). The prevalence of paediatric overweight ranged from 19% to 49 % among boys, and 18% to 43% among girls (WHO, 2014c). Obesity ranged from 6% to 27% among boys and from 5% to 17% among girls with southern European countries having the highest prevalence level (WHO, 2014c).

It should be noted however that issues arise when comparing global prevalence data. Few studies have extensively examined the global situation (Wang, 2001). Some national data is non-represented and/or is self-reported, questioning the validity and accuracy of these studies (Wang and Lobstein, 2006; Elgar et al., 2005). Furthermore the use of varying criteria for defining paediatric overweight and obesity acts as a challenge for international comparisons (Wang and Lostein 2006; Lobstein et al., 2004; Ebbeling et al., 2002; Fruhbeck, 2000; Cole et al., 2000). For instance there are 2% more obese children and adolescents in the US than in the EU as a result of using the CDC 2000 Growth Reference classification (Lob-Cozilius, 2007).

2.3.3 Paediatric overweight and obesity in Ireland

Within the last six decades Irish children have disproportionately increased in weight and height (Layte and McCrory, 2011; Perry et al., 2009). The average height of a nine year old boy and girl increased by 7% however weight increased by 26% and 31% respectively (Layte and McCrory, 2001).

Table 2.3 outlines the recent prevalence studies conducted on Irish primary school aged children. These studies were all objectively measured.

Table 2.3: Recent prevalence studies in Irish primary school children

Study	Reference	Age (Years)	Sample size	Criteria	Results	
					Overweight	Obese
North South Survey of Children's Height, Weight and BMI	Whelton et al., 2007	4 to 16	19,617	IOTF	**RoI** Girls: 28% Boys: 23% **NI** Girls: 25% Boys: 23%	**RoI** Girls: 7% Boys: 6% **NI** Girls: 7% Boys: 5%
Prevalence of overweight and obesity…, using four different definitions	O'Neill et al., 2007	5 to 12	596	UK 90, CDC, IOTF,	Girls ranged from: 9.3 to 16.3% Boys ranged from: 4.1 to 11.2%	
Growing Up in Ireland (GUI)	Layte and McCrory, 2011	9	8,568	IOTF	Overall: 19% Girls: 22% Boys: 17%	Overall: 7% Girls: 8% Boys: 5%
Prevalence rates and comparisons of obesity levels	Barron et al., 2009	4 to 13	969	IOTF	Overall: 17.8% Girls: 17.6% Boys: 17.8%	Overall: 6.8% Girls: 7.1% Boys: 6.6%
The Children's Sport Participation and Physical Activity Study (CSPPA)	Woods et al., 2010	10 to 18	5,397	UK 90	One in four children were overweight or obese	
WHO COSI (Ireland)	Heinen et al., 2014	7 to 9	12,236	IOTF	See Table 2.4	

Table 2.4: COSI (Ireland) findings from 2008, 2010 and 2012

7 year old girls vs. boys	2008	2010	2012
Overweight	26.4% vs. 18.3%	25.7% vs. 16.2%	21.4% vs. 14.4%
Obese	7.5% vs. 4.7%	4.6% vs. 3.8%	5.5% vs. 2.2%
9 year old girls vs. boys	**2008**	**2010**	**2012**
Overweight	No data	23.2% vs. 19.7%	22.0% vs. 20%
Obese	No data	4.8% vs. 4.4%	4.3% vs. 4.1%

The prevalence of overweight and obesity is consistently higher in girls than boys (Keane et al., 2014). Findings from the Irish COSI study indicate an early stabilisation of overweight and obesity for 9 year olds and a continued reduction among 7 year olds however this trend has not been observed in children attending disadvantaged schools (Heinen et al., 2014). Furthermore, whilst the prevalence of paediatric overweight and obesity in Ireland is of concern, a recent epidemiology study conducted by Heinen and colleagues (2014) suggests that the prevalence of childhood obesity is beginning to plateau and this is supported further by an Irish systematic review (Keane et al., 2014).

Overall there seems to be a minor decrease in the prevalence of paediatric obesity during the first round of COSI data compared to later studies (Heinen et al., 2014). Barron and colleagues (2009) concluded that prevalence rates of overweight and obesity among Irish primary school children may be stabilising given the comparison with rates observed between 2002 and 2007. However, further longitudinal studies should be undertaken in order to support these findings. Currently there is no research to indicate that the global prevalence of obesity has stabilised.

2.4 Determinants of Overweight and Obesity

Overweight and obesity can be attributed to several etiologic determinants that are complex and multifactorial (Raychaudhuri and Sanyal, 2012). For instance one determinant can be influenced by the interplay of a variety of other determinants (Stewart, 2011; Verduin et al., 2005) thereby making it difficult to determine the contribution each has on influencing overweight and obesity. Furthermore these determinants can alter or create new interactions in the environment and can affect all age categories, genders and socioeconomic levels (Wu et al., 2003). In addition, children are now developing in an obesogenic environment (Birch and Anzman, 2010) which refers to factors that currently exist in the environment that promote, and harvest unhealthy behaviours and lifestyle choices, and fosters the development of obesity and its determinants (Swinburn et al., 1999). The observed increase in the prevalence of obesity can be attributed to the emergence of an obesogenic lifestyle (Santiago et al., 2013).

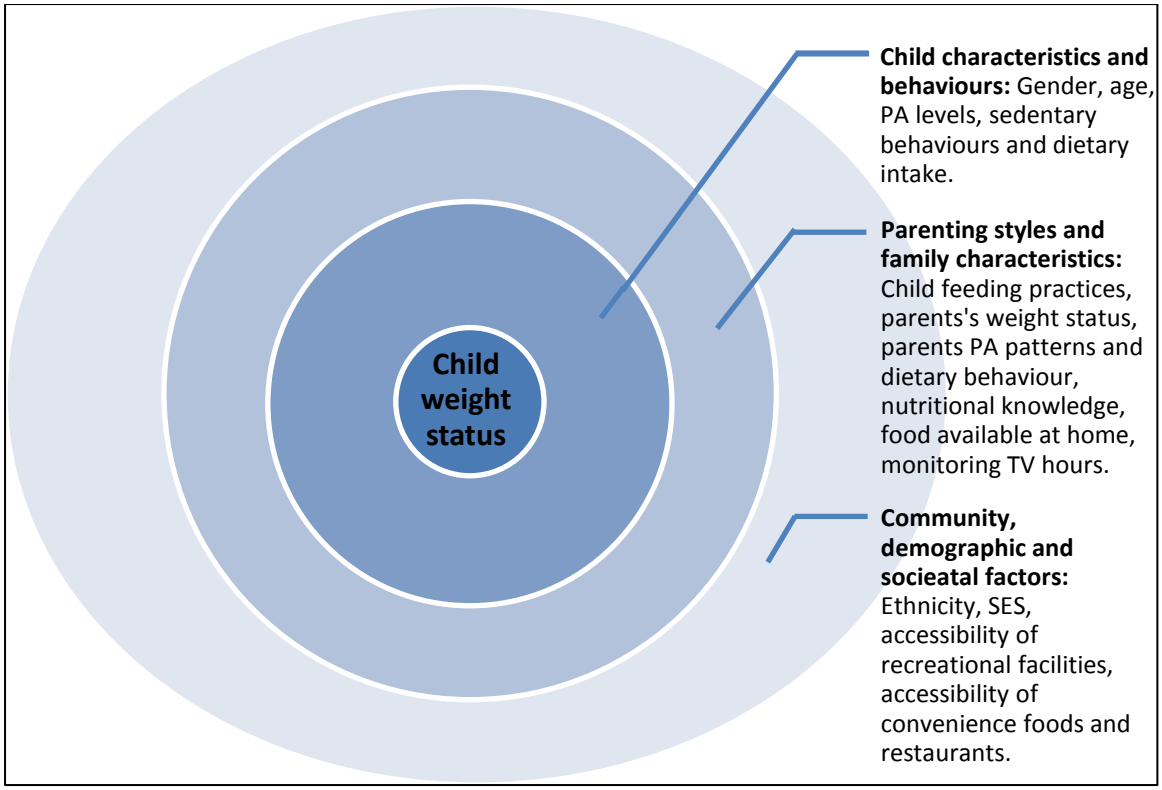


Figure 1: Contextual influences on the development of childhood obesity

Source: Davison and Birch (2001)

2.4.1 Gender and Age

A review of the literature yields no results in studies directly examining gender and/or age as direct determinants of overweight and obesity. To date, studies have examined the prevalence of overweight and obesity between genders (Akarolo-Anthony et al., 2014; Sasson et al., 2014; Basu et al., 2014; Hou et al., 2013; IUNA, 2011) and age groups (Niehues et al., 2014; Badawi et al., 2013; Reilly, 2005b; Wang et al., 2002). In addition whilst obesity has spread across all age groups (González-Gross and Meléndez, 2013), weight gain in children tends to increase with increasing age (Reilly and Dorosty, 1999) which may indicate that as children get older, they become more exposed to the obesogenic environment (Reilly, 2005a). Davison and Birch (2001) state that these two variables can influence the likelihood of participating in PA which may be associated with the risk of becoming overweight or obese as low levels of PA are associated with weight gain.

2.4.2 Physical Activity and Sedentary Behaviour

Physical activity (PA) can be defined as any bodily movement produced by skeletal muscles, resulting in energy expenditure (Caspersen et al., 1985), increased heart rate and being out of breath for a period of time (Janssen et al., 2005). Exercise and sport are sub-categories of PA (Livingstone et al., 2003) whilst physical fitness is classified as an outcome and is related to the ability to achieve specific performance standards (Livingstone et al., 2003; Caspersen et al., 1985).

PA is a complex, multi-dimensional behaviour (Livingstone et al., 2003) and is inversely related to obesity (Swift et al., 2014; Lee et al., 2012; He et al., 2011; Skidmore and Yarnell, 2004; Lee et al., 1999). Adequate, regular levels of PA are associated with various health benefits (Fortier et al., 2012; Vogel et al., 2009; Saxena et al., 2005) and the prevention of chronic diseases (Heitzler et al., 2006).

There is a growing acceptance among experts that low levels of PA (Must and Tybor, 2005; Hill et al., 2003; Humpel et al., 2002; French et al., 2001; Davison and Birch, 2001; Hill and Peters, 1998; Goran et al., 1997; Obarzanek et al., 1994) and high levels of sedentary behaviour (Lane et al., 2014; Costigan et al., 2013; McMurray et al., 2012; Must and Tybor, 2005; Hill et al., 2003; Wu et al., 2003; Hanley et al., 2000) have fostered the development of overweight and obesity.

A review of the literature indicates that demographic, economic, environmental factors, gender, and age can influence people's level of PA (Sallis et al., 2000). The increase in urbanisation has contributed to the reduction in recreational space resulting in children being commuted to constructed recreational facilities (Lob-Corzilius, 2007). Boys are more physically active than girls (Woods et al, 2010; Sallis et al., 2000; Lindquist et al., 1999), PA appears to decline with increasing age (Must and Tybor, 2005) and this decline is greater for girls (Woods et al., 2010). Furthermore PA habits developed during childhood may track into adulthood (Telama et al., 2005; Telama et al., 1997).

In addition sedentary behaviour has been identified as a contributor to excess weight gain (Parsons et al., 2003) and can be defined as muscle inactivity for prolonged periods of time

resulting in low energy expenditure (Bell et al., 2014; Tremblay et al., 2012; Owen et al., 2010; Pate et al., 2008). However the term sedentary can also be used to describe the absence of reaching the recommended threshold of MVPA (Tremblay et al., 2012; Sims et al., 2012). For instance individuals who have low sedentary levels may still not obtain sufficient levels of moderate to vigorous physical activity (MVPA) (Tremblay et al., 2011). Furthermore, recreational activities have shifted from outdoor to indoor activities (Raychaudhuri and Sanyal, 2012; Must and Tybor, 2005) as various forms of entertainment can now be viewed on a variety of screen based devices leading to the term 'screen time' (Must and Tybor, 2005) thereby promoting the development of overweight and obesity (Herman et al., 2014; Costigan et al., 2013; Hands et al., 2011).

Screen time displaces PA (Decelis et al., 2014; Sandercock et al., 2012; Robinson, 2001) and has been associated with higher consumption of energy dense foods and sugar sweetened beverages (Santaliestra-Pasías et al., 2012; Pearson and Biddle, 2011; Robinson, 2001; Muller et al., 2000; Story and Faulkner, 1990). Furthermore studies have indicated a relationship between television food advertising and children's consumption of these foods (Must et al., 2009; Robinson and Killen, 1995; Taras et al., 1989).

2.4.3 Nutritional Behaviour

Nutrition is defined as the intake of food and should be considered in relation to the body's dietary needs (WHO, 2014f). Nutritional intake is a key determinant of obesity as weight gain occurs when energy intake exceeds energy expenditure (WHO, 2014f).

Increased intake of fast foods (Duffey et al., 2007; Pereira et al., 2005), large portion sizes (Rolls et al., 2006; Levitsky and Youn, 2004), high calorific foods (Liou et al., 2010; Harding et al., 2008), dietary fat (Jebb, 2007), breakfast omission (Wang et al., 2013; Brown et al., 2013; Schembre et al., 2013; Horikawa et al., 2011; Smith et al., 2010; Harding et al., 2008; Niemeier et al., 2006) and sugar sweetened beverages (SSBs) (Hu and Vasanti, 2010; Bremer et al., 2009; Vartanian et al., 2007; Malik et al., 2006; WHO/FAO, 2003; Ludwig et al., 2001) are associated with increased weight gain. SSBs includes soft drinks, fruit drinks, energy drinks and vitamin water drinks and are comprised of caloric sweeteners such as high fructose corn syrup (HFCS) and/or fruit-juice concentrates (Hu and Vasanti, 2010).

Fruit and vegetable intake are inversely correlated with excess weight gain (Sturm and Datar, 2005; He et al., 2004) as these are low energy density foods and have a high water and fibre content (Rolls et al., 2005). In addition restrictive nutritional behaviour (dieting) has also been linked to increased weight gain (Lebow et al., 2014; Chaput et al., 2012; Mumford et al., 2008; Mann et al., 2007), often presenting in adolescents and can lead to long-term health morbidities (Misra, 2008).

2.4.4 Genetic Factors

The rapid increase in the prevalence of obesity within one generation suggests the role of environmental factors as opposed to genetic factors (Rhee et al., 2012; Berkey et al., 2000; Rosenbaum and Leibel 1998). However while lifestyle changes have driven the prevalence of overweight and obesity (Must and Tybor, 2005), studies indicate that anthropometric indexes such as height, weight, waist circumference and BMI are between 40 to 70% inheritable (Farooqi and O'Rahilly, 2005; Maes et al., 1997; Stunkard et al., 1990; Clark, 1955). Furthermore, adoption studies have revealed that the BMI of adopted children resembles that of their biological parents (Min et al., 2013; Stunkard et al., 1986). In addition, a study examining the BMI of various twins reared apart and together reported that the childhood environment had little or no influence and genetic influences are more substantial as a predictor of BMI (Stunkard et al., 1990).

2.4.5 Parental and Maternal Obesity

Researchers have also reported strong links between parental and offspring BMI (Murrin et al., 2012; Demerath et al., 2007; Liou et al., 2010; Li et al., 2009; Harding et al., 2008; Griffiths et al., 2007; Martins and Carvalho, 2006; Maes et al., 1997; Whitaker et al., 1997). Furthermore, other researchers suggest that maternal BMI alone can influence offspring BMI (Murrin et al., 2012; Lawlor et al., 2006; Whitaker et al., 1997) but not paternal (Botton et al., 2010). In addition, maternal pre-pregnancy BMI is regarded as another determinant of offspring BMI (Catalano et al., 2009) however this study was not confined to obese women.

It is argued however that child BMI is an indirect measure of fat mass (FM) and very few studies have directly measured the relationship between maternal and/or paternal BMI and offspring BMI (Poston, 2012).

2.4.6 Parental Behaviours

Parental behaviours play an important role in determining children's BMI (Maffeis, 2000) and children's levels of PA (Crawford et al., 2010; Loprinzi and Trost, 2010; Edwardson and Gorely, 2010; Pugliese and Tinsley, 2007; Rhee et al., 2005; Trost et al., 2003) especially for girls (Leary et al., 2013). In addition parents have a profound influence on children's feeding behaviours such as; eating habits, quantity of food and drink consumed and feeding times (Mitchell et al., 2013; Vollmer and Mobley, 2013; McCrory and Layte, 2012). Furthermore studies have noted consistent similarities of dietary patterns in parents and children (Perusse et al., 1988; Laskarzewski et al., 1980).

2.4.7 Maternal Employment

Studies have indicated that maternal employment can contribute to offspring overweight and obesity (Greve, 2011; Liu et al., 2009; von Hinke Kessler Scholder, 2007; Anderson et al., 2003). Liu and colleagues (2009) established that a child is 12.3% more likely to become overweight if the mother is in full time employment, with a stronger effect among mothers of higher income status (Anderson et al., 2003).

It is hypothesised that maternal full time employment leads to less time spent in the household during which children's dietary behaviours and activity levels are not supervised by their mothers (Cawley and Liu, 2007; Anderson et al., 2003). In addition working mothers are more prone to serving their families high calorific meals (Cawley and Liu, 2007; Anderson et al., 2003) thus fostering the development of overweight and obesity.

2.4.8 Breast Feeding

Currently there are inconsistent results linking breast feeding and weight gain in children (Hediger et al., 2001). A systematic review examining nine studies with more than 69,000 participants showed that breastfeeding significantly reduced the risk of obesity in childhood (Arenz et al., 2004). Some theories suggest that differences in the composition of human

breast milk are protective against the development of paediatric obesity (McCrory and Layte 2012; Singhal and Lanigan, 2007; Ong et al., 2002).

A study conducted by Heinig and colleagues (1993) states that the energy density of baby formula can be significantly higher compared to breast milk. Another study found that a high milk protein intake with infant formula during the first year of infancy was shown to induce excessive weight gain (Koletzko et al., 2009) which could be because the concentration of protein is much lower in infant formula compared to breast milk (Darragh and Moughan, 1998).

An Irish study examining breastfeeding and the risk of overweight and obesity indicates that children who were breastfed for five to eight weeks were 47% less likely to be obese compared to children who were not (McCrory and Layte, 2012). However new-borns who were breastfed in excess of twenty six weeks were 62% less likely to be obese at nine years of age (McCrory and Layte, 2012).

2.4.9 Race and Ethnicity

Obesity has disproportionately affected some racial and ethnic groups (Freedman et al., 2012; Barrlow, 2007) which could be primarily due to cultural norms (Gordon-Larsen et al., 2003). The prevalence of overweight increased approximately three and five fold among white and black children respectively who were aged between six to eleven years (Freedman et al., 2012). In addition Rosner and colleagues (1998) found that black and Hispanic girls tend to have greater values of BMI than white females, especially after the age of nine years. However, these findings are not consistent with males although Hispanic boys had higher BMIs than other ethnic groups (Rosner et al., 1998).

2.4.10 Social and Economic Factors

The theory that socio economic status (SES) may contribute to levels of overweight and obesity was first raised over a century ago by Veblen (Veblen 1889; cited in Pouliou and Elliott, 2010). Since then many researchers have examined the relationship between SES and obesity and have found a correlating connection (McLaren, 2007; Baltrus et al., 2007; Truong and Sturm, 2005). Individuals from a low socio economic background may purchase

cheap, high calorie dense foods as opposed to fresh produce thereby leading to excess weight gain (Drewnowski et al., 2004). In addition these individuals may have limited opportunity for PA (Gordon-Larsen et al., 2000). Conversely, those from a higher socio economic background tend to be higher educated and therefore may make healthier dietary choices, but may also be at risk of becoming overweight due to the increased availability of calorie dense foods and leading a western type of lifestyle (Ebbeling et al., 2002; Doak et al., 2002).

An international systematic review of the literature examining the associations between SES and weight gain in children reported mixed results (Shrewsbury and Wardle, 2008). Nineteen out of forty five studies (42%) found SES was inversely associated with adiposity, twelve studies (27%) found no association whilst fourteen (31%) found a mixture of no associations and inverse associations across subgroups (Shrewsbury and Wardle, 2008). Notwithstanding the aforementioned, whilst many studies have examined the links between SES and obesity, not all have examined the same indicators of SES (Pouliou and Elliott, 2010).

In Ireland the Growing Up in Ireland (GUI) study revealed that 19% of boys and 18% girls, from a professional household were classified as overweight or obese (Layte and McCrory, 2011). However this figure increases to 29% of boys and 38% of girls who were from semi and unskilled social-class households (Layte and McCrory, 2011). The CSPPA study however noted that SES did not influence the proportion of children meeting the PA guidelines (Woods et al., 2010).

2.4.11 Transport and Technological Advancements

The ubiquity of modern technology and the development of motorisation have greatly impacted the decrease in PA and in unison with this, energy expenditure and weight gain (Lob-Corzilius, 2007). The effect transport has had on inhibiting active travel has not been fully investigated within social epidemiology (Woodcock and Aldred, 2008) however researchers recognise the importance and health benefits of active transport and travel (Bere et al., 2011). The number of children actively travelling to destinations has declined dramatically within the last three decades with increasing numbers of children now

commuting by car (Schoeppe et al., 2013; Woods et al., 2010; Metcalf et al., 2004). However, the decrease in children actively travelling to school may also be attributed to parental concerns regarding their child's safety (Salmon et al., 2007). As previously mentioned, technological advancements have also impacted sedentary behaviour (Must and Tybor, 2005) and weight gain (Must et al., 2009; Rey-López et al., 2008).

Whilst Irish figures relating to active travel to school are of concern, recent data indicates that the amount of children actively commuting to school is beginning to increase (Woods et al., 2010). Thirty one percent of primary and 40% of post-primary school children actively travelled to school in 2009 compared to 26% (primary) and 30% (post-primary) in 2004 (Woods et al., 2010). According to the GUI study 8% of Irish nine year old children have a computer or laptop in their bedroom, and 35% have a games console (Layte and McCrory, 2011). This study also indicates that those who have a television in their bedroom are more likely to also have a computer or a games console (Layte and McCrory, 2011).

Overall there are conflicting findings regarding the determinants of paediatric obesity, 'thus while many determinants of obesity have been investigated, the relationships among them, including combined or confounding effects, are difficult to interpret' (Santiago et al 2013, p.392). Furthermore it is extremely difficult to successfully investigate the effect of one determinant on overweight and obesity as one determining factor can be influenced by other penetrating factors (Stewart, 2011).

2.5 Guidelines for Physical Activity, Sedentary Behaviour, and Nutrition for Children

The WHO influences the development of national and international PA and nutrition policies (WHO, 2014d).

2.5.1 Physical Activity

Physical activity (PA) has three levels of intensity; light, moderate and vigorous, and these intensity levels vary between individuals (WHO, 2014e). The intensity of PA can be determined using a rating of perceived exertion (RPE) scale measuring from zero to ten (Morishita et al., 2013; Borg, 1962). A rating of zero is associated with no effort, i.e. rest,

whilst a rating of five is perceived as being hard and ten as maximal effort (Morishita et al., 2013).

Light PA is defined as activities that require the least amount of effort (RPE ranging from zero to one) such as casual walking, stretching, sitting and occupations requiring extended periods of sitting (U.S. Department of Health and Human Services, 1996). Moderate PA is defined as activities that require a moderate amount of effort that noticeably increases the heart rate and is usually a three or four on the RPE scale examples include brisk walking, dancing and active games (WHO, 2014e; CDC, 2011b),. Vigorous PA can be described as an activity that results in sweating, rapid breathing and a substantial increase in heart rate (WHO, 2014e; Biddle et al., 2004) and is usually between five and ten on the RPE scale (), examples include running, aerobics and competitive sports.

A review of the literature indicates that there is a global acceptance that children should be physically active (between moderate and vigorous) for sixty minutes or more on a daily basis and furthermore should include vigorous intensity activities at least three times a week (Canadian Society for Exercise Physiology, 2012; U.S Department of Health and Human Services, 2008; Ministry of Education (New Zealand), 2007; EU Physical Activity Guidelines, 2008). However it should be noted that there is no agreed stated duration for engaging in vigorous activities.

This recommendation is also mirrored in Ireland. According to the Department of Health and Children (DHC) children and adolescents (aged two to eighteen years) should accumulate sixty minutes of daily MVPA and should include other components of fitness such as muscle-strengthening, flexibility and bone-strengthening three times a week (Department of Health, 2009).

2.5.2 Sedentary Time

Many countries do not have established guidelines for sedentary time for adults or children. A review of the literature indicates that Australia, Canada and New Zealand are currently the only countries who have developed guidelines for sedentary behaviour. These guidelines recommend children (aged five to eighteen years) to spend less than two hours

of daily screen time and to limit sedentary behaviour (Department of Health, 2014; Canadian Society for Exercise Physiology, 2012; Ministry of Education, 2007).

2.5.3 Nutrition

As previously stated the WHO influences the development of nutrition guidelines however each country is free to develop their own (WHO, 2014d). The WHO sets out specific nutritional information however these mostly relate to malnutrition and guidelines for infants (WHO, 2014d).

In Ireland, in 2011, the Department of Health released new nutrition guidelines using the Food Pyramid as an educational tool (Food Safety Authority of Ireland). The Food Pyramid categorises foods into six different groups and provides recommendations on the number of daily servings from each group. The new Irish guidelines are structured into four different age groups and illustrate how food needs vary according to gender, body size and activity levels (Food Safety Authority of Ireland, 2011). Guidelines for children aged between five to thirteen years are outlined in Table 2.5.

Table 2.5: Children aged 5-13 years recommended servings

Food Category	Boys	Girls	1 Serving Size =
Other foods that are not necessary for healthy eating	Not too much and not too often		Not specified
Fats, spreads and oils	Use sparingly		Not specified
Meat, poultry, fish and alternatives	Main meal 1 serving Light meal 1 serving		Size of the palm of your hand
Milk, yoghurt and cheese	3 to 5 servings		200ml cup of milk/¾ cup of yoghurt/a matchbox size of cheese
Fruit, vegetables and salads	5 servings		An apple/a handful of berries/1 large slice of pineapple/1 cup peppers/ cup of cooked broccoli/cauliflower
Cereals, breads, potatoes, rice and pasta	3 to 5 servings	3 to 4 servings	⅓ cup of raw porridge oats /a slice of soda bread/a medium size potato/a cup of cooked rice/pasta

Physical activity, sedentary behaviour and nutrition deserve equal consideration as all are major contributors to the obesity epidemic. Whilst the PA and nutrition guidelines are well established and communicated, the Irish Government have a duty to create sedentary time guidelines to set out best practice for engaging in acceptable levels of sedentary behaviour.

2.6 Behavioural Trends in Ireland

In Ireland, only a handful of studies have used objective measures to quantify children's PA levels, sedentary and nutritional behaviours, and recruited a representative sample (Woods et al., 2010).

2.6.1 Physical Activity

The Health Behaviour in School-aged Children (HBSC) study found that 51% of children surveyed (n = 16,060, aged 9 to 18 years) state that they are at least moderately active four times a week compared to 53% in 2006 (Kelly et al., 2012). However only 9% of children are vigorously active less than weekly (Kelly et al., 2012). In addition 25% of those surveyed reported being physically active on seven days in the previous week compared to 27% in 2006 (Kelly et al., 2012).

This finding is reflected in the Children's Sport Participation and Physical Activity (CSPPA) study which discovered that 86% of children surveyed (n = 5937, aged 10 to 18 years) are not receiving sufficient amounts of PA and are therefore not meeting the DHC physical activity recommendations (Woods et al., 2010). The CSPPA also noted that girls were less likely to meet these guidelines than boys and the likelihood of meeting the PA guidelines decreases with increasing age (Woods et al., 2010). In accordance with this, the Health Behaviours of School-aged Children (HBSC) study discovered '6% of boys report participating in vigorous exercise less than weekly compared to 13% of girls' (Kelly et al 2010, p.43).

The CSPPA study also states that the proportion of children receiving sufficient PA has not improved since 2004 (Woods et al., 2010) and indicated that one in every four children was deemed to have poor aerobic capacity (Woods et al., 2010). Furthermore only 19% of primary and 12% of post-primary Irish school children met the PA guidelines (Woods et al., 2010).

2.6.2 Sedentary Time

As previously stated Ireland has not yet established any guidelines for sedentary or screen time. A recent study found that high levels of sedentary time (defined as more than three hours of per day) increased the risk of overweight and obesity in high and low active children (Lane et al., 2014).

The CSPPA study used the Australians' Department of Health and Ageing (2004) Physical Activity guidelines to define screen time (maximum duration of two hours). The CSPPA study found that 99% of children surveyed exceeded 120 minutes of daily screen time (Woods et al., 2010).

The Growing Up in Ireland (GUI) study states that one in ten children (n = 8568 aged nine years) watched TV for three hours or more on a weekday and 66% watch TV between one to three hours (Layte and McCrory, 2011). It also noted that 8% of children who are of nine years of age have a laptop or computer stationed in their bedrooms and 35% have a games console (Layte and McCrory 2011). Over the last two to three years small, handheld screens have become ubiquitous and anecdotally further add to the daily sedentary time of Irish children.

2.6.3 Nutrition

The HBSC study discovered that 20% of children surveyed eat fruit and vegetables more than once a day whilst 37% of children surveyed stated that they eat sweets, and 21% reported consuming soft drinks daily (Kelly et al., 2012). The HBSC study illustrates that gender, age and social inequalities exist in relation to fruit consumption (Kelly et al., 2012). Younger children and those from higher social class status are more likely to consume more fruit and vegetables compared to boys, older children and those from other social classes (Kelly et al., 2012). This study also reports that 39% of girls eat sweets once a day compared to 34% of boys, and boys are more likely to report drinking more soft drinks daily than girls (23% v 19% respectively) (Kelly et al., 2012). In addition, older children and children from lower social class groups are more likely to report consuming sweets and soft drinks once a

day or more compared to younger children and those from other social class groups (Kelly et al., 2012).

Overall the aforementioned behavioural trends in Ireland are worsening and have not improved within the last decade. Technological advancements and the plethora of energy dense foods and minerals seem to have critically impacted on individuals' PA and dietary behaviour.

2.7 Health Problems associated with overweight and obesity

Overweight and obesity correlate with multiple physical and psychological comorbidities (Pulgaron, 2013; IASO, 2013; WHO, 2003; Reilly et al., 2003; Kuczmarski and Flegal, 2000; Cole et al., 2000). For each five kg/m² increase in BMI, the risk of developing cardiovascular diseases increases by 40%, diabetes, renal and hepatic diseases between 60% to 120%, respiratory diseases by 20%, and cancer by 10% (The Lancet, 2009).

Paediatric obesity is currently the most prevalent chronic condition affecting the health of children and adolescents (Raychaudhuri and Sanyal, 2012; Craigie et al., 2011; Lobstein and Frelut, 2003). Childhood obesity is a multi-system disease which can cause or exacerbate numerous health problems (Layte and McCrory, 2011; Lobstein et al., 2004; Ebbeling et al., 2002) which may occur as early as six years of age (Juonala et al., 2011). The rise in paediatric obesity has been accompanied by an increase in conditions previously associated with adulthood such as hypertension, fatty liver disease, type II diabetes, and sleep apnea (Raychaudhuri and Sanyal, 2012). In a US nationally representative sample of obese children aged ten to seventeen years, a study reported that almost double of those surveyed had the risk of having three or more reported developmental, physical and mental health conditions (Halfron, 2013).

2.7.1 Psychological Consequences

Various meta-analyse and research indicate that depression (Xu et al., 2011; Griffiths et al., 2011; Layte and McCrory, 2011; de Wit et al., 2010; Luppino et al., 2010; Blaine, 2008; Berkey et al., 2000; Dietz, 1998), teasing, and bullying (Eisenberg et al., 2003) are common psychological problems for overweight and obese individuals. The exact age at which

psychological problems become associated with increasing BMI however, remains unclear (Janssen et al., 2005).

Obese children and adolescents are subject to discrimination (Dietz, 1998) and are socially marginalised (Xie et al., 2005; Strauss et al., 2003) and have fewer friendships (Strauss et al., 2003). Overweight boys are at greater risk of being verbally teased (Xie et al., 2005) whilst overweight girls are more likely to suffer from peer isolation (Pearce et al., 2002) and this risk increases with increasing age (Reilly et al., 2003).

2.7.2 Cardiovascular Disease

Overweight and obesity are extensively well documented independent risk factors for cardiovascular disease (CVD) (De Schutter et al., 2014, McCrindle, 2014; Bastien et al., 2014). Coronary heart disease (CHD) (Park et al., 2012, Bray, 2004), myocardial infarction (MI), angina pectoris, congestive heart failure (CHF), hypertension (defined as BP ≥ 140/90 mm Hg) (Chrostowska et al., 2013, Finer, 2011, Guh et al., 2009), atrial fibrillation and type II diabetes mellitus (Finer, 2011; Abdullah et al., 2010; Bray, 2004; Colditz et al., 1995; Chan et al., 1994) are all forms of CVD (Klein et al., 2004; Must et al., 1999) that are strongly associated with excess weight gain (Reilly et al., 2003). According to a systematic review however, the evidence outlining the link between stroke and excess weight gain is mixed (Park et al., 2012).

Cardiovascular risk factors, originally associated with adult obesity are now becoming associated with obesity in children and adolescents (Reilly, 2005a). Freedman and colleagues (1999) found that 58% of obese children (aged five to ten years) had at least one cardiovascular risk factor and 25% had two or more.

2.7.3 Respiratory Disease

Overweight and obesity can also cause and exacerbate respiratory problems (Rabec et al., 2011). A meta-analysis concluded that adult obesity has been repeatedly associated with an increased risk of developing asthma (Beuther and Sutherland, 2007), however this association in paediatric obesity is not very well documented (Reilly, 2005a). Some studies however, have reported that asthma is a comorbidity of paediatric obesity (Noonan et al.,

2010; Barbiero et al., 2009; Wickens et al., 2005; Reilly et al., 2003; Gilliland et al., 2003) whilst others have found no association (Mahut et al., 2012; Vignolo et al., 2005).

Obstructive sleep apnea (OSA) is another respiratory disease that is related with adult obesity (Tuomilehto et al., 2013; Akinnusi et al., 2012; Finer, 2011; Vgontzas et al., 2000) however, this is not well researched or consistent in paediatric obesity (Esteller-Moré et al., 2012; Verhulst et al., 2007). OSA is characterised by an upper airway obstruction that occurs during sleep as repetitive episodes (Pillar and Shehadeh, 2008) and can result in loud snoring, fragmented sleep, daytime sleepiness and cardiovascular complications (Pi-Sunyer, 2009). The prevalence of OSA among obese and morbidly obese adults ranges from 50% to 98% (Newman et al., 2005). It is hypothesised that increased body weight reduces residual lung volume as increased abdominal weight puts pressure on the diaphragm and alters the upper airway structure (Finer, 2011). Furthermore whilst adult obesity is a significant risk factor in the pathogenesis of OSA, emerging evidence indicates that OSA can lead to or assist the development of overweight and obesity (Ong et al., 2013).

2.7.4 Cancer

Obesity is associated with an increase incidence of many forms of cancer including hormone-dependent cancers such as breast, prostate and endometrial (Finer, 2011).

Findings from various meta-analysis's indicate that overweight and obesity are associated with an increased risk of; gastric cancer (Yang et al., 2009), colorectal cancer (Ma et al., 2013), malignant melanoma (Sergentanis et al., 2013), primary liver cancer (Chen et al., 2012; Larsson, 2007), diffuse large B-cell lymphoma (Castillo et al., 2014), ovarian cancer (Olsen et al., 2007), and is associated with poorer invasive breast cancer prognosis (Robinson et al., 2014). The link between obesity and prostate cancer however remains unclear due to conflicting evidence (Wooding and Rehman, 2014), however a meta-analysis study found a positive association between BMI and benign prostatic hyperplasia (BPH) (enlargement of the prostate) and lower urinary tract symptoms (LUTS) (Wang et al., 2012).

There is limited evidence that paediatric overweight and obesity is linked to the increased risk of developing cancer (Park et al., 2012). Many studies state that childhood obesity

increases the risk of non-alcoholic fatty liver disease (NAFLD) which may lead to primary liver cancer in adulthood (Koppe et al., 2014; Berentzen et al., 2014; Anderson et al., 2014).

2.7.5 Quality of Life

Adult overweight and obesity impacts all aspects of an individual's quality of life (QOL) (Taylor et al., 2013; Forhan and Gill, 2013; Kushner and Foster, 2000). The impact obesity has on children and adolescents' QOL has not been fully explored, however a meta-analysis reports that overweight and obese children, and adolescents had significantly lower physical, and psychosocial health related QOL compared to normal weight peers (UI-Haq et al., 2013). This is in accordance with an earlier study (Nadeau et al., 2011).

2.7.6 Mortality

Obesity has become a global leading risk factor for mortality resulting in at least 3.4 million adult deaths worldwide each year (WHO, 2014a; World Obesity[6], 2014) with more deaths being attributable to excessive weight than underweight (WHO, 2014a). Excess weight gain in adulthood is associated with a large decrease in life expectancy (Song et al., 2010; Peeters et al., 2003; Calle et al., 1999).

A recent meta-analysis from ninety seven studies indicated that overall, obesity was significantly associated with higher mortality whilst overweight was not (Flegal et al., 2013). According to another analysis with approximately 900,000 adults, median survival is reduced by two to four years at BMI values between thirty to thirty five kg/m², and by eight to ten years at 40–45 kg/m² (The Lancet, 2009). In the same study indications were made that for each five kg/m² increase in BMI, overall mortality increased by 30% (The Lancet, 2009). The relationship between obesity and mortality however, appears to vary among ethnic groups and age (Flegal et al., 2005). For instance black men and women with the highest BMI had much lower risks of death (Calle et al., 1999).

A review of the literature indicates that studies examining the association between paediatric obesity and mortality has not been collectively analysed. However according to World Obesity (2014), this generation of children is the first generation predicted to have a

[6] Formerly known as the International Association for the Study of Obesity (IASO)

shorter lifespan than that of their parents. This could be due to the fact that childhood obesity is a precursor of health related illness that can track into adulthood (Gunnell et al., 1998).

In essence, overweight and obesity negatively affect every aspect of an individual's health (Pulgaron, 2013; Raychaudhuri and Sanyal, 2012). Early intervention strategies are therefore vital to help prevent the progression of overweight and obesity. Furthermore effective strategies should be implemented to help overweight and obese individuals achieve a healthier BMI in order to reverse associated health problems.

2.8 Cost of overweight and obesity

Overweight and obesity have become global economic burdens (Kesztyüs et al., 2014) as excess weight gain incurs substantial costs to individuals and society (Wang et al., 2011). Overweight and obesity can contribute to direct costs such as the increase in the utilization of health care services, and indirect costs due to the loss in productivity as a result of sick days associated with obesity (Wenig et al., 2011). However an increasing number of studies have noted that it is important to distinguish between the annual and the lifetime cost of obesity as obese people tend to live shorter lives, and therefore, tend to contribute more to medical resources as opposed to having a negative impact (Anomaly, 2012; van Baal et al., 2008).

According to the WHO overweight and obesity accounts for two to six percent of total health care costs in several developed countries (WHO, 2003). In 2008 the health care cost of obesity in the US was estimated to reach $147 billion per year (Finkelstein et al., 2009) however, one study indicates a higher cost at $190 billion in 2005 (Cawley and Meyerhoefer, 2012). A quantitative review of thirty three US studies estimated that the annual direct medical cost of overweight and obesity for an individual is higher ($266 and $1,723 respectively) than that of a normal weight individual (Tsai et al., 2012).

In 2002 the total cost of overweight and obesity for Europe was estimated to cost approximately €33 billion a year (Fry and Finley, 2005). In the UK the total cost of overweight and obesity was approximately £20 billion in 2007 and this is estimated to reach £27 billion by 2015 for indirect costs alone (Butland et al., 2007). Medical costs of obesity

were estimated to be approximately 30% greater for obese individuals in the UK than their normal weight peers (Withrow and Alter, 2011).

The first study investigating the cost of overweight and obesity in Ireland was recently conducted by Perry and colleagues. Findings from this study revealed that the total cost of obesity for the RoI was estimated at €1.13 billion in 2009 (Perry et al., 2012). Out of this figure 35% of the total cost was attributable to direct healthcare costs whilst 65% was due to a reduction or loss in productivity as a result of absenteeism (Perry et al., 2012).

Overweight and obesity have been shown to contribute to various health and financial consequences and have placed a financial burden on individuals and on society (Kesztyüs et al., 2014; Wang et al., 2011). Collaborative initiatives are urgently needed to effect environmental change in an effort to minimise the health and financial burden of the obesity epidemic.

2.9 Tackling overweight and obesity

Only the main global policies, surveillance and prevention strategies have been outlined in this section as outlining all previous international and national prevention efforts would be an immense and lengthy task.

Obesity is currently recognised as one of the most significant public health issues of the twenty-first century (WHO, 2010; Simmons and Wareham, 2006). Following the WHO publication of The Obesity Report in 2000 which defined obesity as an epidemic, many countries, organisations and institutions have developed policies, surveillance criteria and strategies to help reverse recent obesogenic trends (Bartrina, 2013).

2.9.1 Policy

In 1997 the WHO and the IOTF examined the need to develop public health policies and programmes to tackle the global problem of obesity (WHO, 2014i). The consultation resulted in the publication of an interim report: “Obesity – Preventing and Managing the Global Epidemic” (WHO, 2000). This document contained a review on current

epidemiological information on obesity, determinants and health consequences associated with overweight and obesity (WHO, 2000).

The report presented conclusions and recommendations for developing public health policies and programmes for improving the prevention and management of overweight and obesity (WHO, 2000). It recommended that prevention and management efforts should focus on; the main environmental determinants of obesity, programmes to deal with the percentage of the population who are at a high risk of developing obesity and, management protocols for individuals dealing with existing levels of obesity (WHO, 2000). The report outlined the following levels of preventive action;

- universal or public health prevention (everyone in the community)
- selective prevention (directed at high risk individuals and groups)
- targeted prevention (directed at individuals currently overweight or obese)

The report recognises that the concept of obesity prevention does not simply mean preventing the progression of obesity in overweight individuals; it also aims to address the prevention of normal weight individuals from becoming overweight or obese (WHO, 2000).

The report concluded that the use of BMI for classifying overweight and obesity should be adopted globally and highlighted that sedentary and dietary lifestyles were the main contributors of overweight and obesity (WHO, 2000).

2.9.2 Surveillance

As previously stated, the global prevalence of adult overweight and obesity is monitored using BMI guidelines. Due to the fact that currently, there is no globally accepted definition for paediatric overweight and obesity, the WHO established the Child Obesity Surveillance Initiative in 2005 in twenty one countries in the WHO/Europe Region to allow for inter-country comparisons (WHO, 2014c). This initiative measures weight trends in primary school children aged six to nine years of age (WHO, 2014c). Whilst countries were advised to adhere to certain protocols regarding core items, each country was able to develop its own surveillance strategy (WHO, 2014c).

Nationally representative samples of primary schools are recruited and these schools remain as part of the sample for repeated measurements (WHO, 2014c). Children have their weight and height measurements taken (waist and hip circumference are optional) along with associated co-morbidities, dietary intake and physical activity/inactivity patterns (WHO, 2014c). Data are analysed at both the country level by the national coordinating centre and at European level (WHO, 2014c). Ireland was part of this initiative and the findings were previously discussed in section 2.3.

2.9.3 Public Health Prevention Strategies

Reducing the risks associated with overweight and obesity and tackling the epidemic itself has become an important public health priority (Lobstein, 2004). Public health strategies have aimed to provide and communicate health information to improve public awareness about the benefits of leading a healthy lifestyle and to highlight the consequences of excessive weight gain (Cecchini et al., 2010).

2.9.3 (a) Strategies

WHO Global Strategy on Diet Physical Activity and Health

In May 2004 the WHO Global Strategy on Diet Physical Activity and Health (DPAH) was commissioned to guide the development of action plans in an effort to reduce the global burden of overweight and obesity (WHO, 2014j; Bauman and Craig, 2005). Its' overall goal is to,

'promote and protect health by guiding the development of an enabling environment for sustainable actions at individual, community, national and global levels that, when taken together, will lead to reduced disease and death rates related to unhealthy diet and physical inactivity'

(WHO, 2014j)

International societies are to advocate for the importance of PA and associated risk factors; develop international measures of PA, identify the impacts of sedentary behaviour, and develop global research and intervention agenda (Bauman and Craig, 2005). This strategy suggests a multi-sectorial approach amongst various private and public agencies to help implement diet and PA strategies (Bauman and Craig, 2005).

In addition countries are to document and monitor the implementation of this strategy to act as a useful framework for assessing the actions undertaken by each nation (Bauman and Craig, 2005). Some of Irelands' strategies have been developed and informed by the WHO Global strategy (The National Task Force on Obesity, 2005) and will be outlined later in this chapter.

Commission on Ending Childhood Obesity

In May 2014 the WHO established a Commission on Ending Childhood Obesity that is part of the WHO Global Strategy on Diet Physical Activity and Health (WHO, 2014k). The Commission has been tasked with generating a report specifying which approaches and combinations of interventions are likely to be most effective in tackling childhood and adolescent obesity on a regional, national and international level (WHO, 2014k).

The report will provide a cross-disciplinary approach, and aims to develop a strategy that outlines a number of different approaches that are likely to be effective in different countries (WHO, 2014k). The Commission will deliver its report to the WHO in early 2015 (WHO, 2014k).

Health 2020: the European policy for health and well-being

Health 2020 is a European health policy framework that was adopted in September 2012 following an extensive two year consultation process (WHO Europe, 2014). One of the policy's priorities is to tackle the prevalence of non-communicable diseases within Europe and to improve health by reducing health inequalities (WHO Europe, 2014). Health 2020 is an evidence-based policy that places strong emphasis on political, professional and civil society engagement to ensure health improvement and the reduction of health inequities and to improve leadership and participatory governance for health. (WHO Europe, 2014).

SPOTLIGHT

Sustainable Prevention of Obesity Through integrated strategies (SPOTLIGHT) is a European, evidence based model that aims to increase and combine knowledge on the determinants of obesity, and to identify effective, multi-level intervention approaches (European Commission, 2014; Lakerveld et al., 2012).

SPOTLIGHT brings together a multidisciplinary consortium of thirteen organisations across eight European countries (Belgium, Denmark, France, Hungary, the Netherlands, Norway, Portugal and the United Kingdom) to define the factors necessary for establishing effective health promotion approaches (European Commission, 2014). In addition the project supports the development and implementation of effective obesity prevention approaches led by local authorities, public health and other practitioners (European Commission, 2014). Furthermore it comprises of systematic reviews on environmental determinants of obesity and predictors of success in behaviour change interventions (Lakerveld et al., 2012). An interactive web atlas of multi-level interventions has been developed and outlines impeding factors for implementation (Lakerveld et al., 2012).

Findings will inform governmental authorities and professionals, academics, and private sector stakeholders engaged in the development and implementation of policies to tackle the obesity epidemic in Europe (Lakerveld et al., 2012).

2.9.3 (b) Interventions

A plethora of health promotion interventions have been developed in response to the increase of paediatric obesity (Flynn et al., 2005). As a result it is nearly impossible to discuss them all. Schools are considered as an appropriate setting for interventions as they can be instrumental in facilitating environmental and behavioural transformation (De Bourdeaudhuij et al., 2011; Pate et al., 2006). In addition, school based interventions have proven successful in improving pupils' health status (Wang et al., 2013; Rush et al., 2011; De Bourdeaudhuij et al., 2011; Seo and Sa, 2010; Gonzalez-Suarez et al., 2009; Brown and Summerbell, 2009).

Notwithstanding the complexity of the determinants of obesity, school based interventions have mainly focused on dietary behaviours, physical activity, and sedentary behaviour patterns. Interventions that target more than two determinants of overweight and obesity are proven to be more successful than interventions that target one determinant (Harris et al., 2009; Eliakim et al., 2007). Some reviews state that findings of multi-pronged interventions are inconsistent (Brown and Summerbell, 2009; Katz et al., 2008; Veugelers and Fitzgerald, 2005) but this could be due to variability in methodological approach (Brown

and Summerbell, 2009) as it is not clear which strategy is the most effective in promoting life-long healthy behaviours (Dobbins et al., 2013). There is evidence to suggest that a combined PA and diet intervention may help to tackle paediatric overweight and obesity (Brown and Summerbell, 2009; Katz et al., 2008; Budd and Volpe, 2006; Veugelers and Fitzgerald, 2005; Dietz et al., 2001).

Project Energize

In 2004 the Waikato District Health Board (WDHB) in New Zealand invested in a school based health initiative (Project Energize) to enhance PA and nutrition to reduce adiposity among children, accompanied by a structured evaluation (Graham et al., 2008).

Project Energize is a longitudinal, randomised control trial (RCT) that has been in place since 2005 and is the largest and most comprehensive school based intervention study in New Zealand (Rush et al., 2013, Rush et al., 2011a). Initially the project commenced with sixty two programme schools and sixty two control schools (Graham et al., 2008). Currently there are two hundred and forty four primary and intermediate schools involved in the Energize programme (Sport Waikato, 2014).

In the original study schools were randomly assigned as an intervention or control school (Rush et al., 2011a). Intervention schools were assigned an 'Energizer'; a trained physical activity and nutrition change agent, who worked with the school to achieve the project goals (Rush et al., 2011a). Energizers were teachers/graduates of exercise/nutrition or physical education, employed by Sport Waikato to support the delivery and development of the programme in the intervention schools (Rush et al., 2013). Energizers supported a number of schools in their geographic area (eight to twelve each) by providing professional development to the teachers to support and assist them with initiatives that aim to increase the quality and quantity of PA and nutritional behaviour (Sport Waikato, 2014; Rush et al., 2013).

Children from two age cohorts (five and ten years at enrolment) from the intervention and control schools had their anthropometric and physiological measurements taken, completed a nutrition survey and a fitness test at baseline and two years later (Rush et al., 2004). Overtime Project Energize has proven successful in delivering measurable health

improvements to help reduce excess weight gain across children from ethnic groups and all SES groups (Rush et al., 2013; Rush et al., 2011a). 'Energized' pupils were associated with lower BMI, percentage of body fat (%BF), and systolic BP, and improved physical fitness (Rush et al., 2013; Rush et al., 2011). According to Rush and colleagues (2013) the Energize programme can be applied to other national and international geographic areas.

Project SPARK

Project Sports, Play, and Active Recreation for Kids (SPARK) is a physical education (PE) research based programme that was developed by a multidisciplinary team in San Diego in the late 80's (Sallis et al., 1997). SPARK's overall aim is to create, implement, and evaluate a primary school PE programme for fourth and fifth grade elementary pupils (equivalent to fifth and sixth class pupils in the Irish primary school setting) (Sallis et al., 1997). The SPARK PE programme is designed to enhance PA by disseminating evidence based PE and health programmes to teachers (Dowda et al., 2005). The intervention is led by trained fitness specialists and is implemented four days a week for thirty minutes each session (Sallis et al., 1997).

For evaluation purposes seven schools were randomly assigned one of three conditions as part of a quasi-experimental design (Sallis et al., 1997). Two schools were led by certified PE specialists, two were led by trained classroom teachers, and three were led by untrained classroom teachers (control). Pupils from fourth and fifth grade had their, height, weight and skin fold measurements taken at baseline and two years later (Sallis et al., 1997). Results indicated that pupils spent more minutes per week being physically active in a specialist (forty minutes) and trained teacher led (thirty three minutes) PE class than in control classes (eighteen minutes) (Sallis et al., 1997). The programme was not found to have any statistically significant impact on %BF (Sallis et al., 1997).

CHANGE!

The Children's Health, Activity and Nutrition: Get Educated! (CHANGE!) project is a clustered RCT investigating the effectiveness of a school based PA and nutrition intervention (Fairclough et al., 2013). The project was founded in John Moores University, Liverpool, United Kingdom.

The objectives of the CHANGE! project are to increase PA, decrease sedentary time, improve knowledge and consumption of healthy foods, and to promote healthy body size among ten and eleven year old school children (Liverpool John Moores University, 2013).

Class teachers from the intervention schools received training in the curriculum resource over two training sessions and were fully familiarised with the CHANGE! curriculum prior to implementation (Fairclough et al., 2013). CHANGE! consists of twenty lesson plans, including worksheets and other resources and is delivered through the Personal and Social Health Education strand of school's curricula (Liverpool John Moores University, 2013). In addition the curriculum resource is supplemented by homework tasks that target family involvement (Fairclough et al., 2013).

Twelve schools were recruited and were randomly assigned as either an intervention or control school (Fairclough et al., 2013). Measures were taken at baseline and post-intervention (20 weeks) and at follow up (30-32 weeks), prior to the school summer holidays (Fairclough et al., 2013). Pupils had their anthropometric and body composition measurements taken, completed a cardiovascular fitness test, food intake surveys, eating knowledge and behaviour, physical self-perceptions surveys, behaviour change, quality of life, and had their fundamental movement skills assessed (Fairclough et al., 2013). In addition family PA and dietary behaviour was also measured. The intervention resulted in significant effects on decreasing waist circumference, BMI z-scores, and light PA and was most effective among girls, overweight/obese, and high SES participants (Fairclough et al., 2013).

APPLES

Active Programme Promoting Lifestyle in Schools (APPLES) was a RCT, primary school based intervention in Leeds, United Kingdom (Sahota et al., 2001). The intervention was in place for one academic year and consisted of PA and nutrition component and adopted a whole school community approach (Sahota et al., 2001). The APPLES team provided training and support for teachers, helped develop and implement action plans designed to enhance pupils PA and nutrition behaviour (Sahota et al., 2001).

In an experimental evaluation of the programme, ten schools were randomly assigned as an intervention or control school. Children aged six to eleven had measurements taken at baseline and at intervention end (Sahota et al., 2001). Outcome measures included height, weight, BMI, self-reported PA and nutritional behaviours, psychological measures and evaluation by parents and teachers (Sahota et al., 2001).

Results indicate that vegetable consumption by twenty four hour recall was higher in children in the intervention group than the control group (Sahota et al., 2001). There was no significant difference in BMI, PA and psychological measures, and dieting behaviour between the intervention and control schools (Sahota et al., 2001). Focus groups indicated higher levels of self-reported behaviour change, understanding, and knowledge among children who had received the intervention (Sahota et al., 2001).

Interventions should target the school setting as this strategy results in more favourable outcomes (De Bourdeaudhuij et al., 2011). As overweight and obesity are caused by the interplay of various determining factors (Stewart, 2011), interventions should aim to tackle more than one determinant of obesity. Furthermore, interventions should be objectively evaluated to identify the effectiveness of the methodological approach adopted and should engage various stakeholders in an effort to increase the success of the intervention.

2.10 Tackling overweight and obesity in Ireland

Private and public sectors are all attempting to counteract the obesity epidemic as one organisation simply 'cannot stem the growing tide of obesity' alone (HSE 2008, p.6). As policy and environmental changes are the foundation of obesity prevention (Harvard School of Public Health, 2014), the Irish Government have established and altered new and existing policies, whilst various organisations have undertaken public health strategies to stimulate environmental change to help tackle this growing issue (HSE, 2008).

2.10.1 Background

The Health Promotion Unit (HPU) was established by the Department of Health in 1988 to develop health promotion policies and national campaigns (HSE, 2013a). Since its establishment the HPU, in conjunction with the Irish Government, has created numerous

policies and strategies in an effort to enhance public health and to tackle the determinants negatively impacting society's health (HSE, 2013a).

2.10.1 (a) National Health Promotion Strategy

The National Health Promotion Strategy (NHPS) established the role of health promotion and represented a 'predominantly target-focused approach' (DOHC 2004, p.6). The NHPS sets out policy framework recognising the wider health determinants and emphasises the need for an inter-sectoral and multi-disciplinary approach (DOHC, 2005; DOHC, 2004).

2.10.2 Policies

Only Irish documents and policies that have aimed to directly address the obesity crisis will be outlined in this section.

2.10.2 (a) National Guidelines on Physical Activity for Ireland

In 2009, the Government began the process of setting national policy on PA in Ireland in terms of health, education, environment, sport and transport.

'Get Ireland Active' promotes and encourages the National Guidelines on Physical Activity through the development and communication of key messages and activity based events (Get Ireland Active, 2014). The guidelines were launched by the Department of Health and Children and the Health Service Executive in June 2013 (HSE, 2013b).

The National Guidelines on Physical Activity for Ireland were created based on recommendations from the National Task Force on Obesity, to increase physical activity and reduce the levels of overweight and obesity (The National Task Force on Obesity, 2005). These guidelines highlight the recommendations for PA for children, adolescents and young people, adults, elderly and people with disabilities (HSE, 2013b).

2.10.2 (b) Cardiovascular Health Strategy

The first Cardiovascular Health Strategy was published in 1999 and recognised the efforts required to prevent cardiovascular disease at population level (DOHC, 2004). The new cardiovascular policy, Changing Cardiovascular Health 2010-2019, comes a decade after the

first national cardiovascular health strategy (DOHC, 2010). The key priorities listed in this policy are;

- maintaining a healthy body weight
- healthy eating and physical activity
- reducing salt intake
- refraining from or quitting smoking
- consuming alcohol responsibly

Actions will include fostering inter-sectoral support for initiation of activities promoting health and prevention of activities that maintain or foster unhealthy lifestyle behaviours (DOHC, 2010).

2.10.3 Framework

2.10.3 (a) Health Service Executive Framework for Action on Obesity

In the early 2000s the HSE acknowledged the need for developing 'an inter-departmental and multi-sectoral approach' to address obesity in Ireland (HSE, 2008).

This Framework was developed by the HSE National Working Group on Obesity to translate the recommendations of the National Taskforce on Obesity into tangible actions to address this growing public health issue (HSE, 2008). The Framework has five key strategic priorities each of which are supported by a series of specific actions to be addressed by all sectors (HSE, 2008). These were as follows;

- To enhance the effectiveness in surveillance, research, monitoring and evaluation of obesity.
- To develop a quality uniform approach to the detection and management of obesity.
- To develop Irelands capacity in preventing overweight and obesity and to promote health.
- To communicate messages on obesity effectively.
- To proactively engage and support the work of other sectors in addressing the determinants of obesity and the obesogenic environment (Lynam, 2012).

2.10.3 (b) Healthy Ireland

Healthy Ireland (HI) is a new national framework for action to improve health and wellbeing. The Government plan was launched in March 2013 and will run until 2025 (HSE, 2014c). HI adopts a whole of Government and whole of society approach to improving health and wellbeing and the quality of people's lives.

This new framework has four high-level goals which will be at the heart of all actions and activities, these are;

- Increasing the proportion of Irish people who are healthy at all stages of life
- Reducing health inequalities
- Protecting the public from threats to health and wellbeing
- Creating an environment where every sector of society can play its part

The approach used will be evidence based with evaluation procedures being adopted to help implement and assess the Framework's actions (HSE, 2014c).

2.10.4 Action Groups

2.10.4 (a) National Task Force on Obesity

The National Task Force on Obesity (NTFO) was established in 2004 by the Minister for Health and Children (National Task Force on Obesity, 2005). This taskforce was informed by national policies and strategies, in particular the Cardiovascular Health Strategy and the Health Promotion Strategy (DOHC, 2004). It was also informed by EU initiatives and WHO strategies such as the WHO Global Strategy on Diet Physical Activity and Health (DOHC, 2004).

The aim of the NTFO was to halt the rise and reverse the prevalence of obesity, its determinants and risk factors (National Task Force on Obesity, 2005). This policy document includes recommendations relating to actions across six sectors. In 2006 the HSE established a working group to implement these recommendations. These will be outlined later in this section.

Ninety three recommendations for the prevention and treatment of overweight and obesity were made however a review found only partial implementation of its recommendations had been achieved (Oireachtas Library and Research Services, 2011; Department of Health and Children, 2009). In response to these findings the Department of Health and Children set up a Special Action Group on Obesity to renew efforts to implement the remaining recommendations (Oireachtas Library and Research Service, 2011).

2.10.4 (b) Special Action Group on Obesity

The Special Action Group on Obesity (SAGO) was set up in 2011 consisting of representatives from the Departments of Health, Children and Youth Affairs, Education and Skills, the Health Service Executive, the Food Safety Authority of Ireland, Safe Food and other key stakeholders. The SAGO examines a number of issues aimed at addressing the problem of obesity. In addition the action group liaises with other Departments and organisations in a cross-sectoral approach to help halt the rise in overweight and obesity.

The SAGO concentrates on an assortment of measures including: calorie posting in restaurants, the introduction of a tax on sugar-sweetened drinks, nutritional labelling, marketing of food and drink to children, the supply of healthy food products in vending machines, the detection and treatment of obesity, healthy eating guidelines and the promotion of physical activity.

To date the SAGO have made a substantial impact on the established goals. Calorie posting has commenced in a number of establishments and it is envisaged that this will increase once adherence to this criteria is legally required. The Department of Health established a Steering Group and this group are expected to present findings from a Health Impact Assessment on the health and economic aspects of introducing a Sugar Sweetened Drinks tax. The Healthy Eating Guidelines, including the Food Pyramid were revised and were launched in 2012. These were previously outlined in section 2.5.3.

2.10.5 Public Health Prevention Strategies

Reducing morbidity and mortality related to overweight and obesity has become a public health priority (Katz et al., 2005) with many countries developing various strategies to halt

the progression of obesity. The development of some Irish campaigns and initiatives were influenced by the Report of the National Task Force of Obesity (2005).

2.10.5 (a) Campaigns

In recent years there has been a global increase in the development of public health campaigns aimed at addressing obesity (Puhl et al., 2013). In Ireland, a variety of obesity-related campaigns have been developed in response to the increasing prevalence of adult and childhood obesity.

Childhood Obesity; let's take it on, one small step at a time

This three year campaign was developed by Safe Food and was launched in October 2013 as a new public health campaign to help parents take on childhood obesity (Safe Food, 2014). The aim is to communicate and emphasise practical long term solutions and highlights the negative impact of excess weight gain in children (Safe Food, 2014). The campaign features on most forms of media and includes a free booklet for parents (Safe Food, 2014). Key messages include age appropriate portion sizes, restriction of sugary drinks, increasing PA, reducing screen time, and encouraging more sleep (Safe Food, 2014).

Little Steps

Little Steps is a HSE, Safe Food and Health Promotion Agency (Northern Ireland) campaign aimed at parents and guardians of school aged children (Safe Food, 2014). The development of this strategy was influenced by the recommendations set out by the Obesity Taskforce (Little Steps, 2014). The campaign was launched in 2008 and is designed to provide parents/guardians with information and support to make small improvements to their child's dietary and physical activity behaviour (Safe Food, 2014). The aim of this campaign is to encouraging parents to act as positive role models by practicing a healthier and more active lifestyle (Little Steps, 2014). The campaign uses national television and radio advertising as its main mode of communication. Posters and flyers for GP surgeries and other health outlets have also been developed.

Weigh 2 Live

The Weigh 2 Live campaign was launched in 2009 and targets adults aged between twenty to forty years of age who are attempting to lose excess weight or trying to maintain a healthy weight (Safe Food, 2014). The campaign was informed by the SLAN 2007 survey and is supported by the Irish Nutrition and Dietetics Institute (INDI). Advertising channels included television, web, cinema, print, outdoor and direct marketing (Safe Food, 2014).

Stop the spread

'Stop the Spread' was a two year awareness campaign that was launched in 2011 (Safe Food, 2014). The campaign aimed to increase people's waist circumference awareness as abdominal adiposity is linked to health (Duren et al., 2008). Furthermore overweight people perceive that being overweight is now the 'norm' and this has become visually and socially acceptable (Safe Food, 2014).

Operation Transformation

Operation Transformation is a high profile television campaign in Ireland. The television programme was launched in 2008 and accompanies adult volunteers who wish to change their PA and dietary behaviour to lose weight (Safe Food, 2014).

The Operation Transformation campaign has recently begun to target primary school children 'Operation Transformation: Step it up'. The campaign aims to identify if pupils are reaching the daily recommended steps necessary for being active (15,000 steps, DCU, 2013). A study involving ten primary schools was conducted, involving one class from each school (DCU, 2013). Pupils were given pedometers across a number of weeks to record total number of steps taken during the day (DCU, 2013). The results indicate that pupils were 2,000 steps short per day (DCU, 2013). This campaign was run in conjunction with the airing of the television programme.

2.10.5 (b) Interventions

Recently developed public health strategies in Ireland have recognised the potential of community and school based interventions in enhancing population health and in tackling determinants of overweight and obesity (Department of Health, 2013).

Community based interventions

Community based interventions are defined as group based health promotion, education, advice, counselling or subsidy only interventions, or interventions conducted in a community setting (Hillier-Brown et al., 2014). These interventions are regarded as a promising approach and an important component of a comprehensive response to preventing overweight and obesity (Allender et al., 2011). Irish community based initiatives, directly relevant to this study have been outlined in Table 2.6.

Table 2.6: Irish community based interventions

Initiative	Lead Agency	Region	Specific focus
My Action	Croi Heart and Stroke Charity	ROI	Obesity and CVD prevention, weight management
Description: Delivers dietary, weight and PA interventions, food labelling seminars, health behaviour and change education, psychological intervention and medical intervention (where applicable)			
Physical Activity Programme	Croi Heart and Stroke Charity	ROI	Physical activity and obesity
Description: Aims to increase PA levels by providing accessible exercise programmes for the local population			
Croi Weight Management Programme	Croi Heart and Stroke Charity	All island	Nutrition education and training
Description: Six week weight management programme focusing on diet and healthy eating. Once the programme is complete, individuals are encouraged to attend a weekly weigh-in, providing on-going support and motivation			
Project Weight loss	Cork Sports Partnership	ROI	Weight management
Description: Community based, twelve week weight loss programme. Exercise training programme providing nutritional advice and monitoring individuals' progression.			
Weigh to Health	Belfast Health and Social Care Trust and the Public Health Agency	Belfast	Nutrition education and training programmes
Description: Six week weight loss programme with the support of a group and delivered locally by trained tutors.			
Broadcast Media for Children: Nutrient Profiling	Food Standards Agency Northern Ireland	NI	Evaluation of a weight loss intervention
Description: A nutrient profiling model was developed to help differentiate foods high in fat, salt and/or sugar. The model is used by the media and communication regulator to regulate the advertising of unhealthy foods aimed at children.			
Way to go Kids/Get back challenge	Limerick City Sports Partnership and the HSE	Limerick	Weight loss management programme for adults
Description: The eight week programme targets youths between the ages of 9 and 14 years who are overweight or obese. The programme works with the parents and child to enhance healthy dietary and PA behaviours.			

To the best of the author's knowledge, none of these initiatives have been subject to a systematic impact or process evaluation. Therefore it is difficult to determine the effectiveness of these programmes in tackling the prevalence of overweight and obesity.

School based interventions

Education settings (i.e. preschools, primary and secondary schools) are popular settings for interventions (Jones et al., 2014) as this type of intervention has proven to be effective in improving the overall health status of pupils (De Bourdeaudhuij et al., 2011; Gonzalez-Suarez et al., 2009).

Table 2.7 outlines interventions based within Irish primary schools that are directly relevant to the objectives of this study.

Table 2.7: Irish school based interventions

	Focus	Target group	Creator
Action for Life	Help teachers deliver the Irish PE curriculum	Primary school teachers	Irish Heart Foundation
Active School Flag	Physical activity and physical education	Primary and post primary school children	Department of Education and Skills
Be Active After Soon Activity Programme (Be Active ASAP)	Physical activity	Primary school children – after 7 years of age	Parents/HSE
Bizzy Breaks	Physical activity	Primary school children	Irish Heart Foundation
Food Dudes	Nutrition	Primary school children	University of Wales, Bangor
Let's get active award pocket planner	Physical activity	Primary school children	Irish Heart Foundation

Action for Life

Action for Life provides an education resource package for teachers to assist them with planning and teaching the primary PE curriculum (Irish Heart Foundation, 2014). The programme can also be integrated with Social Personal and Health Education (SPHE) as it focuses on movement education, active play, dance and active sports (Irish Heart Foundation, 2014).

Active School Flag

The Active School Flag (ASF) is a Department of Education and Skills (DES) initiative that recognises primary and post-primary schools that have met criteria to be considered a

physically active and physically educated school (Active School Flag, 2014). Schools seeking the award must provide timetabled PE for all classes in accordance with guidelines (Active School Flag, 2014). Primary schools must provide a minimum of one hour timetabled PE per week for every pupil, and must teach a broad and balanced PE programme in accordance with the curriculum (Active School Flag, 2014).

The ASF adopts a whole community approach; as a result schools are encouraged to collaborate with parents, the local community and outside agencies to help the school obtain this award (Active School Flag, 2014). The ASF remains valid for three years (Active School Flag, 2014).

Be Active ASAP

The Be Active ASAP programme aims to improve the PA patterns of school children by introducing them to a wide variety of activities (Be Active ASAP, 2014). The programme is aimed at seven to eight year olds and is facilitated by teacher leaders, supported by parent leaders, and takes place on school grounds after school, one day a week (Be Active ASAP, 2014). The programme links with the PE Curriculum for first and second class, building on what has been learned in class through age appropriate activities across all areas of the PE curriculum (Be Active ASAP, 2014).

The Be Active ASAP initiative originated from a group of parents and is supported by the HSE in association with the Irish Sports Council (Be Active ASAP, 2014).

Bizzy Breaks

Bizzy Breaks is a series of classroom based activities, designed to get pupils moving on the spot. From their desks, pupils participate in the activity using the available space. The activities focus on strength, flexibility and aerobic fitness (Irish Heart Foundation, 2014). The break lasts no longer than ten minutes, requires minimal to no equipment, and can be conducted with limited floor space (Irish Heart Foundation, 2014). A specially commissioned CD is available for teachers to carry out the breaks.

The aim of the activity is to help contribute to the recommended duration of daily physical activity for children (Irish Heart Foundation, 2014).

Food Dudes

Food Dudes was developed by the Food and Activity Research Unit Bangor University, Wales to encourage children to increase their consumption of fruit and vegetables in school and at home (Food Dudes, 2011). It is based on positive role models (the Food Dudes characters), repeated tasting and rewards (Food Dudes, 2011). The programme consists of two phases; the first phase is a sixteen day intervention with the second phase extending to the home. During the first phase the school is provided with fruit and vegetables, one portion of each per pupil. Pupils watch or listen to a specially designed video of the Food Dudes characters and are rewarded for eating the portion of fruit and vegetable (Food Dudes, 2011).

The second phase encourages children to bring their own fruit and vegetable to school every day in Food Dudes containers (Food Dudes, 2011). Progress is recorded using a wall chart and children are rewarded (Food Dudes, 2011).

In Ireland the initial pilot and the extended pilot ran for two years and were conducted in 2002 and 2005 respectively. The National roll out of this programme commenced in 2007 and was evaluated in 2008. Participants were four to eleven year old children attending a primary school in Dublin (n = 228). The intervention was associated with increased fruit and vegetable intake (Horne et al., 2009).

Let's get active award pocket planner

This new initiative aims to encourage children to accumulate the recommended sixty minutes of daily PA by recording their PA behaviour over a four week period. If children have achieved the PA recommendation, they are awarded with a free certificate of achievement (Irish Heart Foundation, 2014).

As previously stated, the majority of these interventions have not been systematically evaluated however anecdotally they have been regarded as successful. A systematic evaluation should be conducted to determine the effectiveness of these interventions to clarify if these strategies are having an effect on pupils' body composition, PA and nutritional behaviours.

The Irish Government have become committed to tackling the prevalence of overweight and obesity within Irish society. Campaigns and public messages have been well communicated however without adequate financial support, strategies aimed at tackling the prevalence of overweight and obesity will not be effective able to operate. The Irish Government should therefore make financial support more accessible to these types of strategies.

2.11 Measuring Body Composition, Physical Activity, and Nutritional Behaviours

There are various methods available for measuring people's body composition, PA and nutritional behaviours.

2.11.1 Measuring Body Composition

To accurately measure an individual's level of adiposity an instrument must be capable of measuring an individual's body composition (Kushner et al., 1990). Body composition refers to the relative proportions of fat, protein, water and mineral components in the body (Barlow, 2007).

Percentage body fat (%BF) can be measured using accurate laboratory techniques such as Dual Energy X-ray Absorptiometry (DEXA), Magnetic Resonance Imaging (MRI), Bioelectrical Impedance Analysis (BIA) or by using estimation techniques such as; Body Mass Index (BMI), skinfold thickness SKF) and waist circumference to mention but a few.

This section will describe the range of methods available for measuring body composition, and by extension, obesity. Advantages and disadvantages of each method will be briefly outlined.

2.11.1 (a) Dual Energy X-Ray Absorptiometry

Dual Energy X-Ray Absorptiometry (DEXA) is a scanning instrument that directly measures bone mineral mass, fat mass (FM), and fat-free mass (FFM) by using X-rays of two different energy levels (Beechy et al., 2012; Lee and Gallagher, 2008; Duren et al., 2008; Wells and Fewtrell, 2006). DEXA is considered the 'gold standard' for quantifying fat, lean and bone tissue, and for analysing an individual's full and regional body composition (Duren et al., 2008; Dietz and Bellizzi, 1999).

Some of the advantages of DEXA include precision, speed and accuracy (Pateyjohns et al., 2012; The American Journal of Clinical Nutrition, 1996). The precision of absorptiometry and fat mass in DEXA is high compared to other measurements of body composition (Davies and Cole, 1995). Other advantages include minimal radiation dose on participants as it takes ten to twenty minutes to conduct and provides regional values in addition to total body values (Lee and Gallagher, 2008; Mazess et al., 1990; Davies and Cole, 1995)

However, this method of measuring percentage body fat is expensive and is not widely available (Gupta et al., 2010). Due to its nature DEXA is not suitable for field studies or for attempting to quantify the prevalence of overweight and obesity at a population level (Deurenberg and Yap, 1999). DEXA also requires trained technicians and dedicated facilities (Beechy et al., 2012; Pateyjohns et al., 2012). In addition DEXA does not directly measure FFM, it measures FM and gives an estimate that the rest is FFM (Miller et al., 2010).

2.11.1 (b) Magnetic Resonance Imaging

Magnetic Resonance Imaging (MRI) is also referred to as Quantitative Magnetic Resonance (QMR). This method uses differences in nuclear magnetic resonance of hydrogen atoms and hydrogen density to measure the overall composition or to examine the regional fat distribution of an individual's physique (Heymsfield, 2008; Deurenberg and Yap, 1999).

MRI/QMR can accurately measure an individual's FM, lean body mass (LBM), total body water and free water (fluids outside of tissue, for example blood and urine) as it can differentiate between fat and muscle (Miller et al., 2010; Nixon et al., 2010; Goodpaster et al., 2004). Furthermore, LBM and FM are used to calculate other metabolic measures such as energy expenditure thereby increasing the importance of accuracy in body composition data (Kaiyala et al., 2010). MRI can also be used to help diagnose fatty liver disease and type 2 diabetes (Springer et al., 2010; Kelly and Goodpaster, 2001).

As with the use of DEXA scanning, the relative expense and the need for high-tech equipment means that although this method is highly accurate, it is not feasible as an assessment tool for large populations. In addition it is not suitable for very obese individuals as the MRI scanner is not able to accommodate large body sizes (Duren et al., 2008).

2.11.1 (c) Bioelectrical Impedance Analysis

Bioelectrical Impedance Analysis (BIA) measures the body impedance using electrodes that are connected to the body to form a circuit for the current to pass through (Beechy et al., 2012). BIA derives body fluids from bioelectrical indices and uses specific calculations to determine an individual's FM (Khaled et al., 1988), FFM and total body water (TBW) as different body tissues offer varying resistance (Beechy et al., 2012). Due to its low water content, adipose tissue is a poor conductor of the current contrasting to muscle tissue (Kushner 1992, cited in Beechy et al., 2012). Electrolytes are contained in FFM and therefore act as an electrical conductor with electrical properties highly reliant on the ionic state (Khaled et al., 1998).

BIA's characteristics such as non-invasive, simplicity, low cost and portability, makes it a very appropriate method of assessing body composition (Kushner et al., 1990; Cohn, 1985) for individual and at population level. In addition BIA has no weight or height restrictions (Shafer et al., 2009). Furthermore BIA is regarded as being highly suitable for use in school aged children (Wright et al., 2008) and is validated in normal children and adults (Deurenberg et al., 2001).

BIA however, does not assure measurements would be well correlated in individuals as results are affected by numerous variables such as body position, levels of hydration, food and beverage consumption, skin temperature and recent physical activity or weight loss activities (National Institutes of Health Technology Assessment Conference Statement, 1994; Cohn, 1985). According to Ziegler and colleagues (2008) the use of the Tanita BIA scale should be avoided as the results from this measurement are not valid when compared to the laboratory standard, however this study had a small sample size (n = 6).

2.11.1 (d) Body Mass Index

BMI is calculated as the person's weight kg/height m^2 (WHO, 2013a). For the past five decades BMI has been widely used to measure overweight and obesity in adults; however its use in childhood overweight and obesity is relatively new (Cole et al., 1995; Dietz et al., 1998; Wang and Lobstein, 2006). It is accepted as a valid indirect measure to classify adult

and paediatric overweight and obesity and its use has been recommended by the WHO (IASO, 2004).

BMI is an inexpensive, non-invasive measure of body weight that predicts the risk of related complications (Taylor et al., 2010). BMI correlates with body fat and with concurrent health risks (Barlow, 2007) nonetheless it is subject to the following limitations.

BMI is based on weight and does not differentiate between lean mass and fat mass (Cole, 2000), and therefore does not quantify total percentage of adiposity (Kuczmarski and Flegal, 2000). There is also a risk of misdiagnosing adults on the basis of BMI especially among males who have additional muscle mass (Kuczmarski and Flegal, 2000).

In addition, BMI has certain limitations when using it to classify children as overweight or obese. According to Cole et al. (2000) BMI in childhood tends to change substantially with age in contrast to an adult's BMI which tends to increase slowly with age (Cole et al., 1995). This means that classification of childhood overweight and obesity must be age and gender specific.

Notwithstanding the previously mentioned limitations of BMI, it is still considered a reasonable measure to determine overweight and obesity in children as it is a valid, indirect measure of adipose tissue (IASO, 2004).

2.11.1 (e) Skin Fold Thickness

Skin fold thickness (SKT) is used to assess body fat stores by measuring subcutaneous fat thickness in specific regions around the body (Beechy et al., 2012; Duren et al., 2008; Deurenberg and Yap, 1999). The most common areas to take measurements from, are the bicep, tricep, subscapular, and supra-iliac (Pietrobelli and Heymsfield 2002, cited in Beechy et al., 2012; Heymsfield, 2008). Results rely on formulas that convert these numbers into an estimate of a person's percentage of body fat according to a person's age and gender (Beechy et al., 2012).

The accuracy of this method is questionable as it is limited by numerous 'technical errors, biological variation, and the population specificity of the derived populations' (Kushner et al 1990, p.221). Observer variability, fat elasticity and skin tissue (which vary with age and

between individuals) are additional limitations (Kuczmarski et al., 1987). Furthermore the callipers available to measure SKT are often too small when used on abdominal and thigh folds of obese individuals (Duren et al., 2008; Gray et al., 1990).

The accuracy in SKT on the obese is related to an established equation; however the current equation was developed in normal weight individuals and has not been yet validated in obese individuals (Beechy et al., 2012).

This test is useful in monitoring changes in fatness in children because of its characteristics, size and portable. In addition the majority of fat is subcutaneous in children who are overweight or obese (Duren et al., 2008).

2.11.1 (f) Waist Circumference

Waist circumference is defined as 'the abdomen at its narrowest point between the lower costal (10^{th} rib) border and the top of the iliac crest, perpendicular to the long axis of the trunk' (Public Health Intelligence 2008, p.9).

Measuring a child's waist is considered to be more clinically useful than BMI (McCarthy, 2006) as overweight and obesity are associated with increased amounts of intra-abdominal adipose tissue (Duren et al., 2008). This measurement is considered as being safe, easy and inexpensive for assessing overweight and obesity (Teran et al., 1991).

The validity of this method however, is reduced compared with the laboratory methods and on an individual basis, may not be reliable (Deurenberg and Yap, 1999). Accuracy is dependent on the training, knowledge and skills of the person taking the measurements (Wang et al., 2007). Results can also vary pending on observer (Beechy et al., 2012).

To conclude, as of yet there is no globally established method to measure body composition in children (L'Abee et al., 2009). As a result combinations of measurements are used to determine children's body composition.

2.11.2 Measuring Physical Activity Behaviour

Techniques for measuring levels of PA can be classified as objective (motion sensors, heart rate monitors) and subjective (surveys, questionnaires) (Livingstone et al., 2003).

2.11.2 (a) Doubly Labeled Water

Doubly-Labeled Water (DLW) is considered the 'gold standard' method for validation of measurements of energy expenditure (Burrows et al., 2010). DLW is an isotope method (Piper et al., 2014) used to estimate total energy expenditure (TEE) over a period of seven to fourteen days, and incorporates short-term day-to-day variation in physical activity (Loprinzi and Cardinal, 2011; Burrows et al., 2010).

Participants are required to consume a 'heavy water' that contains isotopes of oxygen and hydrogen (Piper et al., 2014). The oxygen is eliminated from the body through water loss and respiratory expiration, the hydrogen is eliminated primarily from water (Piper et al., 2014). The difference between the elimination rates of these two isotopes provides an estimation of CO_2 production and respiration (Piper et al., 2014). However this method is seldom used as it is not suitable for large population based studies due to high cost, moderate participant burden (Kohl et al., 2000), and high technical skills and facilities required for analysis (Burrows et al., 2010).

2.11.2 (b) Accelerometry

Accelerometers are recognised as one of the most effective methods to measure frequency, intensity and duration of PA (Hanggi et al., 2013; Jimmy et al, 2013; Treuth et al, 2012; Spittaels et al, 2012; Pulsford et al., 2011; Healy et al, 2008; Mattocks et al, 2008; Rowlands, 2007), and eliminates recall and social desirability bias (Evenson et al., 2008). In addition this method can be easily applied to studies (Jimmy et al., 2012; Riddoch et al., 2007; Welk, 2005). However the high cost may limit their use in large research studies (Welk, 2005).

Accelerometers use electro-mechanical piezoelectric levers to detect acceleration and are able to monitor and record data between one to three planes of motion; uniaxial, biaxial, and triaxial (Mattocks et al., 2008). Uniaxial accelerometers register movement in a single, vertical, plane (i.e. walking/running) (Jimmy et al., 2013; Mattocks et al., 2008). Triaxial

accelerometers consist of three orthogonal accelerometer units and provide output for each plane (Rowlands, 2007). Research indicates that triaxial accelerometers are more valid in estimating children's PA compared to uniaxial accelerometers (Rowlands, 2007; Welk, 2005).

Accelerometers provide PA scores in 'counts' which are summarised over a specified interval known as an epoch (Pulsford et al., 2011). The most appropriate epoch for assessing PA in children remains unclear (Stone et al., 2009, Freedson et al., 2005) however a five second epoch is regarded as an acceptable epoch length as children's PA is typically short and sporadic often lasting a few seconds (Baquet et al., 2007; Ward et al., 2005; Nilsson et al., 2002; Bailey et al., 1995).

The activity counts are then converted to a threshold to determine the duration participants spent in various levels of PA (Hislop et al., 2012; Pulsford et al., 2011). However as there are currently various thresholds available, making comparisons between studies has proven difficult (Stone et al., 2009). Welk (2005) has recommended that researchers should avoid using additional thresholds to prevent further problems for comparing accelerometer data.

Furthermore the minimum amount of daily PA to be included in the analysis of accelerometer data has been found to vary. Some researchers recommend that the minimum wear time per day should be set at 600 minutes (Troiano, 2008; Riddoch et al., 2007; Penpraze et al., 2006; Anderson et al., 2005) whilst others suggest 480 minutes (Eiberg et al., 2005) and 360 minutes (Treuth et al., 2007).

Variances in establishing epoch length and accelerometry analysis may exist due to the relative immaturity of accelerometer technology. There is a need for a meta-analysis in this area and to develop norms for future research.

2.11.2 (c) Pedometry

Pedometers measure the number of steps taken over a given period and are the simplest method for monitoring PA (Mattocks et al., 2008; Berlin et al., 2006). Pedometers correlate strongly with uniaxial accelerometers (Sylvia et al., 2014). These devices are regarded as being an inexpensive, valid instrument to measure children's PA levels however they cannot

distinguish the intensity, duration or pattern of PA (Mattocks et al., 2008; Rowlands, 2007; Berlin et al., 2006), and have significantly less data storage capacity than accelerometers (Sylvia et al., 2014). Furthermore pedometers may underestimate the number of steps taken at a slower gait speed (Cyarto et al., 2004; Motl et al., 2005) or with irregular, unsteady gait patterns (Swartz et al., 2003). In addition, where the device is placed on the body may affect accuracy (Park et al., 2014).

2.11.2 (d) Heart Rate Monitors

Heart rate monitoring is a physiological indicator of PA and energy expenditure that uses the electrical signal from the heart to measure each heartbeat (Mattocks et al., 2008) and can be used to indirectly assess frequency, intensity and duration of PA (Sirard and Pate, 2001). Heart rate monitors capture energy expenditure during activities not involving vertical trunk displacement that many accelerometers and pedometers miss (Crouter et al., 2004). However, a weak relationship exists between heart rate and energy expenditure during high and low intensity levels (Loprinzi and Cardinal, 2011). Furthermore heart rate is affected by other factors for example; oxygen consumption (Westerterp, 2009), age, body composition, emotional stress, cardiorespiratory fitness (Loprinzi and Cardinal, 2011), caffeine and some medications (Sirard and Pate, 2001).

2.11.2 (e) Self-Report Instruments

Self-report instruments include questionnaires, diaries and proxy reports such as parental report of children's PA. These questionnaires are inexpensive and easy to administer in large populations (Sylvia et al., 2014) but have substantial limitations with children (Mattocks et al., 2008) as children have difficulty recalling, quantifying and categorising PA details (Shephard and Vuillemin, 2003, Sirard and Pate, 2001). Questionnaire content and how it is completed also tends to vary (Sylvia et al., 2014). In addition proxy reports can be unreliable, especially in school-aged children (Pulsford et al., 2011).

Studies involving young children should focus on using objective measures of PA as opposed to subjective (Loprinzi and Cardinal, 2011; Rowlands, 2007). When comparisons are made between the aforementioned PA measurements, triaxial accelerometers provide the best

assessment of PA (Hanggi et al., 2013; Jimmy et al., 2013; Eston et al., 1998) whilst pedometers are suitable for large population studies (Eston et al., 1998).

2.11.3 Measuring Nutritional Behaviour

Gathering accurate and reliable dietary data from children and adolescents is challenging as there is currently no best method for assessing nutritional behaviour (Burrows et al., 2010; Livingstone et al., 2004). There are limitations to using self-reported data collection methods as response bias can occur when respondents report behaviour they perceive as desirable rather than accurate (Richardson et al., 2011). Innovative technologies have enhanced dietary assessment (Illner et al., 2012) as they can improve adherence and communication, eliminate researcher and participant burden, standardise coding and improve data quality (Sharp and Allman-Farinelli, 2014; Illner et al., 2012). However many studies still use traditional methods (Illner et al., 2012) such as food frequency questionnaires and food diaries.

2.11.3 (a) Digital Photography

Digital photography is a promising method for unobtrusively and accurately measuring food intake in adults (Martin et al., 2007) and has recently been validated in children (Higgins et al., 2009). Digital photography does offer an advantage in accuracy compared to food diaries when used for children (Higgins et al., 2009).

Mobile phones are now being used given their vast use, wireless communication, built in camera, bluetooth and infra-red, making them convenient and suitable (Sharp and Allman-Farinelli, 2014; Turner-McGrievy et al., 2013).

An individual's food selection is estimated based on portion size and quantity of waste left over as a percentage of the reference portion (Ngo et al., 2009). However there is a possibility of misreporting as participants may not produce photographs for everything they consume (O'Loughlin et al., 2013).

2.11.3 (b) Food Frequency Questionnaires

Food frequency questionnaires (FFQs) measure usual food intake and are often used in studies as they are easy to administer and are useful for predicting health outcomes

(McPherson et al., 2000). Until children reach an age, where they have the skills and ability to estimate and indicate their nutrition intake (twelve years), parents/guardians are required to complete FFQs (Livingstone et al., 2004). However children from seven years of age are able to participate in unassisted recall, no longer than the previous twenty four hours (Livingstone et al., 2004). FFQs however, have not undergone robust validation (Roberts and Flaherty, 2010) and are subject to report error (Livingstone et al., 2004).

2.11.3 (c) Food Diaries

Food diaries are a traditional method of assessing nutritional behaviour and have been commonly used as they are non-invasive and easy to administer in large studies (Pears et al., 2012; Burke et al., 2012; Hunter et al., 2008). Food is recorded in real time and is therefore not dependent on memory (Svensson et al., 2012). However despite their widespread use their accuracy is dependent on adherence (O'Loughlin et al., 2013) as this method is time consuming. Furthermore participants tend to underestimate intake, particularly children and those who are overweight (O'Loughlin et al., 2013; Svensson et al., 2012; Burrows et al., 2010). Food diaries are a less objective measure of food consumption than observation measures as they provide approximate estimates of a child's current and/or past dietary intake (Pears et al., 2012).

Food frequency questionnaires and diaries are often used to provide estimates of children's dietary consumption over a period of one to seven days (Epstein et al., 2012) however they rely heavily on memory, literacy, (Ngo et al., 2009), ability to estimate portion sizes, and can suffer from intentional or unintentional over or under estimation of consumption (Pears et al., 2012).

2.11.3 (d) Direct observation

The most objective measure of a child's dietary behaviour is for an unbiased and trained researcher to weigh, or visually estimate the food, or mineral before and after consumption (Pears et al., 2012). Whilst this methodological approach has been adopted by various small based studies (Horne et al., 2009; Lowe et al., 2004; Horne et al., 2004), it is labour intensive, intrusive and impractical for larger studies (Pears et al., 2012).

As previously outlined there are various ways to measure body composition, PA and nutritional behaviour. However the 'gold standard' measurement of each of these variables may not be suitable for field testing. Therefore caution should be executed when choosing which measurement to adopt.

2.12 Conclusion

Overweight and obesity are public health burdens that have become a worldwide epidemic (Kearns et al., 2014; Cole et al., 2000). Due to the existence of a globally accepted definition for adult overweight and obesity (WHO, 2014a), global prevalence estimates are relatively accurate. However the absence of a globally unified definition for paediatric overweight and obesity has given rise to difficulties assessing the exact prevalence of childhood obesity (Ebbeling et al., 2002). As a result a vast amount of research has been conducted in order to determine the worldwide prevalence of paediatric overweight and obesity. In addition substantial literature and research has emerged to identify the determinants and health problems associated with overweight and obesity (Chan and Woo, 2010) as excessive weight gain in childhood can track into adulthood.

The aetiology of obesity is however, multifactorial, involving complex interactions among genetic, social and environmental backgrounds and lifestyle behaviours (Chan and Woo, 2010). As a result effective global prevention strategies are difficult to develop. This review of the literature has shown that there is an emerging consensus that a public health approach to develop population-based strategies should be multifaceted and should target lifestyle factors contributing to obesity. Furthermore intervention strategies should target school-based institutions, as these are natural settings for influencing children's' diet and physical activity (Dehghan et al., 2005).

Chapter 3: Methodology

3.1 Introduction

The methodological approach for Project Spraoi[7] is founded on a New Zealand based study Project Energize and derived from further evidence based research (Bergh et al., 2012; Treuth et al., 2012; Rush et al., 2011b; Flodmark et al., 2006; Trost et al., 2002). Some of the materials used during the course of this study were developed by Sport Waikato, New Zealand, and are protected by copyright©[8].

The objectives for this research study were as follows;

Primary:

- To determine whether a school based health intervention, Project Spraoi, could increase physical activity (PA), reduce sedentary time and improve nutritional behaviour in primary school pupils over one academic year.

Secondary:

- To deliver a multi-pronged health intervention involving the whole school community.
- To evaluate the impact of the intervention by comparing measures, gathered pre- and post-intervention, from pupils receiving the intervention with measures from pupils who have not received the intervention.
- To evaluate the process of the intervention by gathering data from school stakeholders.

[7] Project Spraoi is a registered randomised control trial (RCT). RCT number: ISRCTN92611015.
[8] To view these resources contact energize@sportwaikato.org.nz.

3.1.1 Ethics

3.1.1 (a) Child Protection Workshop and Garda clearance

In Ireland all adults working with people under eighteen years of age are required to complete a child protection workshop. The researcher attended this workshop in CIT in April 2013. Garda clearance was obtained in September 2013.

3.1.1 (b) Ethical Approval

Project Spraoi was approved by CIT's Ethics Committee on the 10th October 2013. During the course of this study the researcher complied with the schools' Child Protection Policy and Guidelines, CITs' Ethical Guidelines, Child Protection Policy and Code of Behaviour for working with children.

3.1.1 (c) Consent and testing

Consent from the intervention and control school was sought prior to the commencement of the intervention. A Memorandum of Understanding© (MOU), outlining the role and responsibilities of the school and the Energizer, was signed by the Energizer and school principals confirming the schools willingness to participate in this study.

Parent/guardian and child written consent was sought prior to the commencement of any testing. Parents/guardians were provided with an information letter detailing the tests involved during the stages of data collection. Parents/guardians and pupils were free to withdraw their consent at any stage. A procedure was in place in the event a pupil refused to have any measurement(s) taken however this did not occur during either times of data collection. If this did occur no further pressure was to be placed on the child and s/he would be returned to class by a member of the research team. Further details on parent/guardian and child consent are outlined in section 3.5.2.

Clinically extreme measurements of %BF and BP were managed on a case by case basis informing the class teacher.

3.1.1 (d) Data Protection and Confidentiality

All data collected during the course of this study remain strictly confidential. Data protection procedures were strictly adhered to, to ensure anonymity of all participants. All data entered into computer software packages were coded and anonymised to ensure participants were not identifiable. Recording materials and completed questionnaires will be kept in a secured storage cabinet located in a restricted office in the Department of Sport, Leisure and Childhood Studies for five years.

3.1.1 (e) Harm Minimisation

To minimise physical and psychological risk for pupils, a risk assessment was conducted prior to the intervention. In addition safety standards with regards to risk minimisation were adhered to throughout the intervention. Table 3.1 outlines the potential risk factors and the strategies undertaken to minimise the identified risks from occurring.

Table 3.1: Risk factors and minimisation strategy

Physical Risk Factors		
Risk Factors	**Risk Minimisation Strategy**	**Risk Rating**
Tripping or falling onto a hard surface	Adequate space and lighting, pupils wearing appropriate footwear, laces tied, remove potential hazards	Low
Sprain ankle or wrist	Suitable warm ups, appropriate footwear	Low
Contact with foreign elements, objects or other pupils on the playing area	Inspect area prior to start of each session, remove or isolate any hazards, control pace and number of pupils on the playing area	Low to moderate
Misuse of equipment leading to purposeful or accidental striking of other pupils	Reinforce safety message and rules, establish safe spacing between groups/pupils, discipline potentially dangerous behaviour	Low to moderate
Showing a negative response to exercise – overly heavy breathing, dizziness	Observe physical responses, allow for brief rest after vigorous activities	Low
Psychological Risk Factors		
Risk Factor	**Risk Minimisation Strategy**	**Risk Rating**
Bullying	Condemn bullying, discipline bullying behaviour	Low to moderate
Lack of self-assertiveness	Encourage pupils, promote self-assertiveness, recognise and acknowledge individual accomplishments	Low to moderate

3.1.1 (f) Use of Incentives

It could be considered that assigning an Energizer to the school may have acted as an incentive for the school in accepting the invitation to become the intervention school. The control school, along with other control schools from the wider Project Spraoi group, was offered a sports day in CIT for the senior infants and fourth class pupils as an incentive.

3.2 Methodological Structure

Figure 2 provides a simplified overview of this study's methodological structure. The structure is divided into two components; intervention and evaluation.

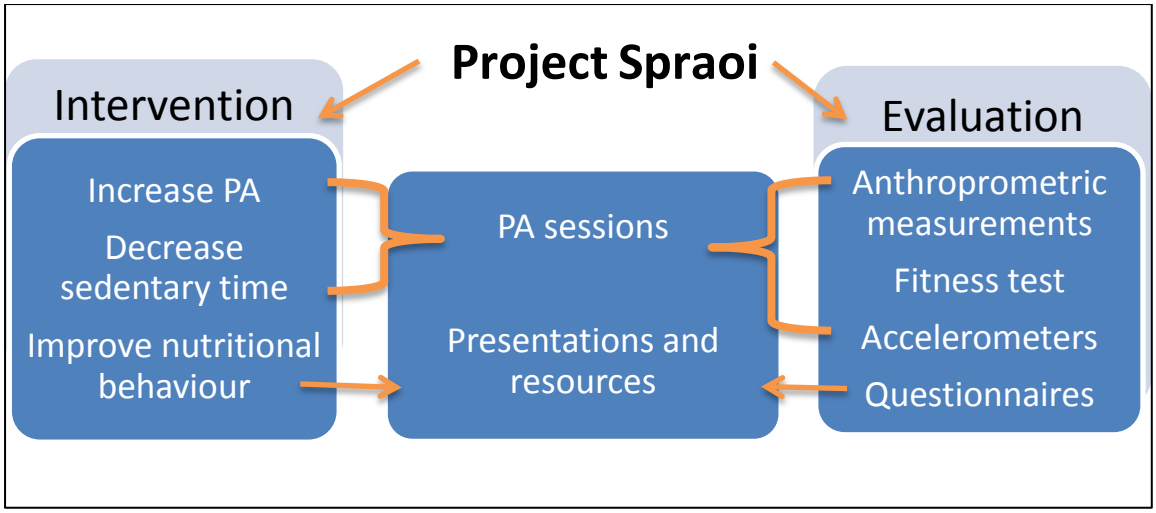


Figure 2: Structure of Project Spraoi

3.2.1 Intervention

The intervention was delivered to one intervention school for one academic year from October 2013 to June 2014. The researcher, known as the 'Energizer', worked with the school as an 'agent of change' to achieve the aforementioned objectives (Rush et al., 2011). The intervention was conducted using a whole school approach model where all classes received the intervention. The primary aims of the intervention were to (i) increase PA, (ii) decrease sedentary time, and (iii) improve nutritional behaviour amongst pupils by engaging with the school stakeholders. In addition the intervention also sought to improve the schools PA and nutritional practice.

Increasing PA and decreasing sedentary time were targeted by delivering additional daily PA sessions to all pupils. These sessions were in addition to the school's Physical Education (PE) curriculum. Nutrition presentations and resources were delivered to teachers, pupils and parents to promote and encourage healthy nutritional behaviour.

On average, the researcher spent two school days (approximately ten hours in total) with the intervention school on a weekly basis for thirty two weeks. Approximately 16 hours of PA, and 1.5 hours of nutritional guidance, were delivered to each class over the course of the intervention. Each session was observed by the class teacher so that they gained knowledge, confidence and skills to deliver further sessions themselves.

3.2.2 Evaluation

The evaluation consisted of two elements; impact and process. An impact evaluation was conducted to determine if the intervention had an effect on indicators of pupils' health, PA and nutritional behaviours. A process evaluation was undertaken to establish teacher's views and attitudes towards Project Spraoi.

The intervention school was involved in both elements of the evaluation while a control school served as the comparator to measure the impact of the intervention. Data from school stakeholders were collected at baseline and near intervention end. Pupils from two class groups (senior infants and fourth class) from the intervention and control school had their anthropometric and physiological measurements taken, completed a nutrition survey and a cardiovascular fitness test, and wore an accelerometer to evaluate the impact of the intervention. Teachers from the intervention school completed a series of questionnaires to inform the delivery of the intervention and to assess its impact and process. Parents/guardians of the pupils from the two class groups from the intervention school completed questionnaires to assess both elements of the evaluation.

The control school did not receive the intervention or project resources. However, whilst the control school did not participate in any health promotion initiatives during the course of this study, no restrictions for pursuing an alternative initiative was placed on the school.

3.3 Intervention Stages

Prior to the delivery of the intervention three stages were conducted and completed.

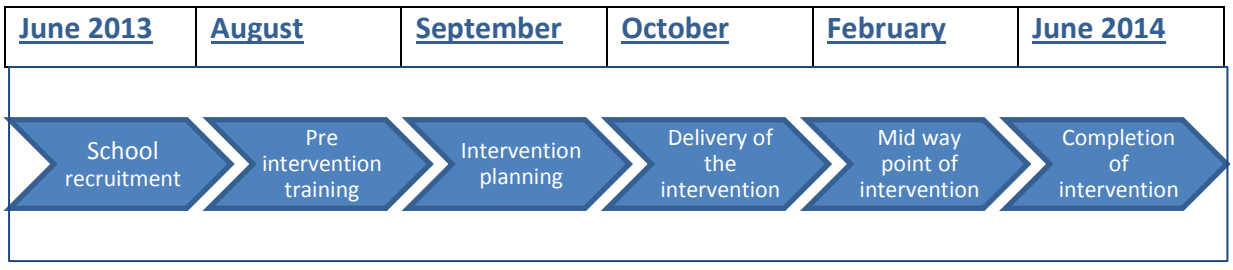


Figure 3: Stages of the intervention

3.3.1 School Recruitment

To inform the process of school selection, a list of inclusion criteria was established in June 2013.

Table 3.2: School criterion for inclusion in the study

Criterion		Explanation
1. Primary school	Yes	To allow for comparisons with Project Energize
2. DEIS (Delivering Equality of Opportunity in Schools)	Excluded	DEIS schools were involved in a related Project Spraoi study
3. School enrolment	200 - 300 pupils	Feasibility and generalisation
4. Gender mixed school	Yes	Generalisation
5. Location	≤ 15km from CIT	Feasibility
6. Demographics	Rural	Urban schools were involved in a related Project Spraoi study
7. Involvement in health promotion projects within the last 12 months	No	To prevent data from being contaminated
8. Awarded the Active School Flag	No	To prevent data from being contaminated
9. Support from principal and staff	Required	Whole school approach and required for successful implementation

Private primary schools were not excluded from this study however none of three private schools in Cork met all of the above criteria. It proved impossible to find schools who met criterion number seven along with the additional criteria.

Based on the outlined criteria, five possible schools were identified. These schools were approached for inclusion in June 2013 via letter (Appendix A). A follow up phone call was then made to each school and a meeting was arranged with the principal and/or 'key teachers'. Key teachers were defined as teachers who were actively involved in health promotion activities within the school. The purpose of the meeting was to inform those in attendance about the project, the requirements from the school and its stakeholders, and to determine the schools' level of interest and support. Schools were recruited based on the schools' level of commitment to engage with the project.

Two schools were selected and contacted with an offer to join Project Spraoi. Prior to accepting the offer, each school was informed of their role in the study, i.e. intervention or control school. An MOU was then signed by the principals.

Table 3.3: General information on the intervention and control school

	Intervention school	Control school
Total pupil enrolment (2013/2014 academic year)	302	318
Total number of boys	166	151
Total number of girls	136	167
Total number of teaching staff	11	11

3.3.2 Pre-Intervention Training

Arrangements were made for the researcher to undertake a PA and nutrition training programme. Training was delivered by members of Project Energize (NZ) to ensure compliance with Project Energize standards. Training for the PA and nutrition sessions occurred over six days between August and October 2013 and were delivered by separate Project Energize staff. Training involved recommendations on planning and delivering the PA and nutrition sessions.

3.3.3 Intervention Planning

Preparations for the delivery of the intervention began in September 2013. A 'lead' teacher was appointed for the duration of the intervention to liaise between the researcher and school staff. Once a lead teacher was appointed the principal and teachers completed a variety of documents to assist with planning the intervention. These documents also formed part of the evaluation and will be outlined later in this chapter.

Table 3.4: Documents completed by school staff

Name of document	Completed by	Purpose
1. Needs Analysis©	All teachers	Teachers' assessment of current practice with regards to PA and nutrition practices and policies.
2. Physical Activity Profile©	All teachers	To establish the duration teachers spent teaching; fitness, physical education (PE) and sports/games.
3. School Stocktake©	Principal	To profile the school's environment, policy, practice and resources with regards to PA and nutrition.

Teachers completed the aforementioned documents in private with no assistance from the researcher or school staff. The school stocktake was completed as a structured interview with the school principal.

An analysis of these completed documents informed an 'Action Plan'© that was drawn up by the researcher and agreed upon by the lead teacher and the principal. The Action Plan was used to design and plan a tailored intervention strategy based on the schools resources, support and capabilities. A 'Spraoi' timetable was then prepared by the lead teacher and agreed by the researcher. This outlined the days and times the researcher delivered the PA sessions to each class. A separate schedule was prepared for the nutrition presentations.

3.3.3 (b) Planning the physical activity sessions

The PA sessions involved games that were designed to incorporate moderate to vigorous activities, maximise participation rates and reduce sedentary time. These sessions were known as 'Huff n' Puff'.

Lesson plans were prepared and tailored to suit the junior (aged five to eight years) and senior (aged nine to thirteen years) age groups (Appendix B). The lesson plans informed teachers what games they could teach on the days when the researcher was not present in the school. Ideally, these games took place outdoors however; alternative indoor games were also prepared in the event of inclement weather conditions.

3.3.3 (c) Planning the nutritional sessions

Improving nutritional behaviour was targeted by planning and delivering presentations and nutritional resources to school stakeholders. The presentations and resources were developed by Project Energize and were tailored, by the Project Spraoi team in consultation with Project Energize, to the Irish setting and to accommodate for the various target audiences. The presentations were delivered separately to each class group in their classroom with their teacher present as part of the standard school day. Presentations for parents/guardians were organised for after school hours.

Teachers, pupils and parents/guardians received nutritional resources to help promote and encourage healthy nutritional behaviour. Nutrition posters, fridge magnets known as 'tip sheets', and health promotion electronic files referred to as 'nuggets' were provided by the researcher. Examples of some of the resources used during the course of the intervention are located in Appendix B. The resources were scheduled for distribution to correspond with the relevant presentation.

The researcher and relevant school staff were involved in scheduling the presentations. Suitable dates for the teacher and pupil presentations were established two weeks in advance and an email outlining the presentation schedule was sent to teachers by the lead teacher. Based on advice from the school principal and the lead teacher, the presentations for parents/guardians were scheduled for early afternoon. The school secretary sent an email two weeks in advance to parents/guardians inviting them to attend the presentations and sent reminder text messages two days prior to each presentation. Presentations for parents/guardians were held in a hall located on the school grounds. No incentives were used to entice parents/guardians to attend the presentations.

3.3.4 Intervention Delivery

The intervention commenced in the third week of October 2013 and continued until the last week of June 2014.

3.3.4 (a) Delivering the physical activity sessions

PA sessions were delivered to every class to (i) increase PA and decrease sedentary time and (ii) educate teachers on the delivery of quality PA sessions.

(i) Increasing PA and decrease sedentary time

This element of the intervention placed an emphasis on keeping pupils' active (or moving) as much as possible throughout each session (Rush et al., 2011). The PA sessions were delivered to all classes for an additional twenty minutes every day. From week one to week sixteen of the intervention the researcher delivered the sessions two days a week. At mid-point of the intervention (February), the researcher reduced the frequency to one day a week to provide time to deliver the nutrition sessions on the second day. Teachers delivered the PA activities modelled by the researcher to their class for twenty minutes on the days the researcher was not present. The twenty minutes would ideally be delivered in one session however teachers could deliver this in segments.

(ii) Educate teachers

The researcher 'modelled' the PA sessions whilst delivering them to each class. Teachers observed the modelled sessions and were encouraged to participate in the activities. The sessions were then delivered by the teachers when they felt competent.

3.3.4 (b) Delivering the nutrition sessions

The nutrition sessions comprised of three presentations and related resources. The presentations were delivered between March and June 2014 and each presentation lasted for approximately thirty minutes. Due to time constraints two presentations for parents/guardians were scheduled together.

As previously stated, nutritional resources were also used to help promote healthy nutritional behaviour. The posters were given to each class teacher to display on the classroom wall. Magnetic tip sheets were given to all pupils during school hours to take home and the nuggets were sent electronically by the researcher to the school secretary for uploading onto the school website or newsletter. In addition, teachers were given a

nutritional resource© relating to the topic after each presentation to help them deliver similar nutrition lessons to their class. Unlike the PA sessions, teachers were not expected to teach nutrition for an additional twenty minutes however they were encouraged to deliver similar presentations and to promote healthy nutritional behaviour.

3.4 Evaluation

This section outlines the methodological approach used to evaluate the impact and process of the intervention.

An impact evaluation was undertaken to determine whether an integrated primary school based health intervention resulted in improvements in pupils (i) PA levels, (ii) nutrition behaviours and (iii) the schools PA and nutritional practice. Various stakeholders and materials were involved in evaluating the impact of the intervention.

A process evaluation was conducted to establish teacher's views and attitudes towards Project Spraoi.

3.5 Impact Evaluation

Data from school stakeholders was gathered at baseline during September and October 2013 and near intervention end during May and June 2014.

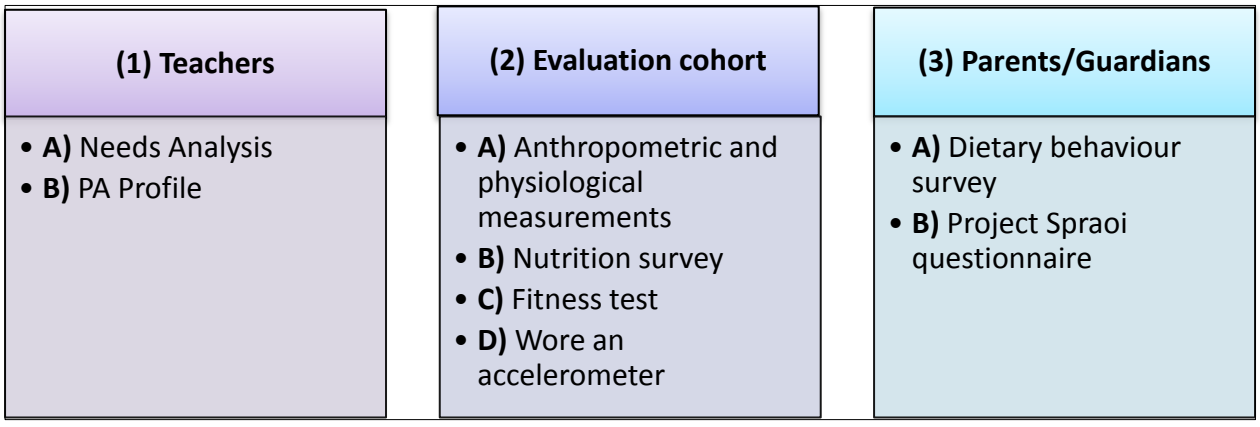


Figure 4: Items/measurements completed by stakeholders: Impact Evaluation

Senior infants (five to seven years of age) and fourth class pupils (nine to eleven years of age) are referred to as the younger and older evaluation cohort respectively. Collectively these groups are referred to as the evaluation cohort.

3.5.1 Teachers

Teachers from the intervention school completed a needs analysis© and PA profile© at baseline and at intervention end.

3.5.1 (a) Needs Analysis and PA Profile

By comparing pre and post intervention data from these documents the researcher was able to determine if teachers felt the intervention had improved the schools PA and nutrition practices.

3.5.2 Evaluation Cohort

For comparison purposes, two age groups were selected; the younger and the older evaluation cohort (n = 165, boys = 84, girls = 81).

Table 3.5: Gender and age summary of evaluation cohort

	Boys	Girls	Mean age
Younger and older evaluation cohort			
Intervention (n = 85)	n = 47 (55.3%)	n = 38 (44.7%)	8.14 years
Control (n = 80)	n = 37 (46.3%)	n = 43 (53.8%)	7.99 years
Younger evaluation cohort			
Intervention (n = 40)	n = 20 (50.0%)	n = 20 (50.0%)	6.01 years
Control (n = 43)	n = 19 (44.2%)	n = 24 (55.8%)	6.05 years
Older evaluation cohort			
Intervention (n = 45)	n = 27 (60.0%)	n = 18 (40.0%)	10.03 years
Control (n = 37)	n = 18 (48.6%)	n = 19 (51.4%)	10.25 years

Consent

Written consent was sought from pupils in the evaluation cohort and their parents/guardians in early October 2013.

The class teachers from the intervention and control school distributed envelopes with an information letter and consent form to pupils in the evaluation cohort during school hours (Appendix D). The envelope was sent home with the child for the attention of their parents/guardians. The consent form was signed by a parent/guardian and the child if both parties agreed to participate in the evaluation.

In the event a child was unable to sign his/her name, he/she was required to colour in a happy face to consent to having their measurements taken or a sad face for the alternative. Parents/guardians were requested to return the consent form within two days. Consent forms were returned by the child to the class teacher in the original envelope. The forms were then collected by the researcher. Only pupils who provided written consent, in addition to parent/guardian written consent were involved in the evaluation.

Table 3.6: Summary of pupils with consent

Intervention school				Control school			
Variable	**Total number**	**Number consented**	**%**	**Variable**	**Total number**	**Number consented**	**%**
Younger evaluation cohort	40	40	100	**Younger evaluation cohort**	48	43	89.5
Older evaluation cohort	47	45	95.7	**Older evaluation cohort**	37	37	100

Consent was not received from some parents/guardians in the intervention school (4.3%; n = 2) and control school (10.5 %; n= 2).

Pupils in the evaluation cohort had their anthropometric and physiological measurements taken, completed a nutritional survey and a fitness test, and wore an accelerometer. At each testing session, each child was involved for a total of thirty minutes of testing.

3.5.2 (a) Anthropometric and Physiological Measurements

The following measurements were taken at baseline in October 2013 and near intervention end in May 2014. Pupils who consented but were absent on the day had their measurements' taken on an alternative date.

Table 3.7: Summary of anthropometric and physiological measurements

Anthropometric measures
Body Size: Height, weight, waist circumference
Body composition: Percentage body fat (%BF). Older evaluation cohort only
Physiological measures
Blood pressure (BP): Systolic and diastolic BP

Procedures and apparatus used for anthropometric and physiological measurements

All measures were obtained by members of the Project Spraoi team who were trained in all methods of measurement. Members were designated particular stations during the collection of data in order to increase the reliability of the testing environment.

The evaluation cohorts were required to wear their school tracksuit and runners to school on the day of testing. A reminder text was sent to parents/guardians of the pupils in the evaluation cohort a day in advance.

On the day of testing a room was set up for the tests. Height, weight and body composition (measured using BIA) were managed by one member, waist circumference and blood pressure were managed by separate members.

Six pupils were taken at a time from their class and brought to the evaluation room to have their measures taken and to complete the nutritional survey. Upon arrival pupils were informed of what measures were being taken. Verbal consent was sought prior to the commencement of any testing.

After verbal consent was obtained, pupils removed their shoes and jumper. There was no order in which pupils were to complete the stations. The detailed protocol followed for conducting the various tests can be found in Appendix E. All measurements were recorded twice and where a pre-determined tolerance was exceeded, a third measurement was taken.

Height

All height measurements were taken using a Seca 213, portable stadiometer (Seca Corporation, Birmingham, UK) and were measured to ± 0.05cm.

Weight

All weight measurements were taken using a portable Tanita electronic scale (WB-110 MA Model, Tanita Corporation, Japan) and were measured to ± 0.05kg.

Waist Circumference

All waist circumference measurements were taken using a standard anthropometric measuring tape and were measured to ± 0.05cm.

Bioelectrical Impedance Analysis

Hands to feet bioelectrical impedance analysis (BIA) in the standing position was measured at a single frequency (50Hz) to ± 5 ohms (electrical unit of resistance Ω; Tanita, BC 418 MA, Body composition analyser, Tokyo, Japan). Due to model restrictions on the device used only pupils from the older evaluation cohort had their body composition measurements taken.

Blood Pressure

Seated resting blood pressure (BP) was measured using an automatic BP Monitor (M2; Omron Corporation, Tokyo, Japan). Resting BP was measured to ± 10 mm Hg (millimetres of mercury) and heart rate was measured to ± 10 beats per minute (BPM).

3.5.2 (b) Nutrition Survey

The evaluation cohort completed a nutrition survey called the 'Knowledge and Attitude Survey'© on the day the physical measurements were being conducted. The questions were from the 'National Survey of Children and Young People's Physical Activity and Dietary Behaviours in New Zealand: 2008/2009' (The University of Auckland, 2010) and were tailored to the Irish setting.

The younger evaluation cohort was asked about whether specific key foods/minerals (milk, water, fruit, vegetables, snacks, fast foods) were healthy or unhealthy using a five point scale. The older evaluation cohort was asked about the importance and the benefits of healthy eating and being fit and active, and what they could do to eat healthy and be active (Sport Waikato and Auckland University of Technology, 2011).

3.5.2 (c) Fitness Test

To assess pupils' levels of cardiovascular aerobic endurance, an outdoor 550m run test was conducted (on grass). This fitness test was constructed as a 110m oval shaped course, pupils had to complete five laps to total 550m. Pupils with resting BP above 200/130 mm Hg were not allowed to participate. Pupils were asked if they had any respiratory problems and if yes were asked if they had the relevant medication with them. Pupils who had their medication with them were allowed to complete the run and were advised to inform a member of the Project Spraoi team if they began to experience any breathing difficulties. Pupils who did not have their medication with them were not allowed to complete the run.

3.5.2 (d) Accelerometers

The evaluation cohort wore an accelerometer for seven consecutive days (with removal for bathing or swimming) between November 2013 and January 2014 (baseline) and May and June 2014 (near intervention end). Pupils wore the accelerometer above the iliac crest on the right hand side of the hip. On the day pupils received their accelerometer the researcher provided them with information relating to the use of the devices. The school secretary sent this information to parents/guardians via email (Appendix E). In addition daily text messages were sent by the researcher to parents/guardians to increase compliance. The researcher was responsible for distributing and collecting the accelerometers from the evaluation cohort.

3.5.3 Parents/Guardians

Parents/guardians of the pupils in the evaluation cohort from the intervention school were the final group of participants involved in assessing the impact of the intervention. Parents/guardians (n = 80) completed a dietary behaviour survey (Food and Drink survey©)

at baseline and at intervention end, and a Project Spraoi questionnaire at intervention end (Appendix F).

3.5.3 (a) Food and Drink Survey

The Food and Drink survey contained thirteen questions asking parents/guardians about their child's/children's usual food and drink behaviour. The survey also asked parents to recall their child's/children's dietary behaviour for the previous seven days.

The surveys were placed in an envelope, addressed to parents/guardians and were given to each child in the evaluation cohort on the day the physical measurements were taken. These envelopes were distributed by the class teacher during school hours and were for the attention of the parents/guardians. Parents/guardians were asked to recall and report what their child consumed in the previous seven days and on an average week. Parents/guardians were requested to return the completed surveys anonymously in the original envelope the following day.

A total of 78 out of 80 (97.5%) parents/guardians from the intervention school completed the survey at baseline and at intervention end.

3.5.3 (b) Project Spraoi Questionnaire for Parents/Guardians

There were 186 families in total attending the intervention school. From the total number of families 20% of parents/guardians were randomly selected to complete a Project Spraoi questionnaire in June 2014 as part of the impact evaluation. This questionnaire was electronically sent to parents/guardians (n = 40) by the school secretary. One parent/guardian was asked to complete the survey. Twenty four parents/guardians out of the forty who received the questionnaire responded (60%).

3.6 Process evaluation

Teachers were asked to complete a weekly recording sheet noting their delivery of the huff n' puff sessions (Appendix C). In addition teachers also completed a Project Spraoi questionnaire at midpoint (February, n = 7) and at intervention end (June, n = 8) (Appendix C). Using a Likert Scale teachers were asked to indicate their level of agreement with

specific statements. The principal, vice principal, secretary, support teachers, caretaker and members of the Board of Management completed a separate Project Spraoi questionnaire at intervention end (Appendix C).

3.7 Data Analysis

Data analysis was undertaken using the Statistical Package for Social Sciences (SPSS), version 22.0. Exact age at measurement, BMI and BP percentiles were calculated using the LMS (Lambda-Mu-Sigma, percentile curves) Growth add in programme, version 2.77, for Microsoft Excel 2010.

Prior to analysis, data was assessed for normality based on the Kolmogorov-Smirnov statistic and the shape of the histogram. These determine if the distribution of scores is reasonably 'normal'. If the histograms' shape approximates a bell shaped curve it suggests that the data is reasonably normal. This will be discussed further in the subsequent chapter.

Where data was normally distributed parametric tests were conducted. Where the normality was unclear, both parametric and non-parametric tests were conducted. Further details are outlined in Chapter 4.

3.8 Rational for Methodological Approach

As previously stated there were two distinct elements to this study; intervention and evaluation. The rational for the methodological approach to both elements is detailed below.

3.8.1 Rational for the design of the intervention

The design of this study was multi-pronged as research indicates that interventions that target two or more determinants of overweight and obesity have been proven to be more successful than those that target one determinant (Seo and Sa, 2010; Eliakim et al., 2007). In addition when this study commenced there was no primary school health intervention in Ireland that simultaneously targeted the determinants targeted in this study. Furthermore elements of the methodological approach used for this study were adopted from an

intervention that has, overtime, proven to be successful in improving children's overall health (Rush et al., 2013; Rush et al., 2011a).

Physical activity, sedentary time and nutritional behaviours are modifiable determinants of overweight and obesity that can contribute to, and help tackle excess weight gain (Leech et al., 2014; Sarma et al., 2014). For instance adequate, regular levels of PA, low levels of sedentary behaviour, and healthy nutritional behaviours, may counteract the development of overweight and obesity (Jakicic and Otto, 2005; Manson et al., 2003).

Twenty minutes was established as the minimum requirement to help improve children's level of PA, cardiovascular fitness and to reduce sedentary behaviour (Sport Waikato and the Auckland University of Technology, 2011). Nutritional presentations were delivered to pupils to increase their knowledge and to promote healthy nutritional behaviours. As a child's nutritional behaviour can stem from and be influenced by that of their parents/guardians (Brown and Ogden, 2004; Wardle, 1995; Olivera et al., 1992) the nutritional presentations were also available for parents to attend.

School stakeholders were involved in this intervention to enhance its success (Potvin et al., 2010).

3.8.2 Rationale for evaluation procedures

As previously stated there were two elements to the evaluation; impact and process.

3.8.2 (a) Impact Evaluation

Various school stakeholders and materials were involved in assessing the impact of the evaluation.

Teachers/school staff

Teachers and additional school staff completed documents to determine if the intervention was successful in improving (i) PA and nutrition practice within the school and (ii) pupils PA levels and nutritional behaviours.

Evaluation cohort

The two age cohorts were chosen to allow for international comparisons to be made with Project Energize. Project Energize selected the younger age group as this age cohort can present critical periods of growth - adiposity rebound and early adolescence (Graham et al., 2008). The ten year old cohort was selected to 'evaluate the potential for intervention over transition into early puberty' (Graham et al 2008, p.1081). In addition the older age cohort has been identified as a potentially important period for adult morbidity and mortality (Cameron and Demerath, 2002).

Anthropometric and physiological measurements

To categorise BMI (age and gender specific) and BP centiles, the UK 1990 (Cole et al., 1995) and the Jackson reference were used respectively (Jackson et al., 2007).

Height and weight measurements were required to calculate BMI and to monitor growth patterns (Cole et al., 2000). In addition BMI was used to indirectly assess pupil's level of adiposity (Rush et al., 2003; Cole et al., 2000, Cole et al., 1995). Waist circumference measurements were taken as this is a stronger indicator of CVD than BMI (Chrostowska et al., 2013). To obtain a direct measurement of %BF, the older evaluation cohort had their body composition measurements taken (McCarthy et al., 2006, Rush et al., 2003).

Originally it was hoped that all pupils from the evaluation cohort would have their %BF taken however due to model restrictions on the device used, only pupils from the older evaluation cohort completed this station. BP readings were taken to determine if the intervention had an impact on pupils' cardiovascular health (Jackson et al., 2007).

Nutrition survey and 550m run

To allow for comparisons to be made with Project Energize the knowledge and attitude survey and the 550m outdoor run were conducted. Project Energize administered the outdoor 550m run as baseline data existed from previous work completed by Hamlin (Sport Waikato and Auckland University of Technology, 2011; Albon et al., 2010). The 600 yard (550m) fitness test was developed to measure children's cardiorespiratory endurance (Rush

et al., 2013) and is considered as a valid test of cardiorespiratory fitness and cardiovascular endurance (Hamlin et al., 2014).

Accelerometers

Accelerometers were used as a direct measure of pupil's levels of PA (Rush et al., 2012). The ActiGraph GT3X triaxial accelerometers (ActiGraph, LLC, Pensacola, Florida, US) were used as these are the most widely used accelerometers (Kim et al., 2014; Welk, 2005) and have been validated to measure PA levels in children (Jimmy et al., 2013; Mattocks et al., 2008). Accelerometry data was initialised and analysed using the ActiLife software (version 6.10.2, ActiGraph, Florida, US).

Initialising accelerometers

Prior to initialising accelerometers an epoch setting must be determined.

Epoch

According to various researchers children's PA patterns are typically short and sporadic (Baquet et al., 2007; Ward et al., 2005; Nilsson et al., 2002; Bailey et al., 1995). Based on these authors' recommendations a five second epoch length was therefore used.

Protocol

Based on research recommendations from Wardet al (2005) the researcher distributed the accelerometers to the evaluation cohort during a typical school day (Ward, 2005). Furthermore based on a review of the literature pupils were asked to wear the accelerometer on an elasticated belt, on the anterior side, above the right iliac crest (Jimmy et al., 2013; Jimmy et al., 2012; Troiano, 2008), during waking times with removal during sleeping and water based activities.

Promotion of compliance

To increase compliance, daily reminder text messages were sent to parents/guardians each morning based on recommendations from Ward et al (2005).

Analysing accelerometer data

To be included in data analysis pupils were required to reach a specified wear time period and threshold.

Wear time validation

A review of the literature indicated that the minimal amount of accelerometer data that was considered acceptable for inclusion in data analysis was set at 600 minutes of wear time per day (Troiano, 2008; Riddocih et al., 2007; Penpraze et al., 2006; Anderson et al., 2005) for four days, including at least one weekend day (Troiano, 2008; Sirard et al., 2008). Non wear time (when the accelerometer was not worn) was defined as twenty minutes of consecutive zero activity based on work by Troiano (2008).

Threshold

Accelerometer output is in activity counts (Rowlands, 2007), these counts are separated into various PA thresholds (i.e. MVPA) (Ward et al., 2005). Currently there are no widely agreed upon cut-points to classify MVPA for children resulting in researchers deciding what they consider the 'best' cut-points (Kim et al., 2012). For the purpose of this study the Evenson (2008) MVPA threshold was selected as this distinguishes various levels of physical activity and physical inactivity among young children (five to eight years).

Parents/Guardians

Parents/guardians completed a Food and Drink survey to allow for comparisons to be made with Project Energize. Parents/guardians also completed a Project Spraoi questionnaire to evaluate the impact of the intervention.

3.8.2 (b) Process Evaluation

As previously stated the overall aim of this intervention was to determine if a multi-pronged school based intervention could enhance pupils PA and nutritional behaviours. Evaluating the process of the intervention was a secondary aim of the intervention.

As this intervention involved a whole school approach all staff from the intervention school were involved in evaluating the process of the intervention. Questionnaires were

developed as part of the process evaluation in order to give teachers and additional school staff an equal voice and to express, privately, their opinions and attitudes towards the intervention.

Chapter 4: Data Analysis, Results and Findings

This chapter comprises of;

1. Assessing normality
2. Baseline analysis of the evaluation cohort (intervention and control school).
3. Impact analysis:
   - Comparison of measures gathered at baseline and near intervention end from the evaluation cohort (intervention and control school, n = 165).
   - Comparison of data gathered pre and post intervention from school stakeholders (intervention school).
4. Process analysis:
   - Analysis of data gathered during the course of the intervention from teachers (intervention school).

Various tests were conducted to analyse non-categorical and categorical measures (referred to as variables from here on in). Non-categorical variables were numerical (height, weight, BMI figure) whilst categorical variables were categories bound within a specified scale (BMI and BP category).

Only significant findings will be presented in this chapter, further findings are presented in Appendix G. Statistical significance was set at $p < .050$ for all tests and is indicated using the asterisk symbol (*).

Due to the testing environment the recommendations for pupils completing the BIA measurement were not implemented. As this affected the validity of the results, the researcher decided not to include these findings in the data analysis as preliminary tests revealed no correlation between BMI and %BF findings.

4.1 Assessing Normality: Child evaluation cohort

Normality was assessed for non-categorical variables. Presented below is the normality score of distribution (Kolmogorov-Smirnov statistic). Normality was also assessed based on the shape of the histogram (Appendix G). A significant result indicates that the score was outside the parameters of normal distribution (i.e. < .050).

Table 4.1: Normality of data using Kolmogorov-Smirnov statistic

Younger evaluation cohort (n = 83)	Baseline		Near intervention end	
	Intervention	Control	Intervention	Control
Height	.200	.200	.200	.200
Weight	.200	*.034	*.017	.200
BMI	.124	*.000	.089	.200
Systolic BP	.200	.200	.200	.200
Diastolic BP	.200	.146	.200	.200
Waist circumference	.200	*.000	.200	.200
Cardiovascular endurance[9]	.136	*.000	.200	*.044
Daily PA	.200	.200	.200	.200
Older evaluation cohort (n = 82)	**Baseline**		**Near intervention end**	
	Intervention	**Control**	**Intervention**	**Control**
Height	.200	.200	.154	.200
Weight	.066	*.004	*.022	*.000
BMI	.200	*.000	.200	*.000
Systolic BP	.200	.099	*.004	.200
Diastolic BP	.104	.200	.200	*.003
Waist circumference	.200	*.000	.200	*.000
Cardiovascular endurance	.008	*.033	.088	*.000
Daily PA	.200	.200	.200	.200

The shape of the histograms for each of the above marked variables appears to be reasonably distributed (bell shaped), with a minority of scores clustering to the left or right of the curve (Appendix G). These scores can therefore be classified as being normally distributed. However based on the Kolmogorov-Smirnov statistic, where some scores were revealed as not being normally distributed (*), parametric and non-parametric tests were conducted for these variables. Parametric tests make assumptions that the parameters of the distribution of scores are normally distributed whilst no assumptions are made about the distribution of scores in non-parametric tests (Pallant, 2013).

Where no significant difference was found the parametric result is presented, non-parametric analysis is presented in Appendix G. While assessing for normality outliers were identified and retained as they did not skew the data (Appendix G).

[9] Time taken to complete the 550m run

4.1.1 Statistical Analysis

Table 4.2 outlines the tests used to analyse anthropometric and physiological variables. Statistical analysis of the data obtained from teachers will be discussed later in this chapter.

Table 4.2: Tests for baseline and impact analysis: Evaluation cohort

	Measures	Baseline analysis	Impact analysis	Test type
Non-categorical measures with normal distribution	Height, weight, BMI figure, waist circumference, cardiovascular endurance and daily PA	Independent Sample t-test	Paired sample t-test	Parametric
Non-categorical measures without normal distribution	Weight, BMI figure, waist circumference, cardiovascular endurance	Not applicable[10]	Wilcoxon Signed Rank test	Non-parametric
Categorical measures	BMI category, BP category, met the recommended level of daily PA, nutritional surveys	Mann-Whitney U test	Wilcoxon Signed Rank test	Non-parametric

4.2 Baseline Analysis

Baseline anthropometric and physiological measures were initially analysed in order to determine pupils' measures and lifestyle behaviours at baseline, and to determine if any statistically significant differences existed between the intervention and control evaluation cohorts' baseline measures.

4.2.1 Anthropometric and Physiological Measurements

Presented in Table 4.3 is the mean value, standard deviation (SD ±), and significance value (p) for each variable.

[10] Baseline analysis revealed normal distribution for these variables. Therefore there was no requirement to conduct further tests

Table 4.3: Comparison of baseline measures from Intervention and Control pupils

Younger evaluation cohort (intervention n = 39, control n = 43)			
Variable	**Intervention**	**Control**	**P value**
Height (cm)	117.76 ± 4.57	117.12 ± 5.07	.547
Weight (kg)	22.48 ± 2.80	22.74 ± 2.96	.679
BMI (kg/m²)	16.17 ± 1.35	16.71 ± 1.79	.128
Waist (cm)	55.31 ± 3.43	55.49 ± 3.47	.820
Older evaluation cohort (intervention n = 43, control n = 37)			
Variable	**Intervention**	**Control**	**P value**
Height (cm)	140.80 ± 5.93	141.19 ± 6.17	.773
Weight (kg)	34.70 ± 5.97	36.22 ± 8.02	.358
BMI (kg/m²)	17.44 ± 2.12	18.02 ± 8.25	.320
Waist (cm)	60.81 ± 5.05	62.14 ± 8.36	.405

No statistically significant differences for the above variables were revealed. Variables that proved to be not normally distributed (weight, BMI and waist) were also analysed by conducting a Mann-Whitey U-test. No differences between both tests were found (Appendix G).

For categorical measures (BMI and BP), a Mann-Whitney U-test revealed a statistically significant difference between the intervention and control schools' younger and older cohorts' BP ($p < .050$).

Pupils from the intervention school had a lower frequency of normal BP (n = 36, 43.9%) compared to the control group (n = 63, 78.8%). In addition a higher proportion of pupils from the intervention school had higher BP compared to the control (n = 20, 24.4% v. n = 5, 6.3%). The remaining pupils from the intervention and control school had between normal to high BP (n = 26, 31.7% v. n = 12, 15.0% respectively).

No statistically significant difference existed between the intervention and control cohorts' BMI however, the percentage of overweight and obese pupils differed between the schools.

The percentage of overweight pupils was higher in the intervention school (n = 10, 12.2%) compared to the control (n = 4, 5.0%), yet a higher percentage of pupils from the control school were obese (n = 5, 6.3%) compared to the intervention (n = 1, 1.2%). Nonetheless

the percentage of pupils with a healthy BMI was similar in both schools (n = 71, 86.6% intervention, n = 68, 85% control).

4.2.2 Nutrition: Knowledge and Behaviour

To assess pupils' nutritional knowledge and behaviour the evaluation cohort (intervention and control school) and their parents/guardians (intervention school), completed a Knowledge and Attitude survey, and a Food and Drink survey respectively.

4.2.2 (a) Knowledge and Attitude Survey

A Mann-Whitney U-test revealed no statistically significant difference in the younger cohorts' nutritional knowledge ($p > .050$). To further assess the younger cohorts' nutritional knowledge a scoring system was developed. Scores from each question were accumulated to calculate an overall mark out of 30; scales that were negatively marked were reversed. At baseline the mean cumulative score was 24.92 and 23.79 for the intervention and control school respectively thus further indicating that no significant difference in pupils' nutritional knowledge was present ($p = .178$).

The older cohort were asked five questions relating to the importance of healthy eating and physical activity, and what could they do lead a healthier, more active lifestyle. Two questions were multiple choice, three questions were open ended resulting in a large quantity of answers being obtained.

Data analysis revealed a statistically significant difference in the older cohorts' nutritional knowledge. The answers that proved to have a significant difference are presented in Table 4.4. The figures presented in this table represent the number and percentage of pupils who called out these answers. For instance out of the 43 pupils from the intervention school, 38 pupils (20.9%) said 'to not eat chocolate, sweets or lollipops'.

Table 4.4: Nutritional knowledge with significant differences – Older cohort

	Intervention (n = 43)		Control (n = 37)		
Question: Tell me some of the things you can do to eat healthy	**N**	**%**	**N**	**%**	**P value**
Not eat chocolate, sweets, lollipops	38	20.9	25	67.6	*.024
Drink low fat milk instead of full fat	25	26.7	12	32.4	*.022
Question: Why is it good for you to eat healthy?	**N**	**%**	**N**	**%**	**P value**
To have healthy bones	9	20.9	1	2.7	*.015
To be fit	12	26.7	21	56.8	*.006

Overall whilst a significant difference in nutritional knowledge for the older cohort was identified, this was only for four out of the seventy answers obtained (2.8%).

4.2.2 (b) Food and Drink Survey

As parents/guardians from the control school did not complete this survey no baseline comparison was possible.

To determine pupils' baseline nutritional behaviours, data obtained from parents/guardians (n = 78) from the intervention school was analysed using descriptive frequencies. A minority of parents/guardians (n = 6, 7.7%) did not realise there were questions on the back of the survey, as a result these missing variables were inputted into SPSS as 'missing'. Table 4.5 contains the frequency of answers that were of particular interest to this study.

Table 4.5: Nutritional habits of pupils' based on parental survey at baseline

	Frequency	n	% that do..
How many days in an average week (Mon-Sun) does your child have something to eat for breakfast	7	75	96.2
Over the past five days, how often did your child bring lunch to school from home	5	71	91.0
When your child takes lunch to school from home, what do they usually take?			
Fruit or vegetables	Yes	64	82.1
Fruit string, rollups, squirts	Yes	3	3.8
Muesli bar, biscuit, cake, chocolate, muffin	Yes	16	20.5

How many servings of X does your child usually eat/drink in one day?

	Fruit		Vegetables		Water		Plain milk	
Serving frequency	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
0-1	28	38.9	20	38.9	20	27.8	33	46.5
2-3	38	52.8	27	55.6	5	37.5	30	42.3
4-5	6	8.4	22	5.6	22	30.5	5	7.0
6-7	0	0	3	0	3	4.2	3	4.2

In the past 7 days, how many times did your child eat/drink the following

	Snacks		Fast Food		SSBs		Juice Drink	
Serving frequency	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
0-1	5	6.9	63	97.2	63	87.5	23	31.9
2-3	12	16.7	6	2.8	6	8.3	10	13.8
4-5	16	22.3	2	0	2	2.8	13	18.0
6-7	30	41.7	1	0	1	1.4	22	30.6
8-10	6	8.4	0	0	0	0	1	2.8
14-21	3	4.2	0	0	0	0	3	1.4

Results from this survey indicate that during a typical school week a high percentage of pupils usually have a breakfast every morning (n = 75, 96.2%) and bring fruit or vegetables as part of their lunch to school (n = 64, 82.1%). In addition when parents/guardians were asked to recall their child's dietary behaviour for the previous seven days, very few reported their child consuming more than one glass of a sugary sweetened beverage (SSB, n = 9, 12.5%).

Whilst these figures illustrate that pupils had relatively good dietary behaviour, a small percentage of pupils' dietary intake could be improved. For instance 20.5% (n = 16) of parents/guardians stated that their child usually brings a muesli bar, biscuit, cake, chocolate or muffin to school as part of their lunch. In addition some parents/guardians (n = 14, 17.9%) said that their child does not consume fruit (n = 3, 4.2%), vegetables (n = 10, 13.9%), water (n = 3, 4.2%) or milk (n = 10, 14.1%) on an average day. The researcher was not able

to determine if the same pupils did not consume fruit and water (n = 3, 4.1%) as the surveys were completed anonymously.

4.2.3 Cardiovascular Endurance

Presented below is the average time taken by pupils to complete the 550m run (presented in seconds), SD and P values.

Table 4.6: Time taken by pupils to complete the 550m run at baseline

Younger evaluation cohort			
Variable	**Intervention (n = 39)**	**Control (n = 36)**	**P value**
550m run	212.56 seconds ± 25.82	228.61 seconds ± 30.52	*.016
Older evaluation cohort			
Variable	**Intervention (n = 43)**	**Control (n = 34)**	**P value**
550m run	160.42 seconds ± 23.12	166.82 seconds ± 26.36	.260

A statistically significant difference in the time taken to complete the 550m run was revealed (*.016). At baseline the younger cohort from the intervention school completed the run 16.05 seconds faster compared to the same cohort from the control school. There was no clear reason for this discrepancy.

4.2.4 Physical Activity

At baseline the percentage of pupils from the intervention and control school who met the inclusion[11] criteria was 98.78% (n = 72) and 82.5% (n = 75) respectively.

Table 4.7: Duration of pupils' daily PA at baseline

Younger evaluation cohort			
	Intervention (n = 38)	**Control (n = 34)**	**P value**
Average daily PA in minutes	51.51 ± 10.06	59.50, ± 15.24	*.012
Older evaluation cohort			
	Intervention (n = 43)	**Control (n = 32)**	**P value**
Average daily PA in minutes	51.03 ± 7.64	47. 91, ± 12.26	.179

An Independent-Sample t-test revealed that the control schools' younger cohort was more physically active (p = .012) and therefore less sedentary compared to the intervention

[11] As previously stated the inclusion criteria were set at 600 minutes of wear time per day for four days including at least one weekend day.

school (+7.99 minutes). Whilst the older cohort from the intervention school were more physically active compared to the control (+3.12 minutes), this was not statistically significant (p = .179).

Based on pupils' daily PA, the researcher was able to determine if pupils met the recommended 60 minutes of PA (Department of Health, 2009). Findings from a Mann-Whitney U-test revealed no statistically significant difference for the younger (intervention n = 38, control n = 34, p = .068) and older cohort (intervention n = 43, control n = 32, p = .417). Findings from this test also indicated that more pupils from the control younger cohort (n = 18, 41.9%) met the PA guidelines compared to the intervention (n = 12, 31.6%).

Overall, 68.4% (n = 26) of the younger and 76.7% (n = 33) of the older cohort from the intervention school did not meet the daily PA guidelines compared to 47.1% (n = 16) and 84.4% (n = 27) from the control school cohorts respectively. Pupils who did not meet the recommended duration of daily PA were categorised as sedentary.

Baseline analysis indicated a statistically significant difference in BP and nutritional knowledge (older cohort only) however this was for a small percentage of answers (2.8%). Furthermore, statistically significant differences were found in cardiovascular endurance and daily PA for the younger cohort.

4.3 Impact Analysis

In order to determine if the intervention was successful in enhancing pupils PA and nutritional behaviours, and school practice, comparison of data gathered at baseline and near intervention end from the evaluation cohort and school stakeholders were made.

4.3.1 Evaluation Cohort

Not all pupils from the younger evaluation cohort from the control school had their measurements re-taken in May 2014. This class group was split between two classrooms and the principal agreed to only have one class re-tested (n = - 15, - 34.9%).

4.3.1 (a) Anthropometric and Physiological Mean Change

For non-categorical variables the difference in the mean values from baseline to near intervention end, the SD and P values are shown in Table 4.8.

Table 4.8: Changes in pupils' anthropometric and physiological measures

Younger evaluation cohort				
Variable	**Intervention (n = 38)**	**P value**	**Control (n = 28)**	**P value**
Height	+2.98 ± 0.87	*.000	+2.42 ± 0.76	*.000
Weight	+1.99 ± 0.96	*.000	+0.98 ± 0.74	*.000
BMI figure	+0.56 ± 0.53	*.000	+0.42 ± 0.49	.649
Waist	+0.80 ± 2.26	.036	-0.268 ± 2.46	.569
Older evaluation cohort				
Variable	**Intervention (n = 43)**	**P value**	**Control (n = 36)**	**P value**
Height	+2.58 ± 0.87	*.000	+1.85 ± 5.82	.065
Weight	+2.31 ± 1.53	*.000	+1.53 ± 2.52	*.001
BMI figure	+0.45 ± 0.60	*.000	+0.43 ± 2.50	.310
Waist	+2.03 ± 2.53	*.000	+1.01 ± 2.87	.041

A Paired-Sample t-test was conducted to assess anthropometric changes over time between the intervention and control groups. Findings indicate that pupils' height, weight and BMI significantly changed however these changes can be attributed to increasing growth levels during the year.

A Wilcoxon Signed Rank test was also conducted for scores that proved to not have normal distribution to ensure the above findings were accurate. The results from this test correspond with findings from the Paired-Sample t-test with little or no change to the significance value (Appendix G).

For categorical variables a Wilcoxon Signed Rank test was also conducted, the P value is shown in Table 4.9.

Table 4.9: Difference in anthropometric and physiological measures without normal distribution

	Intervention		Control	
Variable	**Younger (n = 39)**	**Older (n = 35)**	**Younger (n = 28)**	**Older (n = 36)**
BMI	.180	.317	1.000	.414
BP	*.031	*.002	.317	.854

A statistically significant positive change in the intervention cohorts' BP was revealed. Figure 5 illustrates the effect the intervention had on pupils' BP compared to the control school.

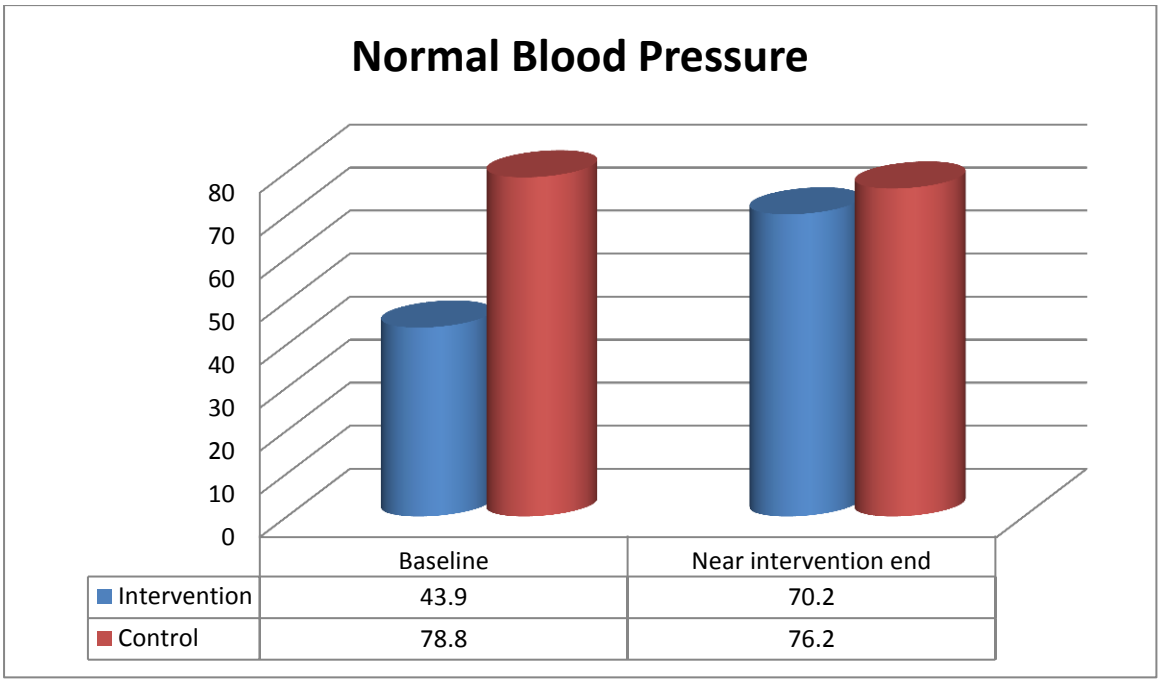


Figure 5: Impact of the intervention on pupils normal BP

In the intervention school, whilst the median value for BP did not change (Md = 2, normal to high), a higher percentage of pupils had normal BP near intervention end (n = 59, 70.2%) compared to baseline (n = 36, 43.9%). Furthermore less pupils had high BP near intervention end (n = 10, 11.9%) compared to baseline (n = 20, 24.4%).

Findings from the Wilcoxon Signed Rank test revealed that the percentage of pupils from the control school with normal BP did not significantly improve. At baseline 78.8% of pupils (n = 63) had normal BP compared to 76.2% (n = 48) near intervention end.

Overall findings indicate that BP significantly improved in pupils receiving the intervention compared to those who did not. No improvements in pupils' BMI figure or waist circumference were found.

4.3.1 (b) Nutrition: Knowledge and Behaviour

Knowledge and Attitude Survey

For the intervention younger cohort, a statistically significant improvement in children's nutritional knowledge on SSBs and fast foods (p = .009, p = .032 respectively) was revealed.

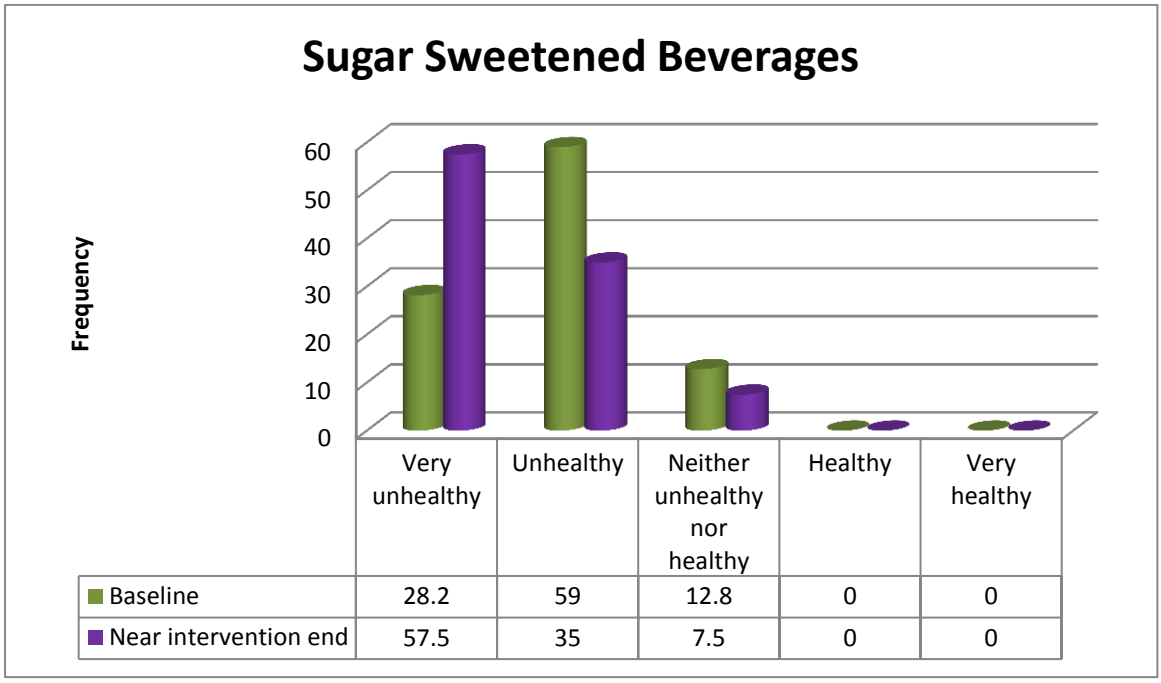


Figure 6: Frequency of SSBs consumption – Intervention younger cohort

Whilst pupils from the intervention school were aware that SSBs were not healthy, the median percentile for the SSB question improved from unhealthy at baseline (Md = 2, n = 23, 59.9%) to very unhealthy near intervention end (Md = 1, n = 23, 57.5%). This is due to a 29.3% increase (n = 12) in the percentage of pupils stating that SSBs were very unhealthy.

Pupils from the control school did not improve their knowledge on SSBs (p = .110). At baseline less than half of the pupils from the control school stated that SSBs were 'very unhealthy' (n = 15, 34.9%) however at intervention end very few pupils repeated this

answer (n = 7, 25.0%) with some stating SSBs were 'healthy' (n = 1, 3.6%) and 'very healthy' (n = 1, 3.6%).

Pupils from the intervention school also improved their nutritional knowledge on fast foods. Findings are illustrated in Figure 7.

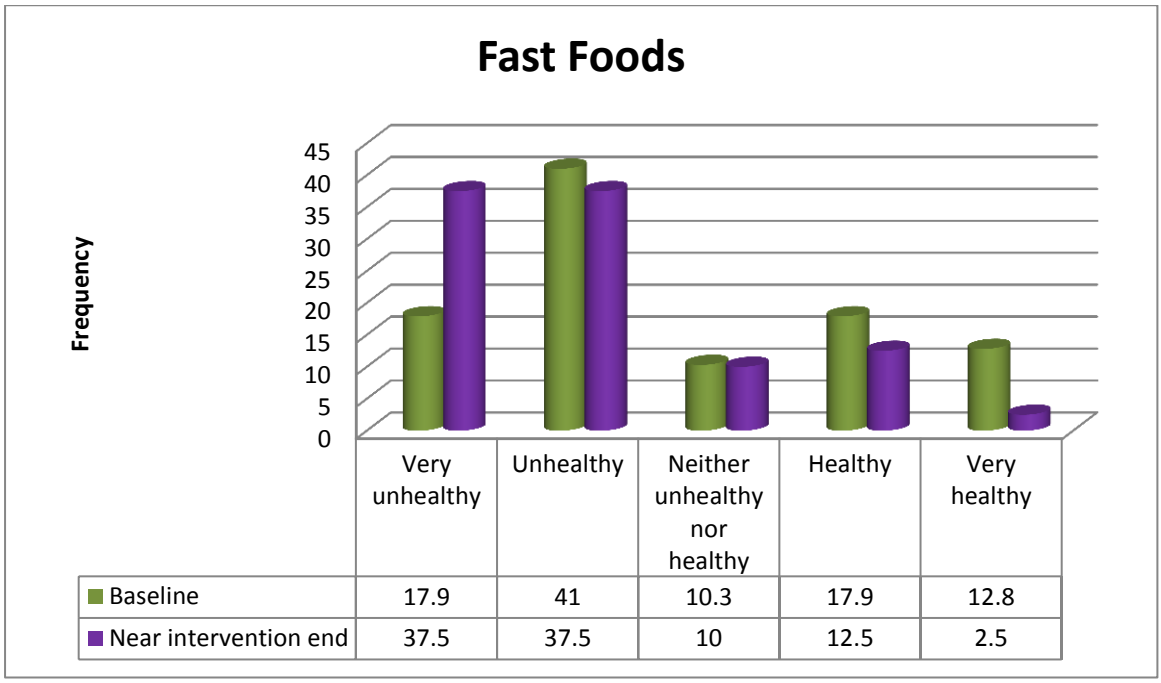


Figure 7: Nutritional knowledge on fast food – Intervention younger cohort

Whilst the median percentile did not change (Md = 3, unhealthy, n = 4, 10%), a higher percentage of pupils (+ 19.6%) from the intervention school stated that fast foods 'very unhealthy' near intervention end (n = 15, 37.5%) compared to baseline (n = 7, 17.9%). In addition less pupils stated fast foods were 'very healthy' (n = 1, 2.5%) near intervention end compared to baseline (n = 5 12.8%).

A statistically significant improvement in the control evaluation cohorts' nutritional knowledge on fruit and vegetables (p = .010), and fast food (p = .007) was also revealed. At baseline few pupils stated that fruit and vegetables were 'very unhealthy' (n = 3, 7.0%) and 'unhealthy' (n = 2, 4.7%) however no pupil stated that fruit and vegetables were 'very unhealthy' or 'unhealthy' near intervention end. This could be due to the fact however that the number of pupils re-tested at intervention end was less compared to baseline (n = 28

and n = 43 respectively). In addition more pupils (n = + 13, + 56.4%) stated that fruit and vegetables were 'healthy' near intervention end compared to baseline.

A Paired-Sample t-test was also conducted to determine if the intervention impacted the younger evaluation cohorts' overall nutritional knowledge score. The difference in the cumulative score over the testing periods, the SD and P values are shown in Table 4.10.

Table 4.10: Improvements in nutritional knowledge score – Younger cohort

Younger evaluation cohort				
	Intervention (n = 39)	**P value**	**Control (n = 28)**	**P value**
Score	+ 1.43 ± 3.35	*.011	+ 3.14 ± 4.37	*.001

Findings revealed a statistically significant improvement in nutritional knowledge from pupils in both schools. This is in accordance with the previously discussed findings regarding SSBs, fast food and fruit and vegetables.

In the older evaluation cohort the answers that had a statistically significant improvement are presented in Table 4.11.

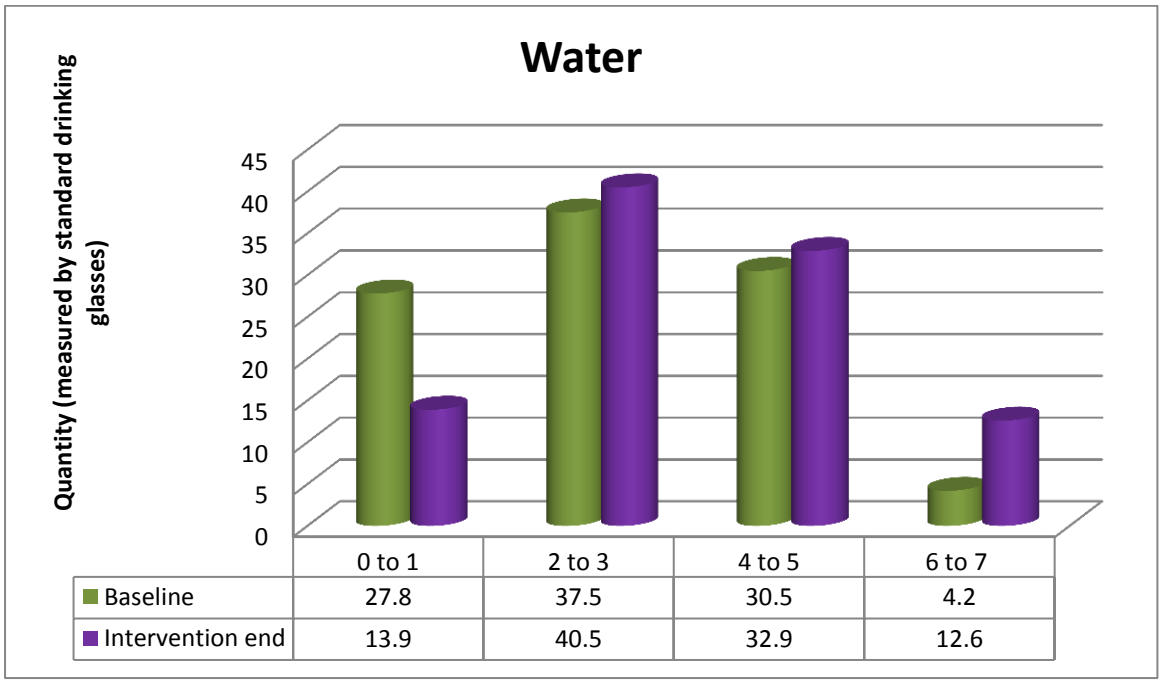
Table 4.11: Improvements in pupils' nutritional knowledge - Older cohort

	Baseline (n = 43)		Near intervention end (n = 45)			
Question: Tell me some of the things you can do to eat healthy						
	n	**%**	**n**	**%**	**Z Score**	**P value**
(Decrease) Fizzy Drinks	17	39.5	44	97.8	-4.025	*.000
(Decrease) Fruit Juice	2	4.70	25	55.6	-3.651	*.000
(Decrease) Fruit Drink	4	9.30	20	44.4	-2.858	*.000
(Increase) Breakfast	43	0	12	26.7	-3.464	*.001
(Decrease) Plain water	25	58.1	38	84.4	-2.191	*.002
(Increase) Low fat or full fat milk	25	58.1	37	82.2	-2.117	*.005
(Decrease) Muffins	5	11.6	16	35.6	-3.000	*.005
(Decrease) Crisps	6	14.0	17	37.8	-3.128	*.008
(Decrease)Takeaways	5	11.6	16	35.6	-2.268	*.012
Question: Why is it good for you to eat healthy?						
	n	**%**	**n**	**%**	**Z Score**	**P value**
You look better	1	2.3	11	24.4	-2.673	*.004
Question: Why is it good to be fit and active?						
	n	**%**	**n**	**%**	**Z Score**	**P value**
You feel good about yourself	43	0	9	20.0	-2.111	*.008
You do better at sports	17	39.5	22	48.9	-4.536	*.012
You have more energy	4	9.3	11	24.4	-2.000	*.035

Overall pupils improved their knowledge on what they can do to improve their dietary behaviour. Some of the answers that had a significant improvement for this question were to decrease the consumption of fizzy, fruit and juice drinks ($p < .050$ for all), to drink more water and milk ($p = .002$, $p = .005$ respectively) and to have breakfast ($p = .001$). These improvements could be due to the Sugary Drinks and Breakfast presentations. Pupils also improved their knowledge on why is it good to eat healthy and to be fit and active. Overall the older evaluation cohort from the intervention school improved their nutritional knowledge on approximately 18.6% of the total amount of answers obtained during the testing periods. No statistical significance was identified for any of the above answers from the control school (Appendix G).

Food and Drink Survey

A Wilcoxon Signed Rank test revealed that pupils' consumption of water increased (p = .034) whilst the consumption of juice drinks decreased (p = .024). These findings correspond with findings from the Knowledge and Attitude Survey and are illustrated in the Figures below.



	0 to 1	2 to 3	4 to 5	6 to 7
Baseline	27.8	37.5	30.5	4.2
Intervention end	13.9	40.5	32.9	12.6

Figure 8: Frequencies on how water consumption as reported by parents/guardians

At baseline very few parents/guardians reported that their child was consuming between six to seven glasses of water daily (n = 3, 4.2%) however at intervention end a higher portion of parents/guardians reported that their child was consuming this amount (n = 10, 12.6%).

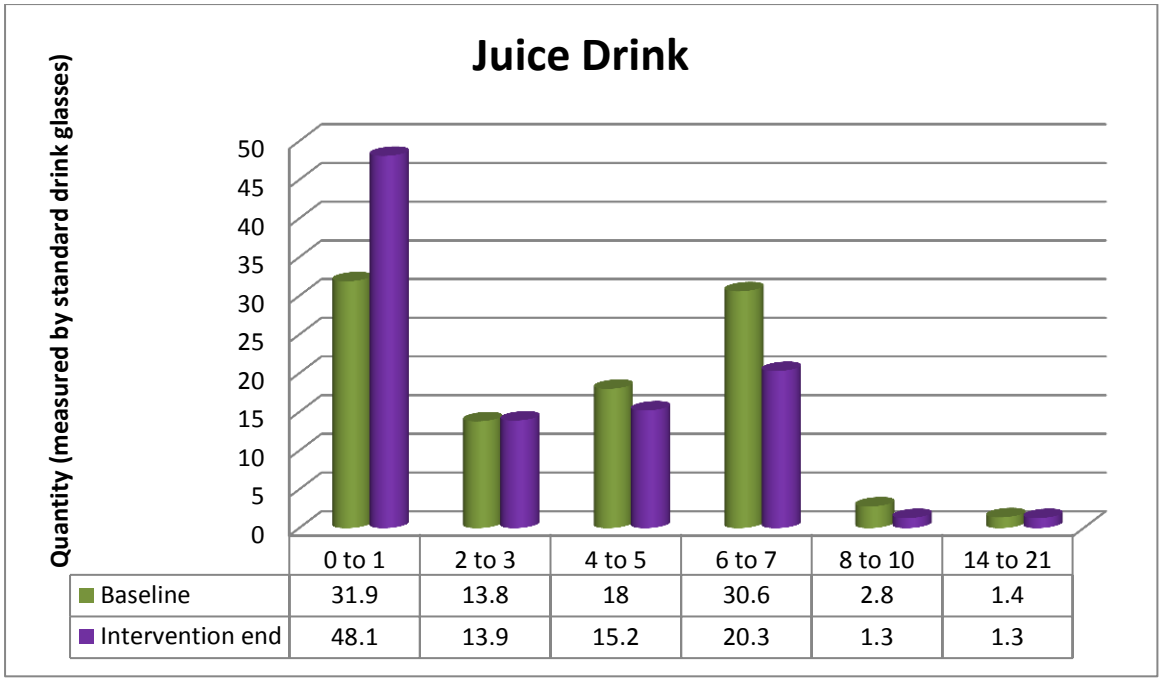


Figure 9: Drink your child consumed in the last 7 days

According to the results from the Food and Drink survey, the frequency of consuming six to seven glasses of a juice drink in a week significantly decreased from baseline (n = 22, 30.6%) to intervention end (n = 16, 20.3%). In addition more parents/guardians reported their child consuming between zero to one glass of juice at intervention end (n = 38, 48.1%) compared to baseline (n = 23, 31.9%). Furthermore the quantity of children drinking no glass of juice increased at intervention end (n = 28, 35.4%) compared to baseline (n = 17, 23.6%).

4.3.1 (c) Cardiovascular endurance

The difference in time taken to complete the run (presented in seconds), the SD and P values are shown in Table 4.12.

Table 4.12: Changes in pupils' cardiovascular endurance

Younger evaluation cohort				
	Intervention (n = 38)	**P value**	**Control (n = 23)**	**P value**
Time to complete the run (in seconds)	-12.66 ± 25.26	.004*	-17.78 ± 40.99	.049*
Older evaluation cohort				
	Intervention (n = 43)	**P value**	**Control (n = 32)**	**P value**
Time to complete the run (in seconds)	-6.60 ± 10.06	.000*	-13.31 ± 17.87	.000*

Findings from a Paired-Sample t-test revealed that cardiovascular endurance of the evaluation cohorts from both schools significantly improved. This finding has also been replicated in the Wilcoxon Signed Rank test (Appendix G). Whilst the control younger cohort improved their cardiovascular endurance significantly more than the other groups (-17.78 seconds), the p value is just below the significance level ($p < .050$).

Baseline analysis indicated a statistical significant difference in the younger evaluation cohort. Pupils from the intervention school completed the run 16.05 seconds faster than pupils from the control school. This explains that whilst the control younger cohort saw the biggest improvement, the significance of this finding was border-line.

4.3.1 (d) Physical Activity

Findings relating to pupils' PA are presented in Table 4.13 and 4.14. Pupils who did not meet the recommended 60 minutes of daily PA were classified as sedentary as they were not sufficiently active.

Table 4.13: Changes in pupils' daily PA

Younger evaluation cohort				
	Intervention (n = 38)	**P value**	**Control (n = 28)**	**P value**
Daily PA (in minutes)	+ 8.09 ± 12.55	*.001	- 6.03 ± 10.98	*.032
Older evaluation cohort				
	Intervention (n = 43)	**P value**	**Control (n = 32)**	**P value**
Daily PA (in minutes)	- 0.23 ± 14.84	.929	+ 8.38 ± 10.32	*.001

The younger cohort from the intervention school increased their daily PA by 8.09 minutes whilst pupils from the control school decreased their PA levels by 6.03 minutes. No statistical significance difference was identified in the intervention older cohort however the control older cohort significantly improved their levels of PA (+8.38 minutes).

Table 4.14: Met the recommended duration of PA

	Intervention				**Control**			
	Younger		**Older**		**Younger**		**Older**	
Met recommended PA	45.7%	.317	32.4%	.157	33.3%	.102	50.0%	*.007

Baseline analysis revealed that the younger evaluation cohort from the control school were the only group who had met the daily requirements of PA and were therefore the only group not classified as sedentary.

Despite the improvements in the intervention younger cohorts' daily PA (+ 8 minutes), the majority of pupils did not reach the recommended 60 minutes of PA near intervention end, resulting in 54.3% (n = 19) of the intervention younger cohort being sedentary. In addition 67.6% (n = 23) of the intervention older cohort were sedentary at intervention end. However these frequencies show a slight improvement as a higher percentage of pupils from the younger (n = 25, 65.8%) and older (n = 23, 67.6%) cohort were sedentary at baseline.

Notwithstanding these findings the frequency of pupils' reaching daily PA increased from baseline (n = 23, 28.4%) to near intervention end (n = 27, 39.1%) however this was not statistically significant.

ANCOVA

A one-way analysis of covariance (ANCOVA) was conducted to assess if there was a significant difference in pupils' measures for the intervention cohort and the control cohort, while controlling for their baseline scores.

The use of ANCOVA recommends that the following assumptions are approximately met;

- Baseline data was measured pre intervention
- Valid and reliable measures were used
- Normality of the data was assessed (Appendix G)
- Outliers were identified and retained as they did not skew the data (Appendix G)

As these assumptions were approximately met, non-categorical variables that proved to have a statistically significant difference between the testing periods were analysed using the ANCOVA test.

A one-way between-groups analysis of covariance was conducted to compare the effectiveness of the intervention on pupils' cardiovascular endurance. The independent

variable was the type of school (intervention, control), and the dependent variable was the time taken to complete the run near intervention end. The time taken to complete the run at baseline was used as the covariate in this analysis.

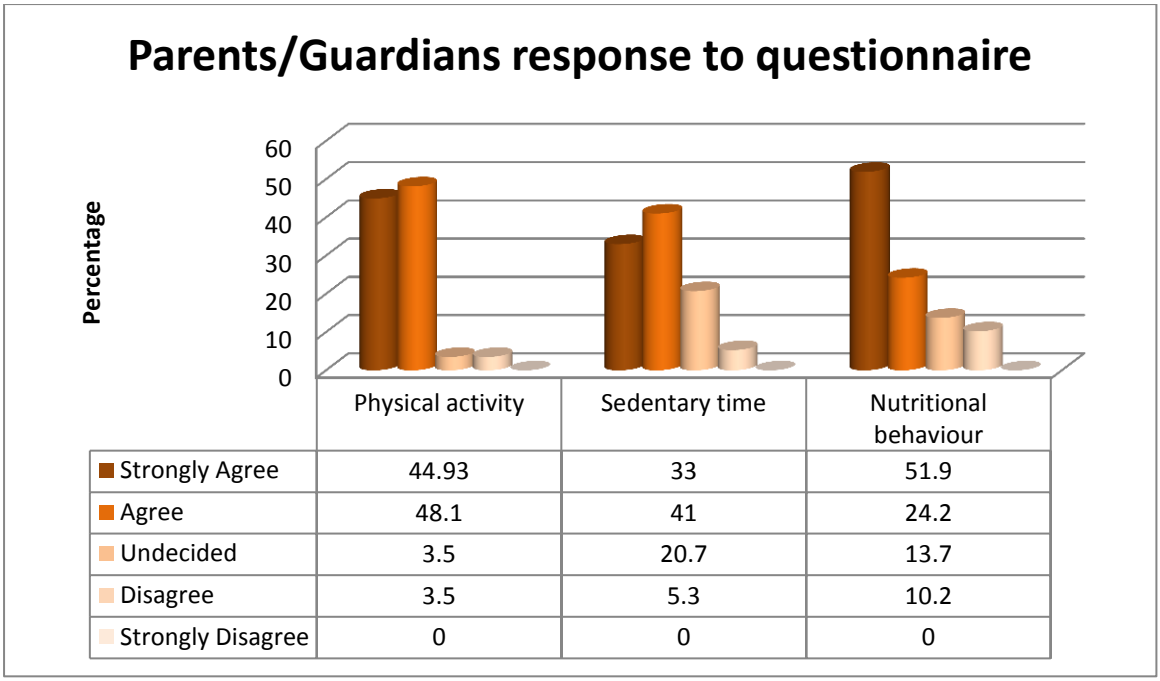
Preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of the covariate (Appendix G). After adjusting for baseline scores, there was no significant difference between the intervention and control cohort in the time taken to complete then run near intervention end $p = .363$, partial eta squared = .006. Meaning pupils from the intervention and control school improved their cardiovascular endurance equally. The influence of the covariates (cardiovascular endurance) was significant ($p = .000$).

4.3.2 School stakeholders

Parents/guardians and teachers from the intervention school completed various documents to determine if the intervention had an impact on (i) pupils' PA, sedentary time, and nutritional knowledge, and (ii) the schools' PA and nutrition practice.

4.3.2 (a) Parents/Guardians

Due to the vast amount of data already gathered, a subsample of parents/guardians was targeted to complete a questionnaire. Twenty percent (n = 40) of parents/guardians were randomly selected to complete a Project Spraoi Questionnaire (PSQ) at intervention end, 60% responded (n = 24). Findings regarding PA, sedentary time and nutritional behaviour are presented in Figure 10.



	Physical activity	Sedentary time	Nutritional behaviour
Strongly Agree	44.93	33	51.9
Agree	48.1	41	24.2
Undecided	3.5	20.7	13.7
Disagree	3.5	5.3	10.2
Strongly Disagree	0	0	0

Figure 10: Responses to Project Spraoi Questionnaire: Parents/Guardians

A high percentage of parents/guardians agreed (n = 20, 93.03%) that Project Spraoi had a positive impact on their child's PA whilst only a small percentage were undecided (n = 2, 3.5%) or disagreed (n = 2, 3.5%). In addition the majority of parents/guardians agreed that the intervention had a positive impact on their child's sedentary (n = 31, 74%) and nutritional behaviour (n = 35, 76.1%) however some parents/guardians were undecided (n = 9, 20.7%, n = 5, 13.7% respectively). Furthermore a small percentage of parents/guardians disagreed that the intervention did not have a positive impact on PA (n = 2, 3.5%), sedentary time (n = 3, 5.3%), or nutritional behaviour (n = 3, 10.2%).

Parents/guardians were asked if they made any changes to their grocery shopping after attending the nutrition presentations, 66.7% of parents/guardians who attended the presentations reported yes (n = 2) whilst 33.3% reported no (n = 1). Parents/guardians were asked to provide feedback on Project Spraoi; some of the comments were as follows;

''All of my children are eating a bit healthier now and sugary drinks are a thing of the past…'

'They were very enthusiastic about healthy eating and exercise after the information…''

''…their knowledge has increased greatly.''

''...they learnt a lot''.

4.3.2 (b) Teachers

Teachers completed a Needs Analysis and a PA profile at baseline (n = 9) and intervention end (n = 9). Due to the construction of the Needs Analysis it was not possible to statistically analyse this data. The PA Profile was analysed using a Paired-Sample t-test. Findings from both of these documents will be presented under the following sub-headings; Physical Activity and Nutrition.

Physical Activity

At baseline, based on the Needs Analysis, teachers (n = 8) identified the schools provision of a variety of after school sports as being the main aspect it performed strongly on. In addition teachers felt the school performed well on delivering the PE curriculum to pupils (n = 3) and supporting team based achievements (n = 3). Overall teachers did not feel that the school could improve on increasing PA within the school. However at intervention end teachers identified Project Spraoi as a practice the school performed well on (n = 5).

Results from analysing the PA Profile are presented below. The difference in the mean values, SD and P values are shown in Table 4.15.

Table 4.15: Changes in the schools' PA

	Mean value	Standard deviation	P value
Fitness	+ 31.11 minutes	± 32.29	*.020
PE	+ 4.44 minutes	± 26.03	.622
Sport/games	+ 10.00 minutes	± 41.31	.488

Teachers were asked to state 'how many minutes of each activity does your class do each day?' A statistically significant increase in the duration teachers spent instructing fitness activities from baseline to intervention end was identified (+ 31.11 minutes, p = .020). The intervention had no statistically significant impact on the schools PE or sports and games however this could be due to the fact that at baseline, teachers identified these areas as practices the school already performed well on.

Nutrition

At baseline all teachers who completed the Needs Analysis identified the schools healthy eating policy as the main nutrition practice the school performed well in (n = 9). The healthy eating policy encourages pupils to have a healthy lunch Monday to Thursday (on these days pupils are not allowed bars, sweets, biscuits or cake). Treats are allowed on Fridays however fizzy drinks and crisps are banned. In addition teachers (n = 5) identified informing pupils about the food pyramid and organising a nutrition week (n = 4) as other elements the school performed well on. At baseline teachers (n = 4) identified restricting the consumption of sugary drinks as an area the school could improve on.

At intervention end teachers identified the promotion of water and milk as healthy drinks as an aspect the school performed well on (n = 2). Furthermore teachers (n = 2) also acknowledged the restriction of using treats as prizes for pupils as another area the school performed well on. Whilst these values are small, no teacher commented that these were elements that the school had performed well at during the collection of baseline data.

Overall, based on the PA Profile, the intervention had a statistically significant impact on PA (fitness, p = .020). Based on the Needs Analysis teachers stated that the promotion of water and milk as every day drinks and the restriction of treats had improved during the course of the intervention.

4.4 Process Analysis

Teachers completed a PSQ at mid-point (n = 7) and at intervention end (n = 8) whilst other school stakeholders completed a separate PSQ at intervention end. In addition teachers were also asked to complete a PA weekly recording sheet to determine how frequently they were delivering the PA sessions to their class. However, due to a lack of compliance the teacher PSQs were the only documents included for data analysis which was conducted using descriptive frequencies.

4.4.1 Teacher Project Spraoi Questionnaire

At mid-point the teacher PSQ consisted of eight questions, three of these questions were asked again at intervention end with ten additional questions. Findings regarding the

overall objective of this study are discussed below. Other findings are presented in Appendix G.

Overall teachers agreed that the intervention had a positive impact on pupils' PA (n = 9, 100%), sedentary time (n = 6, 75%) and nutritional knowledge (n = 9, 100%). However teachers felt that delivering the additional, daily twenty minutes of PA was not manageable (mid-point n = 5, 71.5%, intervention end n = 7, 87.5%).

On both PSQs teachers were asked to identify what barriers limited them in fulfilling the twenty minutes. Barriers identified by teachers included; ''*loaded curriculum demands*'' (mid-point n = 3, intervention end n = 6) which meant ''*other subjects suffered*'' (intervention end n = 2), ''having *no hall in the school*'' (intervention end n = 2) and ''poor *weather conditions*'' (intervention end n = 3).

The majority of teachers (85.7%) were unsure if the school would implement Project Spraoi without an Energizer for the next academic year. Overall teachers felt that Project Spraoi ''*is a great project*'' (n = 5) but a more ''*realistic expectation*'' (n = 3) is required as the Irish primary school curriculum is overloaded.

Whilst the magnitude of change was small, the results indicate that pupils' PA and nutritional behaviours had improved. This is further supported by findings from the parent/guardian survey. Findings from the process evaluation indicate that whilst teachers felt the intervention did have an impact on pupils PA and nutritional behaviour, committing to the requirement of delivering additional, daily PA was not feasible.

Chapter 5: Discussion, Recommendations and Conclusion

This chapter consist of;

- A discussion on the findings relating to the specific objectives of this research
- An outline of the study's strengths and limitations
- Recommendations for future research studies and policies
- Conclusion on the primary objective.

5.1 Discussion on research findings

This study examined if an Energizer led, multi-pronged school based intervention could enhance pupils' PA and nutritional behaviours over one academic year, in an effort to tackle paediatric obesity in Irish primary school pupils. To determine this, the author delivered and evaluated an intervention; Project Spraoi.

Throughout the course of the intervention the author had two roles; Energizer and researcher. The primary objective of the Energizer was to deliver a multi-pronged health intervention to all classes, involving and engaging the whole school community. The secondary objective was to improve PA and nutritional practice within the school.

The researchers' role was to evaluate the impact and process of the intervention by gathering and comparing data gathered from school stakeholders. Further impact evaluation involved comparisons between the intervention and control school evaluation cohorts.

These roles aimed to achieve the objectives of this study which were as follows;

Primary objective:

- To determine whether a school based health intervention, Project Spraoi, could increase physical activity, reduce sedentary time and improve nutritional behaviour in primary school pupils over one academic year.

Specific objectives:

- To deliver a multi-pronged health intervention involving the whole school community.
- To evaluate the impact of the intervention by comparing measures, gathered pre- and post-intervention, from pupils receiving the intervention with measures from pupils who have not received the intervention.
- To evaluate the process of the intervention by gathering data from school stakeholders.

A conclusion on the primary objective can be made once findings relating to each specific objective have been analysed. Each of these specific objectives will be initially discussed; a discussion on the primary objective of this research will conclude this chapter.

5.1.1 Delivering an intervention involving the whole school community

The Energizer delivered a multi-pronged intervention involving pupils, teachers and parents/guardians, however some school stakeholders (i.e. principal, secretary, support teachers, Board of Management, caretaker) had minimal or no involvement in the intervention.

In addition not all elements of the intervention were targeted at all school stakeholders. For instance teachers were expected to deliver the PA element of the intervention to their class on a daily basis however no expectation was placed on them to deliver nutritional presentations. Furthermore nutrition presentations were available for parents/guardians to attend however no support was given to help parents/guardians encourage their child/children to be more physically active.

Whilst delivering the intervention to each class, the Energizer attempted to engage teachers in the intervention by encouraging them to participate in the modelled PA sessions. Anecdotal observations however, indicated that not all teachers were actively engaging in the sessions. This is supported with findings from the teacher questionnaire, completed at intervention end, which revealed that only a small minority of teachers were actively involved in delivering the activities when the Energizer was no present. In addition,

subjective observations revealed that teachers who did engage with pupils while delivering the sessions appeared to lead a more physically active lifestyle.

Interventions targeting the primary school setting should be mindful of all school stakeholders and their attitudes and perceptions towards school based interventions. This suggests that the success of the intervention may be affected by teachers' level of support. If teachers do not support the intervention or believe it is not feasible, the longevity of the intervention may be short lived. Primary school interventions should therefore seek teacher support, ensure the intervention can be managed within the school setting and ensure school stakeholders are equally involved in all elements of the intervention.

5.1.2 Evaluation

The role of the researcher was to determine if this methodological approach could enhance pupils' PA and nutritional behaviour and improve PA and nutritional practice within the school. In addition the researcher also evaluated the process of the intervention.

5.1.2 (a) Impact Evaluation

The aim of the intervention was to increase PA, decrease sedentary time and improve nutritional behaviour. Findings indicate a statistically significant increase in the younger cohorts PA however, no statistically significant increase was found in the older cohort. As discussed in the Literature Review this may be due to the fact that children's PA decreases with increasing age. Notwithstanding this suggestion, findings from the teacher and parent/guardian Project Spraoi questionnaires revealed that these stakeholders agreed that the intervention positively impacted pupils' PA and sedentary behaviours. The social desirability[12]effect however may have contributed to some of these findings.

PA and sedentary behaviour were measured using accelerometers and whilst these devices provide a direct measure of various physical activities, there are limitations to their use. These devices cannot be worn during water based activities and therefore cannot monitor swimming based activities. The week pupils from the intervention school wore an accelerometer (near intervention end), parents/guardians (n = 9) informed the researcher

[12] The tendency to report an answer in a manner that is deemed to be socially more acceptable than reality (Callegaro, 2008)

that their child did not wear the device consistently due to participating in water based activities as a result of the warm weather. As a result accelerometry findings may have underestimated the total duration of pupils PA levels. Furthermore, as stated in the Literature Review, there is currently no definite epoch length for assessing children's PA behaviour. In addition the inclusion criteria for accelerometry data analysis have been found to vary. Whilst the researcher made every effort to follow procedures most suited to this research, alternative epoch settings and inclusion criteria may have provided different results.

While delivering the intervention the author observed pupils who had verbally stated that they did not enjoy PA, were participating in the intervention activities. Whilst the intervention did not significantly improve PA overall, it is possible that the intervention changed pupils' attitudes towards PA.

In addition, findings indicate that both cohorts from the intervention school significantly improved their cardiovascular endurance. This finding is in accordance with findings from Project Energize (Rush et al., 2013). However, findings also indicate that the evaluation cohort from the control school significantly improved their cardiovascular endurance. Whilst determining the exact contributing factors to this improvement may be difficult, pupils attending the control school wear their school tracksuit as their daily school uniform. Furthermore the control school had access to a variety of sporting facilities compared to the intervention school. These factors may have therefore indirectly encouraged pupils to be more physically active.

As discussed in Chapter Two, direct observation is the most objective method to assess a child's dietary behaviour. However this method is not suitable for field studies, is invasive and labour intensive. Furthermore food diaries and FFQ's have not been validated for measuring children's dietary behaviour and have various limitations.

The Knowledge and Attitude survey and the Food and Drink survey were used by Project Energize to gather baseline data on children's' nutritional knowledge and behaviours. These materials were not used to evaluate the impact of the Energize intervention on improving children's nutritional knowledge and behaviours. As a result the lack of statistically

significant data generated from these questionnaires did not come to the researchers' attention until data was analysed.

Notwithstanding the above, the intervention was associated with significant improvements in nutritional knowledge and behaviour. However, the impact of the intervention on pupils' nutritional knowledge and behaviour may have been diluted as baseline nutritional knowledge and behaviour appeared to be better than what a previous cross-national Irish study had indicated. In the HBSC report, 20% children surveyed reported consuming fruit more than once a day (Kelly et al., 2012) compared to 38.9% of pupils surveyed in this study. In addition 21% of children stated that they consume SSBs once a day or more (Kelly et al., 2012) compared to 12.5% of the children surveyed from the intervention school. However, direct comparisons between the HBSC study is difficult to make due to the different methodological approaches used.

Due to the inability to control for external influences on nutritional knowledge, it is possible that improvements may be accredited to other factors. Notwithstanding this possibility it should be noted that pupils' nutritional knowledge regarding SSBs and fast food significantly improved in the intervention school compared to the control. This could be attributed to the nutrition presentations which focused on SSBs, breakfast and the four food groups. The key messages from these presentations were to reduce the consumption of juice, fruit juice and fizzy drinks and encourage the consumption of natural water and milk. In addition pupils were encouraged to have a breakfast every morning and to only have sweets/treats/fast food on special occasions.

The success of the intervention may have been diluted as the intervention was in place for thirty two weeks however pupils' had their measures re-taken on week twenty six of the intervention and not at intervention end. It was hoped that pupils would be re-tested closer to June however this month is an extremely busy period for schools and it was likely that some pupils would have been missing due to early summer holidays.

As previously stated the Energizer also aimed to improve PA and nutritional practice within the school. The intervention significantly improved the duration teachers spent instructing fitness activities to their class (+ 31.11 minutes per week), however no significant

improvements in PE or sports/games were found. This could be a culmination of the schools pre-existing commitment in delivering the PE curriculum and developing various sporting and games opportunities for pupils. This conclusion is supported by findings from the Needs Analysis which indicated that at baseline and intervention end, teachers stated these were areas the school already performed well on. Furthermore, at baseline teachers (n = 9) felt that the school could not improve on PA.

Regarding nutrition practice, at baseline teachers felt that the school could improve on pupils' intake of water and milk and limit the consumption of treats at school. At intervention end teachers identified the promotion of water and milk, and the restriction of using treats as prizes for pupils as areas the school improved on during the course of the intervention which could be attributed to the Sugary Drinks and Four Food Groups presentations.

Whilst the intervention was successful in improving elements of PA and nutrition practice, its impact may have been diluted as the intervention school was a Health Promoting School, was previously involved in the Food Dudes programme, achieved various awards in sporting events, and imposed a strict nutritional policy which was generally adhered to by all stakeholders. It is possible that the intervention would have had a stronger impact in a school that was not a health promoting school or in a school with an existing health issue. However, as previously stated finding a school that met this criterion along with the additional criteria was virtually impossible.

According to the latest Irish research by Woods et al (2010) one in four Irish primary school children are currently overweight or obese. However BMI findings from this study indicate that one in eight pupils from the intervention school were overweight or obese, meaning 50% less pupils from the intervention school were overweight or obese compared to the general population.

Overall PA and BMI findings for this study did not mirror the results from Project Energize however this could be explained by the fact that the Energize programme is evaluated after the intervention is in place for two academic years. Findings however were similar to the

APPLES evaluation where no statistically significant change in PA and BMI was found after one academic year.

5.1.2 (b) Process Evaluation

Overall teachers felt that the twenty minutes of daily, additional PA was not realistic due to a variety of barriers. The mid-point teacher questionnaire supported this finding as results revealed the existence of barriers for delivering the additional activities. Barriers identified by teachers were; the Irish primary school curriculum, lack of facilities and weather. To overcome the last two barriers, the Energizer provided teachers with indoor based activities. However due to the size and layout of the class rooms, and pupils' school materials, facilitating indoor based activities proved to be inconvenient for teachers.

The effectiveness of a school based intervention could be influenced by a variety of factors outside the researchers' control. For instance the intervention school did not have its own sports hall and this was identified as a barrier in delivering the PA sessions to pupils as poor weather conditions resulted in the PA sessions being delivered in the classroom. In addition structured school days may act as a barrier to school based interventions (Gibson et al., 2008). This conclusion is supported with findings from the process evaluation as teachers from the intervention school reported that the primary school curriculum was a barrier to delivering the PA sessions.

5.2 Strengths and Limitations

All types of research designs have strengths and weaknesses that can impact on the validity of the research findings (Thomas et al., 2005).

5.2.1 Internal Validity

Internal validity is the extent to which the results that are detected in a study are a true reflection of reality rather than the result of extraneous variables (Cormack, 2000). Due to the extraordinary complexity of the determinants of obesity, it was impossible to control all external variables.

Notwithstanding the above, teachers and the evaluation cohorts were exposed to the same testing procedures during both stages of data collection to maximise internal validity. Due to the design of this research study however it was not possible to monitor conditions on parents/guardians.

5.2.1 (a) Validity of instruments/materials used

Validity refers to the degree to which an instrument measures what it is supposed to measure (Thomas et al., 2005).

All anthropometric and physiological measurement instruments used during the course of this study were valid instruments suitable for field research. Manufacturing operating guidelines were adhered to, to maximise validity. A review of the literature indicates that DEXA scans are the most objective measure of body composition however due to the nature of this study this method was not practical. As discussed in the Literature Review, BMI was used as it is considered a valid, indirect measure of assessing children's adipose tissue.

The knowledge and attitude survey was an indirect measure of pupil's nutritional behaviour and knowledge. The 550m run is an indirect, valid measure of cardiovascular endurance (Hamlin et al., 2014) however there is currently no validity value for this test.

5.2.2 External Validity

External validity refers to the generalisability of the research findings (Thomas et al., 2005; Cormack, 2000).

As previously mentioned school recruitment was based on specified criterion to maximise the generalisability of this study. Furthermore every effort was made to recruit a control school with similar demographics and environment as the intervention school.

The intervention and control school are directly comparable, in terms of size and gender profile, with approximately 20% of Cork primary schools.

5.2.3 Reliability

Reliability can be defined as the extent to which a measure, procedure or instrument has 'consistency, or repeatability' (Thomas et al 2005, p.197).

BMI measurements of children (height and weight) collected by trained staff are regarded as reliable (Crespi et al., 2012).

5.2.4 Inter-Tester Reliability (Objectivity)

Inter-tester reliability refers 'to the degree to which different testers can achieve the same scores on the same subject' (Thomas et al., 2005).

As previously stated all anthropometric and physiological measurements were obtained by members of the Project Spraoi team who were trained in all methods of measurement. In addition, to decrease errors and to increase inter-tester reliability; the same member from the Project Spraoi team was responsible for the same test(s) during the collection of pupils' measurements.

5.2.5 Limitations

Due to the delay in obtaining ethical clearance from CIT the intervention did not commence until the third week of October 2013. Furthermore not all nutritional presentations were delivered to the school stakeholders prior to the collection of intervention end data as a result of time constraints. These limitations may have affected relevant data and possible findings.

The collection of accelerometer data took place over an eight week and four week period at baseline and near intervention end respectively due to the lack of accelerometer devices. This time line may impact findings from accelerometry data.

As previously stated not all pupils from the younger evaluation cohort from the control school had their measurements re-taken near intervention end. This may have affected some of the research findings.

5.2.6 Content validity

Content validity is the extent to which a measurement adequately measures the elements under investigation (Cormack, 2000). The poor construction of the Knowledge and Attitude survey emerged as an issue after baseline data was collected. This survey was developed for the collection of baseline data for Project Energize. It was not used for follow up data.

5.2.7 Inter-Tester Reliability

The objectivity of the evaluation may have been comprised as the researcher was involved in delivering and evaluating the intervention. This was imposed due to the logistics of this project.

Notwithstanding the limitations of the research design mentioned above, every effort was made to maximise the validity, reliability and objectivity of this research study.

5.3. Recommendations

This research was an ambitious study, aimed at tackling three determinants of obesity in a primary school setting. Targeting and objectively measuring these determinants is challenging, but feasible. The following are recommendations for future research studies and for the development of Irish policies have been outlined.

5.3.1 Future Research

5.3.1 (a) Methodological Approach

Any future roll-out of Project Spraoi, or similar interventions, should attempt to;

- Increase the objectivity of Project Spraoi, the 'Energizer' and the researcher role should be separated. However, due to the logistics of this project this may not be feasible.
- Target additional school stakeholders and give each element of the intervention equal importance.
- Recruit a focus group involving pupils from the intervention school to assess their attitudes towards Project Spraoi.

- Investigate other valid and reliable methods to assess pupil's %BF in the school based setting.
- Explore and use validated methods to measure or assess pupil's nutritional knowledge.
- Use varying methods of data collection to allow for triangulation of process evaluation findings.
- Increase compliance in completing data collection resources, materials required to be completed by school stakeholders should be sent in the weeks prior to the end of the academic year.
- Help teachers overcome the barrier of the school curriculum; the Energizer could aim to incorporate the PA sessions into the primary school curriculum.

The intervention school involved in this study has enrolled in a new Project Spraoi study which will explore the possibility of altering the Spraoi activities to make them cross-curricular. Findings from this study will determine if teachers feel that this approach is more realistic in delivering the additional twenty minutes of daily PA.

5.3.1 (b) Future Studies

Findings from this research study indicate that one in eight children is overweight or obese. This contradicts previous findings which state that one in four children is overweight or obese (Woods et al., 2010). In addition a recent study suggests that the obesity epidemic in Irish children has plateaued (Heinen et al., 2014). As a result there seems to be a lack of consensus on the prevalence of obesity amongst Irish primary school children. Future studies should investigate the current level of childhood obesity in Ireland in an effort to determine if paediatric obesity has stabilised.

Due to the unpredicted rise in the prevalence of overweight and obesity, a variety of Irish prevention strategies have been developed however the majority of these have not been subject to an evaluation. Irish research studies aiming to tackle obesity should therefore evaluate pre-existing interventions or methodological approaches that have not been subject to an evaluation to determine their effectiveness, as opposed to creating new strategies.

Further research is needed to investigate the impact of technological advancements on Irish children's PA behaviour. According to the literature, technology has negatively affected PA (Must et al., 2009; Rey-López et al., 2008; Lob-Corzilius, 2007) however this has not been objectively measured in the Irish context.

5.3.2 Policies

Classifying paediatric overweight and obesity

- Publicly funded interventions should, as a condition of the funding, should be systematically evaluated.
- Ireland should aim to establish its own nationally representative BMI-age and gender reference curves. This would allow Irish children to be assessed relative to centiles based on nationally representative data.
- Until the development of nationally representative BMI curves, the Irish Government should identify which reference should be adopted within the Irish setting in order to allow for comparisons to be made between Irish studies and to help establish the true prevalence of paediatric obesity in Ireland.

Development of Guidelines

- Sedentary behaviour, as with obesity, is omnipresent and can foster the development of various health consequences. There is a need for Ireland to develop national guidelines on sedentary behaviour for adults and children to help enhance public health.

5.4 Final Conclusion

For the award sought, this research was an ambitious study that set out to accomplish multiple and complex goals within a short time frame.

Based on the current literature and the methodological approach adopted by Project Energize, this intervention targeted the primary school setting in an effort to tackle paediatric obesity. Delivering an intervention in the primary school setting can pose as challenging as support and commitment is required not only from school stakeholders but also from the individual(s) delivering the intervention. Furthermore, trying to effect change

in children's' PA and nutritional behaviour is ambitious and challenging as these behaviours can be influenced by the interplay of a variety of other determining factors. This in turn makes measuring this change, and concluding if an improvement in PA and nutrition behaviour was a direct result of the intervention or from other external factors, difficult. Notwithstanding this realisation, successfully measuring change in children's PA and nutritional behaviour is achievable. Researchers however must ensure that objective instruments are used and protocols are vigorously adhered to.

Within one academic year, Project Spraoi was associated with positive change in pupils PA and nutritional behaviour. Whilst results indicate that the magnitude of some changes was small, the change in pupil's behaviours was nonetheless positive.

Longitudinal implementation of this intervention is required to determine its impact over a longer duration as it is premature to conclude that it was unsuccessful in significantly improving pupil's PA and sedentary behaviours, BMI and waist circumference. However, according to a meta-analysis of school-based PA interventions it is possible that pupils' lean muscle mass increased and fat mass decreased with no overall change in BMI (Harris et al., 2009). Another meta-analysis noted that interventions longer than one academic year led to a significant change in BMI (Gonzalez-Suarez et al., 2009). The intervention was successful in significantly improving pupil's BP, cardiovascular endurance and nutritional knowledge.

School-based interventions should aim to frequently engage all school stakeholders in the delivery of the intervention to help strengthen its impact. Whilst direct teacher involvement was essential for the interventions' implementation and ultimately its success, involving other school stakeholders could have contributed to the overall impact of the intervention (Jones et al., 2014). Furthermore the success of the intervention might have been strengthened if families from the intervention school were directly targeted more frequently (Fruhbeck, 2000).

Furthermore the primary school setting should remain as the key focus for health interventions as it is an important setting in which to initiate behavioural change (De

Bourdeaudhuij et al., 2011; Pate et al., 2006). School based interventions may be better implemented and sustained if built into the curriculum.

Bibliography

Abdullah, A., Peeters, A., de Courten, M., Stoelwinder, J. (2010) 'The magnitude of association between overweight and obesity and the risk of diabetes: A meta-analysis of prospective cohort studies', *Diabetes Research and Clinical Practice,* 89(3), available: Science Direct database [accessed 03 September 2014].

Active School Flag (2014) *About the Active School Flag* [online], available: http://www.activeschoolflag.ie/index.html [accessed 30 September 2014].

Akarolo-Anthony, S.N., Willet, W.C., Spiegelman, D., Adebamowo, C.A. (2014) 'Obesity epidemic has emerged among Nigerians', *BioMed Central Public Health*, 14(455), available: Ebscohost database [accessed 25 August 2014].

Akinnusi, M.E., Saliba, R., Porhomayon, J., El-Solh, A.A. (2012) 'Sleep disorders in morbid obesity', European Journal of Internal Medicine, 23(3), available: Science Direct database [accessed 04 September 2014].

Albon, H.M, Hamlin, M.J, Ross, J.J. (2010) 'Secular trends and distributional changes in health and fitness performance variables of 10-14-year-old children in New Zealand between 1991 and 2003', British Journal of Sports Medicine, 44(4), available: Ebscohost database [accessed 16 September 2014].

Alexy, U., Sichert-Hellert, W., Kersting, M., Manz, F., Schöch, G. (1999) 'Fruit Juice Consumption and the Prevalence of Obesity and Short Stature in German Preschool Children: Results of the DONALD Study', Journal of Pediatric Gastroenterology & Nutrition, 29(3), available: Ebscohost database [accessed 21 August 2014].

Allender, S., Nichols, M., Foulkes, C., Reynolds, R., Waters, E., King, L., Gill, T., Armstrong, R., Swinburn, B. (2011) 'The development of a network for community-based obesity prevention: the CO-OPS Collaboration', *BioMed Central Public Health,* 11, available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3053245/ [accessed 18 November 2014].

Anderson, C.B., Hagströmer, M., Yngve, A. (2005) 'Validation of the PDPAR as an adolescent diary: effect of accelerometer cut points', Medicine and Science in Sports and Exercise,

37(7), available: http://journals.lww.com/acsm-msse/pages/articleviewer.aspx?year=2005&issue=07000&article=00021&type=abstract [accessed 15 September 2014].

Anderson, E.L., Howe, L.D., Fraser, A., Callaway, M.P., Sattar, N., Day, C., Tilling, K., Lawlor, D.A. (2014) 'Weight trajectories through infancy and childhood and risk of non-alcoholic fatty liver disease in adolescence: The ALSPAC study', *Journal of Hepatology,* 61(3), available: Science Direct database [accessed 11 September 2014].

Anderson, P.M., Butcher, K.F., Levine, P.B. (2003) 'Maternal employment and overweight children', *Journal of Health Economics,* 22(3), available: Science Direct database [accessed 20 August 2014].

Anomaly, J. (2012) 'Is Obesity a Public Health Problem?', *Public Health Ethics,* 5(3), available: Ebscohost database [accessed 18 August 2014].

Arenz, S., Rückerl, R., Koletzko, B., von Kries, R. (2004) 'Breast-feeding and childhood obesity—a systematic review', *International Journal of Obesity,* 28(10), available: http://www.nature.com/ijo/journal/v28/n10/full/0802758a.html [accessed 20 August 2014].

Badawi, N, E-S., Barakat, A.A., El Sherbini, S.A., Fawzy, H.M (2013) 'Prevalence of overweight and obesity in primary school children in Port Said city', *Egyptian Pediatric Association Gazette*, 61(1), available: Science Direct database [accessed 29 September 2014].

Bailey, R.C., Olson, J., Pepper, S.L., Porszasz, J., Barstow, T.J., Copper, D.M. (1995) 'The level and tempo of children's physical activities: an observational study', *Medical & Science in Sport Exercise,* 27(7), available: Ebscohost database [accessed 29 August 2014].

Baltrus, P.T., Everson-rose, S.A, Lynch, J.W., Raghunathan, T.E., PhD, Kaplan, G.A. (2007) 'Socioeconomic Position in Childhood and Adulthood and Weight Gain over 34 Years: The Alameda County Study', *Annals of Epidemiology,* 17(8), available: Science Direct database [accessed 19 August 2014].

Baquet, G., Stratton, G., Van Praagh, E., Berthoin, S. (2007) 'Improving physical activity assessment in prepubertal children with high-frequency accelerometry monitoring: A methodological issue', *Preventive Medicine,* 44(2), available: Science Direct database [accessed 08 September 2014].

Barbiero, S.M., Pellanda, L.C., Cesa, C.C., Campagnolo, P., Beltrami, F., Abrantes, C.C. (2009) 'Overweight, obesity and other risk factors for IHD in Brazilian schoolchildren', *Public Health Nutrition,* 12(5), available: http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=5450532&fileId=S1368980008003200 [accessed 03 September 2014].

Barlow, S.E. (2007) 'Expert Committee Recommendations Regarding the Prevention, Assessment and Treatment of a Child and Adolescent Overweight and Obesity: Summary Report', *Pediatrics*, 120(S164), available: http://pediatrics.aappublications.org/content/120/Supplement_4/S164.full.pdf+html [accessed 23 May 2013].

Barron, C., Comiskey, C., Saris, J. (2009) 'Prevalence rates and comparisons of obesity levels in Ireland', *British Journal of Nursing*, 18(13), available: http://www.nurse2nurse.ie/Upload/NA6134bjn2009.pdf [accessed 24 April 2014].

Bartrina, J.A. (2013) 'Public health and the prevention of obesity: Failure or success?', *Nutricion Hospitalaria,* 28(5), available: Ebscohost database [accessed 18 August 2014].

Bastien, M., Poirier, P., Lemieux, I., Després, J-P. (2014) 'Overview of Epidemiology and Contribution of Obesity to Cardiovascular Disease', *Progress in Cardiovascular Diseases*, 56(4), available: Science Direct database [accessed 03 September 2014].

Basu, M., Das, P., Dhar, G., Datta, S., Chattopaddhyay, S., Bagchi, S., Pal, R. (2014) 'Pattern and determinants of overweight and obesity among future physicians', *Nepal Journal of Epidemiology*, 4(1), available: Ebscohost database [accessed 10 August 2014].

Bauman, A., Craig, C.L. (2005) 'The place of physical activity in the WHO Global Strategy on Diet and Physical Activity', *International Journal of Behavioral Nutrition and Physical Activity*, 2(10), available: http://www.ijbnpa.org/content/2/1/10 [accessed 12 November 2014].

Bayne-Smith, M., Fardy, P.S., Azzollini, A., Magel, J., Schmitz, K.H., & Agin, D. (2004). Improvements in heart health behaviors and reduction in coronary artery disease risk factors in urban teenaged girls through a school-based intervention: The PATH programme, *American Journal of Public Health,* 94(9), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1448490/ [accessed 13 October 2014].

Be Active ASAP (2014) *Be Active ASAP* [online], available: http://www.beactiveasap.ie/ [accessed 18 November 2014].

Beechy, L., Galpern, J., Petrone, A., Krupa Das, S. (2012) 'Assessment tools in obesity – Psychological measures, diet, activity and body composition', *Physiology & Behaviour*, 107(1), available: Science Direct database [accessed 03 September 2013].

Bell, J.A., Kivimaki, M., Batty, G.D., Hamer, M. (2014) 'Metabolically healthy obesity: What is the role of sedentary behaviour?', *Preventive Medicine,* 62 [May 2014], available: Science Direct database [accessed 18 September 2014].

Bere, E., Oenema, A., Prins, R.G., Seiler, S., Brug, J. (2011) 'Longitudinal associations between cycling to school and weight status', *International Journal of Pediatric Obesity,* 6(3-4), available: Ebscohost database [accessed 18 August 2014].

Berentzen, T.L., Gamborg, M., Holst, C., Sørensen, T.I.A., Baker, J.L. (2014) 'Body mass index in childhood and adult risk of primary liver cancer', *Journal of Hepatology,* 60(2), available: Science Direct database [accessed 11 September 2014].

Berg, I.H., Bjelland, M., Grydeland, M., Lien, N., Andersen, L.F., Klepp, K.I, Anderssen, S.A., Ommundsen, Y. (2012) 'Mid-way and post-intervention effects on potential determinants of physical activity and sedentary behaviour, results of the HEIA study – a multi-component school-based randomized trial', *International Journal of Behavioural Nutrition and Physical Activity*, 9(63), available: http://www.ijbnpa.org/content/9/1/63 [accessed 28 January 2014].

Berghöfer, A., Pischon, T., Reinhold, T., Apovian, C.M., M Sharma, A., Willich, S.N. (2008) 'Obesity prevalence from a European perspective: a systematic review', *BioMed Central*

Public Health, 8(200), available: http://www.biomedcentral.com/content/pdf/1471-2458-8-200.pdf [accessed 05 August 2014].

Berkey, C.S., Rockett, H.R.H., Field, A.E., Gillman, M.W., Frazier, A.L., Camargo, C.A., Colditz, G.A. (2000) 'Activity, Dietary Intake, Weight Changes in a Longitudinal Study of Preadolescent and Adolescent Boys and Girls', *Pediatrics*, 105(4), available: http://www.pediatricsdigest.mobi/content/105/4/e56.full [accessed 24 July 2013].

Berlin, J.E., Storti, K.L., Brach, J.S. (2006) 'Using Activity Monitors to Measure Physical Activity in Free-Living Conditions' *Journal of the American Physical Therapy Association,* 86(8), available*:* http://ptjournal.apta.org/content/86/8/1137.full#ref-48 [accessed 23 September 2014].

Beuther, D.A., Sutherland, E.R. (2007) 'Overweight, Obesity, and Incident Asthma: A Meta-analysis of Prospective Epidemiologic Studies', *American Journal of Respiratory and Critical Care Medicine,* 175(7), available: http://www.atsjournals.org/doi/abs/10.1164/rccm.200611-1717OC#.VAcTkPldX9s [accessed 03 September 2014].

Birch, L.L., Anzman, S.L. (2010) 'Learning to eat in an Obesogenic Environment: A Developmental Systems Perspective on Childhood obesity', *Child Development Perspectives,* 4(2), 138-143.

Biddle, S.J.H., Gorely, T., Stensel, D.J. (2004) 'Health-enhancing physical activity and sedentary behaviour in children and adolescents', *Journal of Sports Sciences*, 22(8), available: Ebscohost database [accessed 01 October 2013].

Blaine, B. (2008) 'Does depression cause obesity? A meta-analysis of longitudinal studies of depression and weight control', *Journal of Health & Psychology,* 13(8), available: Ebscohost database [accessed 03 September 2014].

Borg, G. (1962) '*Physical Performance and Perceived Exertion'*, Lund, Sweden: Gleerup, available: http://w3.psychology.su.se/staff/eb/Borg_G_1962_thesis.pdf [accessed 19 January 2015].

Botton, J., Heude, B., Maccario, J., Borys, J-M., Lommez, A., Ducimetièrec, P., Charles, M.A. (2010) 'Parental body size and early weight and height growth velocities in their offspring', *Early Human Development,* 86(7), available: Science Direct database [accessed 29 August 2014].

Bray, G.A. (2004) 'Medical Consequences of Obesity', *The Journal of Clinical Endocrinology & Metabolism,* 89(6), available: http://petergreenlaw.com/wp-content/uploads/2012/11/Medical-Consequences-of-Obesity.pdf [accessed 24 August 2-14].

Broadcasting Authority of Ireland Children's Commercial Communications Code 2011, Consultation Document, Dublin 2, available: http://www.bai.ie/?page_id=1929 [accessed 15 May 2013].

Bremer, A.A, Auinger, P., Byrd, R.S. (2009) 'Relationship Between Insulin Resistance–Associated Metabolic Parameters and Anthropometric Measurements With Sugar-Sweetened Beverage Intake and Physical Activity Levels in US Adolescents Findings From the 1999-2004 National Health and Nutrition Examination Survey', *Archives Pediatrics Adolescents and Medicine,* 163(4), available: http://archpedi.jamanetwork.com/article.aspx?articleid=381243 [accessed 25 April 2014].

Brown, A.W., Bohan Brown, M.M., Allison, D.B. (2013) 'Belief beyond the evidence: using the proposed effect of breakfast on obesity to show 2 practices that distort scientific evidence', *The American Journal of Clinical Nutrition,* [04 September 2013], available: http://ajcn.nutrition.org/content/early/2013/09/04/ajcn.113.064410.abstract [accessed 08 September 2014].

Brown, T., Summerbell, C. (2009) 'Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence', *International Association for the Study of Obesity. Obesity Review*, 10(1), available:http://www.sport.admin.ch/compi/dateien/dokumentation/Brown08ReviewSchoolBasedInterventions.pdf [accessed 15 March 2014].

Budd, G.M., Volpe, S.L. (2006) 'School-based obesity prevention: research, challenges, and recommendations', *Journal of School Health*, 76(10), available:

http://extranet.nuorisuomi.fi/download/attachments/3245041/School-Based+Obesity+Prevention.+Research,+Challenges,+and+recommendations.pdf [accessed 14 March 2014].

Burke, L.E., Styn, M.A., Sereika, S.M., Conroy, M.B., Ye, L., Glanz, K.,Sevick, A.N., Ewing, L.J. (2012) 'Using mHealth Technology to Enhance Self-Monitoring for Weight Loss', *American Journal of Preventive Medicine,* 43(1), available: Science Direct database [accessed 24 September 2014].

Burns, C. (2013) 'ActiGraph Accelerometers', *Accelerometer training*, 12-August, Cork Institute of Technology, unpublished.

Burrows, T.L., Martin, R.J., Collins, C.E. (2010) 'A Systematic Review of the Validity of Dietary Assessment Methods in Children when compared with the Method of Doubly Labeled Water', *Journal of the American Dietetic Association,* 110(10), available: Science Direct database [accessed 26 September 2014].

Butland, B., Jebb, S., Kopelman, P., McPherson, K., Thomas, S., Mardell, J., Parry, V. (2007) *Tackling obesities: future choices – project report, 2,* London: Foresight Programme of the Government Office for Science, available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287937/07-1184x-tackling-obesities-future-choices-report.pdf [accessed 25 April 2014].

Calle, E.E., Thun, M.J., Petrelli, J.M., Rodriguez, C., M.D., Heath, C.W. (1999) 'Body-mass index and mortality in a prospective cohort of U.S. adults', *The New England Journal of Medicine*, 341(15), available: http://www.nejm.org/doi/full/10.1056/NEJM199910073411501 [accessed 07 August 2014].

Cameron, N., Demerath, E.W. (2002) 'Critical periods in human growth and their relationship to diseases of aging', *American Journal of Physical Anthropology,* 119(35), available: Ebscohost database [accessed 16 August 2014].

Canadian Society for Exercise Physiology (2012) '*Canadian Physical Activity Guidelines, Canadian Sedentary Behaviour Guidelines'*, [online], available:

http://www.csep.ca/CMFiles/Guidelines/CSEP_Guidelines_Handbook.pdf [accessed 01 October 2013].

Carter, M.A., Swimburn, B. (2004) 'Measuring the 'obesogenic' food environment in New Zealand primary schools', *Health Promotion International*, 19(1), available: http://heapro.oxfordjournals.org/content/19/1/15.full.pdf+html [accessed 27 January 2014].

Caspersen, C.J., Powell, K.E., Christensen, G.M. (1985) 'Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research', *Public Health Reports* 100(2), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1424733/pdf/pubhealthrep00100-0016.pdf [accessed 28 January 2014].

Castillo, J.J., Ingham, R.R., Reagan, J.L., Furman, M., Dalia, S., Mitri, J. (2014) 'Obesity Is Associated With Increased Relative Risk of Diffuse Large B-Cell Lymphoma: A Meta-Analysis of Observational Studies', *Clinical Lymphoma Myeloma and Leukemia,* 14(2), available: Science Direct database [accessed 04 September 2014].

Catalano, P.M. (2003) 'Obesity and Pregnancy –The propagation of a viscous cycle?', *Journal of Clinicial Endocrinology and Metabolism*, 88(8), available, http://jcem.endojournals.org/content/88/8/3505.full.pdf+html [accessed 22 August 2013].

Catalano, P.M., Farrell, K., Thomas, A., Huston-Presley, L., Mencin, P., de Mouzon, S.H., Amini, S.B. (2009) 'Perinatal risk factors for childhood obesity and metabolic dysregulation', *American Journal of Clinical Nutrition,* 90(5), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2762159/ [accessed 29 August 2014].

Cawley, J. (2006) 'Markets and Childhood Obesity Policy', *Markets and Childhood Obesity Policy*, 16(1), available: http://files.eric.ed.gov/fulltext/EJ795890.pdf [accessed 21 August 2014].

Cawley, C., Liu, F. (2007) 'Maternal employment and childhood obesity: A search for mechanisms in time use data', *National Bureau of Economic Research,* Working paper

13600, available: file:///C:/Users/R00015773/Downloads/6403368.pdf [accessed 20 August 2014].

Cawley, J., Meyerhoefer, C. (2012) 'The medical care costs of obesity: An instrumental variables approach', *Journal of Health Economics,* 31(1), available: Science Direct database [accessed 25 April 2014].

Clark, P.L. (1955) 'The Heritability of Certain Anthropometric Characters as Ascertained from Measurements of Twins', *The American Journal of Human Genetics* , 8(1), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1716621/pdf/ajhg00404-0054.pdf [accessed 29 August 2014].

Cecchini, M., Sassi, F., Lauer, J.A., Lee, Y.Y., Guajardo-Barron, V., Chisholm, D. (2010) 'Tackling of unhealthy diets, physical inactivity, and obesity: health effects and cost-effectiveness', *The Lancet,* 376(1775), available: http://www.who.int/choice/publications/Obesity_Lancet.pdf [accessed 27 October 2014].

Centers for Disease Control and Prevention (2012) '*Defining overweight and obesity*', [online], available: http://www.cdc.gov/obesity/adult/defining.html [accessed 22 May 2013].

Centers for Disease Control and Prevention (2011a) '*About BMI for children and Teens'*, [online], available: http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html#What is BMI percentile [accessed 22 May 2013].

Centers for Disease Control and Prevention (2011b) '*Physical Activity - Glossary of terms'*, [online], available: http://www.cdc.gov/physicalactivity/everyone/glossary/ [accessed 15 July 2014].

Centers for Disease Control and Prevention (2000a) '*Overweight and obesity: basics about childhood obesity'*, [online], available: http://www.cdc.gov/growthcharts/percentile_data_files.htm [accessed 11 May 2013].

Centers for Disease Control and Prevention (2000b) *'Growth Charts: CDC Clinical Growth Charts'*, [online], available: http://www.cdc.gov/growthcharts/ [accessed 12 June 2013].

Chan, J.M., Rimm, E.B., Colditz, G.A., Stampfer, M.J., Willett, W.C. (1994) 'Obesity, Fat Distribution, and Weight Gain as Risk Factors for Clinical Diabetes in Men', *Diabetes Care,* 17(9), available: http://care.diabetesjournals.org/content/17/9/961 [accessed 24 August 2014].

Chan, R.S.M., Woo, J. (2010) 'Prevention of Overweight and Obesity: How Effective is the Current Public Health Approach', *International Journal of Environmental Research and Public Health,* 7(3), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2872299/ [accessed 12 November 2014].

Chaput, J-P., Leblanc, C., Pérusse, L., Després, J-P., Bouchard, C., Tremblay, A. (2012) 'Risk Factors for Adult Overweight and Obesity in the Quebec Family Study: Have We Been Barking Up the Wrong Tree?', *Obesity,* 17(10), available: http://onlinelibrary.wiley.com/doi/10.1038/oby.2009.116/pdf [accessed 15 September 2014].

Chen, Y., Wang, X., Wang, J., Yan, Z., Luo, J. (2012) 'Excess body weight and the risk of primary liver cancer: An updated meta-analysis of prospective studies', *European Journal of Cancer,* 48(14), available: Science Direct database [accessed 04 September 2014].

Chrostowska, M., Szyndler, A., Hoffmann, M., Narkiewicz, K. (2013) 'Impact of obesity on cardiovascular health', *Best Practice & Research Clinical Endocrinology & Metabolism,* 27(2), available: Science Direct database [accessed 03 September 2014].

Cohn, S.H. (1985) 'How valid are bioelectric impedance measurements in body composition studies?', *American Journal of Clinical Nutrition*, 42(5), available: http://ajcn.nutrition.org/content/42/5/889.full.pdf+html?sid=88a4795a-a21a-4551-9ea3-62ba6420d24d [accessed 09 July 2013].

Colditz, G.A., Willett, W.C., Rotnitzky, A., Manson, J.E. (1995) 'Weight Gain as a Risk Factor for Clinical Diabetes Mellitus in Women', *Annals of Internal Medicine,* 122(7), available: http://annals.org/article.aspx?articleid=708530 [accessed 24 August 2014].

Cole, T.J., Freeman, J.V., Preece, M.A. (1995) 'Body Mass Index Reference Curves for the UK, 1990', *Archives of Disease in Childhood*; 73(1), available:

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1511150/pdf/archdisch00623-0033.pdf [accessed 30 May 2013].

Cole, T.J., Bellizzi, M.C., Flegal, K.M., Dietz, W.H. (2000) 'Establishing a standard definition for child overweight and obesity worldwide: international survey'. *British Medical Journal*, 320, [06 May 2000], available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC27365/pdf/1240.pdf [accessed 27 August 2013].

Collison, K.S., Zaidi, M.Z., Subhani, S.N., Al-Rubeann, K., Shoukri, M., Al-Mohanna, F.A. (2010) 'Sugar-sweetened carbonated beverage consumption correlates with BMI, waist circumference, and poor dietary choices in school children', *BioMed Central Public Health*, 10 [09 May 2010], available: http://www.biomedcentral.com/content/pdf/1471-2458-10-234.pdf [accessed 25 April 2014].

Cormack, D. (2000) *The Research Process in Nursing,* 4th ed., Oxford: Blackwell Science.

Costigan, S.A., Barnett, L., Plotnikoff, R.C., Lubans, D.R. (2013) 'The Health Indicators Associated With Screen-Based Sedentary Behaviour Among Adolescent Girls: A Systematic Review', *Journal of Adolescent Health*, 52(4), available: http://ac.els-cdn.com/S1054139X12003242/1-s2.0-S1054139X12003242-main.pdf?_tid=7bf6dee4-0f12-11e3-b193-00000aab0f6c&acdnat=1377605963_2fc976195cadba1e58b5274284a1e066 [accessed 27 August 2013].

Craigie, A.M, Lake, A.A., Kelly, S.A., Adamson, A.J., Mathers, J.C. (2011) 'Tracking of obesity-related behaviours from childhood to adulthood: a systematic review', *Maturitas,* 70(3), available: http://dro.dur.ac.uk/10160/1/10160.pdf [accessed 26 August 2014].

Crawford, D., Cleland, V., Timperio, A., Salmon, J., Andrianopoulos, N., Roberts, R., Giles-Corti, B., Baur, L., Ball, K. (2010) 'The longitudinal influence of home and neighbourhood environments on children's body mass index and physical activity over 5 years: the CLAN study', *International Journal of Obesity,* 34(7) [July 2010], available: http://www.nature.com/ijo/journal/v34/n7/full/ijo201057a.html [accessed 18 September 2014].

Crespi, C.M., Alfonso, V.H., Whaley, S.E., Wang, M.C. (2012) 'Validity of child anthropometric measurements in the Special Supplemental Nutrition Programme for Women, Infants, and Children', *Pediatric Research,* 71(3), available: http://www.nature.com/pr/journal/v71/n3/full/pr201137a.html [accessed 06 October 2014].

Crouter, S.E., Albright, C., Bassett, D.R. (2004) 'Accuracy of Polar S410 Heart Rate Monitor to Estimate Energy Cost of Exercise', *Journal of Medicine and Science in Sport and Exercise,* 36(8), available: Science Direct database [accessed 23 September 2014].

Cyarto, E., Myers, A., Tudor-Locke, C. (2004) 'Pedometer Accuracy in Nursing Home and Community-Dwelling Older Adults', *Medicine and Science in Sport and Exercise,* 36(2), available: http://journals.lww.com/acsm-msse/pages/articleviewer.aspx?year=2004&issue=02000&article=00006&type=abstract [accessed 23 September 2014].

Darragh, A.J., Moughan, P.J. (1998) 'The amino acid composition of human milk corrected for amino acid digestibility', *British Journal of Nutrition*, 80(1), available: http://journals.cambridge.org/download.php?file=%2FBJN%2FBJN80_01%2FS0007114598001731a.pdf&code=8ab438176919d6b35695a37a3d8fa71f [accessed 26 August 2013].

Davies, P.S.W., Cole, T.J. (1995) 'Body Composition Techniques in Health & Disease', *Society of the Study of Human Biology,* Symposium 36, available: Ebscohost database [accessed 19 September 2013].

Davey Smith, G., Steer, C., Leary, S., Ness, A. (2007), 'Is there an intrauterine influence on obesity? Evidence from parent-child associations in the Avon Longitudinal Study of Parents and Children (ALSPAC)' *Archives of Disease and Childhood*, 92(10), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2083247/pdf/876.pdf [accessed 22 August 2013].

Davison, K.K., Birch, L.L. (2001) 'Childhood overweight: a contextual model and recommendations for future research', *Obesity Reviews*, 2(3), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2530932/ [accessed 23 August 2013].

De Bourdeaudhuij, I., Van Cauwenberghe, E., Spittaels, H., Oppert, J.M., Rostami, C., Brug, J., Van Lenthe, F., Lobstein, T., Maes, L. (2011) 'School-based interventions promoting both physical activity and healthy eating in Europe: A systematic review within the HOPE project', *Obesity Reviews*, 12(3), available: Science Direct database [accessed 18 March 2013].

Decelis, A., Jago, R., Fox, K.R. (2014) 'Physical activity, screen time and obesity status in a nationally representative sample of Maltese youth with international comparisons', *BioMed Central Public Health,* 14(664), available: Ebscohost database [accessed 12 January 2015].

Dehghan, M., Akhtar-Danesh, N., Merchant, A.T. (2005) 'Childhood obesity, prevalence and prevention', *Nutrition Journal,* 4(24), available: http://www.nutritionj.com/content/4/1/24 [accessed 12 November 2014].

Demerath, E.W., Choh, A.C., Czerwinski, S.A., Lee, Sun, S.S., Cameron Chumlea, W.M., Duren, D., Sherwood, R.J., Blangero, J., Towne, B., Siervogel, R.M. (2007) 'Genetic and Environmental Influences on Infant Weight and Weight Change: The Fels Longitudinal Study', *American Journal of Human Biology*, 19(5), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2801417/ [accessed 09 August 2014].

de Onis, M., Blössner, M., Borghi, E. (2010) 'Global prevalence and trends of overweight and obesity among preschool children', *American Journal of Clinical Nutrition,* 92(5), available: http://ajcn.nutrition.org/content/92/5/1257.full.pdf [accessed 03 July 2013].

de Onis, M., Blössner, M. (1997) 'WHO Global Database on Child Growth and Malnutrition', Programme of Nutrition, World Health Organisation, Geneva, available: http://whqlibdoc.who.int/hq/1997/WHO_NUT_97.4.pdf [accessed 08 August 2014].

de Onis, M., Onyango, A.W., Borghi, E., Siyam, A., Nishida, C., Siekmann, J. (2007) 'Development of a WHO growth reference for school-aged children and adolescents', *Bulletin of the World Health Organisation,* 85(9), available: http://www.scielosp.org/scielo.php?pid=S0042-96862007000900010&script=sci_arttext [accessed 27 October 2014].

Department of Children and Youth Affairs (2013) National Strategy for Research and Data on Children's Lives 2011 — 2016 IMPLEMENTATION REPORT: Action Plan Update 2012, Dublin 4: Department of Children and Youth Affairs.

Department of Health (2014) '*Australia's Physical Activity and Sedentary Behaviour Guidelines', Make your move – Sit less – Be active for life! Australia's Physical Activity and Sedentary Behaviour Guidelines for children (5-12 years)*', [online], available: http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines#apa512 [accessed 02 July 2014].

Department of Health (2009) '*The National Guidelines on Physical Activity for Ireland*', Get Ireland Active, Promoting Physical Activity in Ireland, [online], available: http://www.dohc.ie/publications/pdf/active_guidelines.pdf [accessed 17 May 2013].

Department of Health and Children (2008) '*Survey of Lifestyle, Attitudes and Nutrition in Ireland (SLAN)',* Dublin 2: The Stationary Office, Dublin, available: http://www.dohc.ie/publications/slan07_report.html [accessed 02 July 2013].

Department of Health and Children (2004) '*Ready, Steady, Play! A National Play Policy*', Dublin: The Stationary Office, available: http://www.dcya.gov.ie/viewdoc.asp?fn=/documents/Publications/NCOPlayPolicy_eng.pdf [accessed 30 September 20013].

De Schutter, A., Lavie, C.J., Milani, R.V. (2014) 'The Impact of Obesity on Risk Factors and Prevalence and Prognosis of Coronary Heart Disease—The Obesity Paradox', *Progress in Cardiovascular Disease,* 56(4), available: Science Direct database [accessed 03 September 2014].

Deurenberg, P., Andreoli, A., Borg, P., Kukkonen-Harjula, K., de Lorenzo, A., van Marken Lichtenbelt, W.D., Testolin, G., Vigano' R., Vollaard' N. (2001) 'The validity of predicted body fat percentage from body mass index and from impedance in samples of five European populations', *European Journal of Clinical Nutrition*, 55(11), available: http://www.nature.com/ejcn/journal/v55/n11/abs/1601254a.html [accessed 14 July 2014].

Deurenberg, P. Yap, M. (1999) 'The assessment of obesity: methods for measuring body fat and global prevalence of obesity', *Best Practice & Research Clinical Endocrinology & Metabolism,* 13(1), available: Science Direct database [accessed 27 June 2013].

de Wit, Luppino, F., Van Straten, A., Penninx, B., Zitman, F., Cuijpers, P. (2010) 'Depression and obesity: A meta-analysis of community-based studies', *Psychiatry Research,* 178(2), available: Science Direct database [accessed 03 September 2014].

Dietz, W., Bellizzi, M. (1999) 'Introduction: the use of body mass index to assess obesity in children', *American Journal of Clinical Nutrition,* 70(1), available: http://ajcn.nutrition.org/content/70/1/123s.full.pdf+html [accessed 01 July 2013].

Doak, C., Adair, L., Bentley, M., Fengying, Z., Popkin, B. (2002) 'The underweight/overweight household: an exploration of household sociodemographic and dietary factors in China', *Public Health Nutrition,* 5(1A), available: http://www.cpc.unc.edu/projects/nutrans/research/bellagio/papers/PHNDualBurden-Doak.pdf [accessed 19 August 2014].

Dobbins, M., Husson, H., DeCorby, K., LaRocca, R.L. (2013) 'School-based physical activity programmes for promoting physical activity and fitness in children and adolescents aged 6 to 18 (Review)', *The Cochrane Library,* Issue 2, available: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD007651.pub2/pdf [accessed 16 October 2014].

Dowda, M., Sallis, J.F., McKenzie, T.L., Rosengard, P., Kohl, H.W. (2005) 'Evaluating the sustainability of SPARK Physcial Education: A case study of translating research into practice', *Research Quarterly for Exercise Sport,* 76(1), available: http://www.sparkpe.org/resultsDowda.pdf [accessed 14 October 2014].

Drewnowski, A., Darmon, N., Briend, A. (2004) 'Replacing Fats and Sweets with Vegetables and Fruits—A Question of Cost', *American Journal of Public Health,* 94(9), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1448493/ [accessed 19 August 2014].

Duffey, K.J., Gordon-Larsen, P., Jacobs Jr, D.R., Williams, O.D., Popkin, B.M. (2007) 'Differential associations of fast food and restaurant food consumption with 3-y change in

body mass index: the Coronary Artery Risk Development in Young Adults Study', *The American Journal of Clinical Nutrition,* 85(1), available: http://ajcn.nutrition.org/content/85/1/201.long [accessed 18 September 2014].

DuRant, R.H., Baranowski, T., Johnson, M., O. Thompson, W. (1994) 'The Relationship among Television Watching, Physical Activity, and Body Composition of Young Children', *Pediatrics,* 94(4), available: http://pediatrics.aappublications.org/content/94/4/449.short [accessed 19 August 2014].

Duren, D.L, Sherwood, R.J., Czerwinski, S.A., Lee, M., Choh, A.C., Siervogel, R.M., Chumlea, W.M. (2008) 'Body Composition Methods: Comparisons and Interpretation', *Obesity Technology,* 2(6), available: Science Direct database [accessed 19 September 2013].

Ebbeling, C.B., Pawlak, D.B., Ludwig, D.S. (2002) 'Childhood Obesity: Public-health crisis, common sense cure', *The Lancet*, 360(9331), available: http://www.allhealth.org/briefingmaterials/LancetObesityRev-393.pdf [accessed 27 August 2013].

Edwardson, C.L., Gorely, T. (2010) 'Parental influences on different types and intensities of physical activity in youth: A systematic review', *Psychology of Sports and Exercise,* 11(6), available: Science Direct database [accessed 18 September 2014].

Eiberg, S., Hasselstrom, H., Grønfeldt, V., Froberg, K., Svensson, J., Andersen, L.B. (2005) 'Maximum oxygen uptake and objectively measured physical activity in Danish children 6-7 years of age: the Copenhagen school child intervention study', *British Journal of Sports Medicine,* 39(10), available: http://bjsm.bmj.com/content/39/10/725.long [accessed 15 September 2014].

Eisenberg, M.E., Neumark-Sztainer, D., Story, M. (2003) 'Associations of Weight-Based Teasing and Emotional Well-being Among Adolescents', *Archives of Pediatrics & Adolescent Medicine*, 157(8), available: http://archpedi.jamanetwork.com/article.aspx?articleid=481394 [accessed 21 August 2014].

Elgar, F.J., Roberts, C., Tudor-Smith, C., Moore, L. (2005) 'Validity of self-reported height and weight and predictors of bias in adolescents', *Journal of Adolescent Health*, 37(5), available: http://www.jahonline.org/article/S1054-139X(04)00433-1/abstract [accessed 03 July 2014].

Ellaway, A., Macintyre, S., Bonnefoy, X. (2005) 'Graffiti, greenery, and obesity in adults: secondary analysis of European cross sectional survey', *British Medical Journal,* 331(7517), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1215553/pdf/bmj33100611.pdf [accessed 21 August 2013].

Eliakim, A., Nemet, D., Balakirski, Y., Epstein, Y. (2007) 'The Effects of Nutritional-Physical Activity School-based Intervention on Fatness and Fitness in Preschool Children', *Journal of Pediatric Endocrinology and Metabolism,* 20(6), available: Science Direct database [accessed 22 August 2014].

Emilio, G.L., José, A.C.M., de Jesús, G.G.C., Antonio, G.L.P., Alberto, P.L.C., Judit, A.F. (2010) 'Estudio epidemiológico de enfermería sobre la prevalencia de sobrepeso, obesidad y su asociación con hypertension arterial en una población de estudiantes en la ciudad de Granada y su provincia', Nutricion Clinica, 30(2), available: http://www.nutricion.org/publicaciones/revista_2010_02/Estudio%20epidemiologico.pdf [accessed 22 August 2014].

Epstein, L.H., Gordy, C.C., Raynor, H.A., Beddome, M., Kilanowski, C.K., Paluch, R. (2012) 'Increasing Fruit and Vegetable Intake and Decreasing Fat and Sugar Intake in Families at Risk for Childhood Obesity', *Obesity Research,* 9(3), available: http://onlinelibrary.wiley.com/doi/10.1038/oby.2001.18/pdf [accessed 24 September 2014].

Erhart, M., Herpertz-Dahlmann B., Wille N., Sawitzky-Rose, B., Hölling, H., Ravens-Sieberer, U. (2012) 'Examining the relationship between attention-deficit/hyperactivity disorder and overweight in children and adolescents', *European Child & Adolescent Psychiatry*, 21(1), available: Science Direct database [accessed 27 August 2013].

Esteller-Moré, E., Castells-Vilella, L., Segarra-Isern, F., Argemí-Renom, J. (2012) 'Childhood Obesity and Sleep-related Breathing Disorders', *Acta Otorrinolaringologica (English Edition),* 63(3), available: Science Direct database [accessed 09 September 2014].

Eston , R.G., Rowlands , A.V., Ingledew, D.K. (1998), 'Validity of heart rate, pedometry, and accelerometry for predicting the energy cost of children's activities', *Journal of Applied Physiology*, 84(1), available: http://jap.physiology.org/content/84/1/362 [accessed 23 September 2014].

European Commission. (2014) *'Research and Innovation: Health: Spotlight',* [online], available: http://ec.europa.eu/research/health/public-health/health-promotion-and-disease-prevention/projects/spotlight_en.html [accessed 14 October 2014].

European Union Physical Activity Guidelines. (2008) '*Recommended Policy Actions in Support of Health-Enhancing Physical Activity'*, [online], available: http://ec.europa.eu/sport/library/documents/c1/eu-physical-activity-guidelines-2008_en.pdf [accessed 25 September 2013].

Evans, D.S., Glacken, M., Goggin, D. (2011) 'Childhood obesity: the extent of the problem among 6-year-old Irish national school children', *Child: Care, Health and Development*, 37(3), available: Ebscohost database [accessed 24 April 2014].

Evenson, K.R., Catellier, D.J, Karminder, G., Ondrak, K.S., McMurray, R.G. (2008) 'Calibration of two objective measures of physical activity for children', *Journal of Sports Sciences,* 26(14).

Fairclough, S.J., Hackett, A.F., Davies, I.G., Gobbi, R., Mackintosh, K.A., Warburton, G.L., Stratton, G., van Sluijs, E.M.F., Boddy, L.M. (2013) 'Promoting healthy weight in primary school children through physical activity and nutrition education: a pragmatic evaluation of the CHANGE! randomised intervention study', *BioMed Central Public Health,* 13:626, available: http://www.biomedcentral.com/1471-2458/13/626 [accessed 12 November 2014].

Faith, M.S., Flint, J., Fairburn, C.G., Goodwin, G.M., Allison, D.B. (2012) 'Gender Differences in the Relationship between Personality Dimensions and Relative Body Weight', *Obesity Research,* 9(10), available: http://onlinelibrary.wiley.com/doi/10.1038/oby.2001.86/pdf [accessed 29 August 2014].

Farooqi, I.S., O'Rahilly, S. (2005) 'New advances in the genetics of early onset obesity', International *Journal of Obesity,* 29(10), available: http://www.nature.com/ijo/journal/v29/n10/full/0803056a.html [accessed 09 August 2014].

Finer, N. (2011) 'Medical consequences of obesity', *Medicine*, 39(1), available: Science Direct database [accessed 22 August 2014].

Flegal, K.M., Graubard, B.I., Williamson, D.F., (2005) 'Excess deaths associated with underweight, overweight, and obesity', *The Journal of the American Medical Association*, 293(15), available: http://jama.jamanetwork.com/article.aspx?articleid=200731 [accessed 07 August 2014].

Flegal, K.M., Kit, B.K., Orpana, H., Graubard, B.I. (2013) 'Association of All-Cause Mortality with Overweight and Obesity Using Standard Body Mass Index Categories A Systematic Review and Meta-analysis', *The Journal of the American Medical Association*, 309(1), available: http://jama.jamanetwork.com/article.aspx?articleid=1555137 [accessed 21 August 2013].

Flegal, K.M., Ogden, C.L. (2011) 'Childhood Obesity: Are We All Speaking the Same Language?', *Advances in Nutrition,* 2(2), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3065752/ [accessed 27 October 2014].

Flodmark, C-E., Marcus, C., Britton, M. (2006) 'Interventions to prevent obesity in children and adolescents: a systematic literature review', *International Journal of Obesity*, 30(4), available: http://www.nature.com/ijo/journal/v30/n4/pdf/0803290a.pdf [accessed 23 June 2014].

Flynn, M.A.T., Mc Neil, D.A., Maloff, B., Mutasingwa, D., Wu, M., Ford, C., Tough, S.C. (2005) 'Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations', *Obesity Reviews,* 7(1), available: http://onlinelibrary.wiley.com/doi/10.1111/j.1467-789X.2006.00242.x/pdf [accessed 09 April 2014].

Finkelstein, E.A., Trogdon, J.G., Cohern, JW., Dietz, W. (2009) 'Annual medical spending attributable to obesity: payer-and service-specific estimates', *Health Affairs*, 28(5), available: http://www.indabahealthandwellness.com/Obesity-Study.pdf [accessed 25 April 2014].

Finucane, M.M., Stevens, G.A., Cowan, M.J., Danaei, G., Lin, J.K., Paciorek, C.J., Singh, G.M., Gutierrez, H.R., et alia (2011) 'National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9·1 million participants', *The Lancet*, 377(9765), available: http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(10)62037-5/abstract [accessed 23 July 2014].

Food Dudes (2011) *Food Dudes Healthy Eating Programme* [online], available: http://www.fooddudes.ie/html/research.html [accessed 30 September 2013].

Food Safety Authority of Ireland, (2011) 'Healthy Eating and Active Living for Adults, Teenagers and Children over 5 Years – A Food Guide for Health Professionals and Catering Services', Department of Health, Health Service Executive, Safe Food, Dubin 1, available: file:///C:/Users/R00015773/Downloads/HEG%20LEAFLET%20FINAL.pdf [accessed 07 August 2014].

Forhan, M., Gill, S.V. (2013) 'Obesity, functional mobility and quality of life', *Best Practice & Research Clinical Endocrinology & Metabolism*, 27(2), available: Science Direct database [accessed 09 September 2014].

Fortier, M.S., Duda, J.L., Guerin, E., Teixeira, P.J. (2012) 'Promoting physical activity: development and testing of self-determination theory-based interventions', *International Journal of Behavioural Nutrition and Physical Activity,* 9(20), available: http://www.ijbnpa.org/content/9/1/20 [accessed 19 September 2014].

Freedman, D.S., Kettel Khan, L., Serdula, M.K., Ogden, C.L., Dietz, W.H. (2012) 'Racial and Ethnic Differences in Secular Trends for Childhood BMI, Weight, and Height', *Obesity,* 14(2), available: http://onlinelibrary.wiley.com/doi/10.1038/oby.2006.39/pdf [accessed 19 August 2014].

Freedson, P., Pober, D., Janz, K.F. (2005) 'Calibration of accelerometer output for children', *Medicine & Sport in Sports & Exercise,* 37(11), available: Ebscohost database [accessed 29 August 2014].

French, S.A., Story, M., Neumark-Sztainer, D., Fulkerson, J.A., Hannan, P. (2001) 'Fast food restaurant use among adolescents: associations with nutrient intake, food choices and behavioural and psychosocial variables', *International Journal of Obesity*, 25(12), available; http://www.nature.com/ijo/journal/v25/n12/full/0801820a.html [accessed 11 July 2014].

Fruhbeck, G. (2000) 'Childhood Obesity: Time for action, not complacency', *British Medical Journal*, 320(7231), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1127123/ [accessed 23 May 2013].

Fry, J., Finley, W. (2005) 'The prevalence and costs of obesity in the EU', *Proceedings of the Nutrition Society*, 64(3), available: http://journals.cambridge.org/download.php?file=%2FPNS%2FPNS64_03%2FS0029665105000431a.pdf&code=ed487654513cefacb1a15cd526574854 [accessed 25 April 2014].

Gibson, C.A., Smith, B.K., DuBose, K.D., Greene, J.L., Bailey, B.W., Williams, S.L., Ryan, J.J., Schmelzle, K.H., Washburn, R.A., Sullivan, D.K., Mayo, M.S., Donnelly, J.E. (2008) 'Physical activity across the curriculum: year one process evaluation results', *International Journal of Behavioural Nutrition and Physical Activity,* 7(5), available: http://www.ijbnpa.org/content/5/1/36 [accessed 23 September 2014].

Gibson, S. (2008) 'Sugar-sweetened soft drinks and obesity: a systematic review of the evidence from observational studies and interventions', *Nutrition Research Reviews* (2008), 21(2), available: http://journals.cambridge.org/download.php?file=%2FNRR%2FNRR21_02%2FS0954422408110976a.pdf&code=99bf02c271ad0e5167d2aaa56a4c8e16 [accessed 25 April 2014].

Gilliland, F.D., Berhane, K., Islam, T., McConnell, R., Gauderman, J.W., Gilliland, S.S., Avol, E., Peters, J.M. (2003) 'Obesity and the Risk of Newly Diagnosed Asthma in School-age Children', *American Journal of Epidemiology,* 158(5), available: http://coep.pharmacy.arizona.edu/HOPE/maureen/Obesity%20and%20the%20Risk%20of%20Newly%20Diagnosed%20Asthma%20in%20School-age%20Children.pdf [accessed 22 August 2014].

González-Gross, M., Meléndez, A. (2013) 'Sedentarism, active lifestyle and sport: impact on health and obesity prevention', *Nutricion Hospitalaria*, 28(5), available: Ebscohost database [accessed 25 August 2014].

Gonzalez-Suarez, C., Worley, A., Grimmer-Somers, K., Dones, V. (2009) 'School Based Interventions on Childhood Obesity A Meta-Analysis', *American Journal of Preventive Medicine*, 37(5), available: http://www.ajpmonline.org/article/S0749-3797(09)00525-X/abstract [accessed 27 August 2013].

Goodpaster, B.H,. Stenger, V.A., Boada, McKolanis, T., Davis, D., Ross, R., Kelley, D.E. (2004) 'Skeletal muscle lipid concentration quantified by magnetic resonance imaging', American *Journal of Clinical Nutrition*, 79(7), available: http://ajcn.nutrition.org/content/79/5/748.full.pdf [accessed 14 July 2014].

Goran, M.I., Hunter, G., Nagy, T.R., Johnson, R. (1997) 'Physical activity related energy expenditure and fat mass in young children', *International Journal of Obesity and Related Metabolic Disorders* : Journal of the International Association for the Study of Obesity, 21(3), available: Ebscohost database [accessed 29 August 2014].

Gordon-Larsen, P., Harris, K.M., Ward, D.S., Popkin, B.M. (2003) 'Acculturation and overweight-related behaviors among Hispanic immigrants to the US: the National Longitudinal Study of Adolescent Health', *Social Science & Medicine,* 57(11), available: http://www.cpc.unc.edu/projects/nutrans/publications/PennyAcculturation-SSM.pdf [accessed21 August 2014].

Gordon-Larsen, P., McMurry, R.G., Popkin, B.M. (2000) 'Determinants of Adolescent Physical Activity and Inactivity Patterns', *Pediatrics,* 105(6), available: http://pediatrics.aappublications.org/content/105/6/e83.short [accessed 19 August 2014].

Gortmaker, S.L., Swinburn, B., Levy, D., Carter, R., Mabry, P.L., Finegood, D., Huang, T., Marsh, T., Moodie, M. (2011) 'Changing the future of obesity: science, policy, and action', *The Lancet*, 378(9793), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3417037/pdf/nihms321570.pdf [accessed 27 August 2013].

Graham, D., Appleton, S., Rush, E., McLennan, S., Reed, P., Simmons, D. (2008) 'Increasing activity and improving nutrition through a schools based programme: Project Energize. 1. Design, programme, randomisation and evaluation methodology', *Public Health Nutrition,* 11(10), available: http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=2185316&fileId=S136898000700153X [accessed 12 February 2013].

Gray, D.S., Bray, G.A., Bauer, M., Kaplan, K., Gemayel, N., Wood, R., Greenway, F., Kirk, S. (1990) 'Skinfold thickness measurements in obese subjects', *The American Journal of Clinical Nutrition*, 51(4), available: http://ajcn.nutrition.org/content/51/4/571.short [accessed 03 September 2013].

Greenwood, J.L.J., Stanford, J.B. (2008) 'Preventing or Improving Obesity by Addressing Specific Eating Patterns', *Journal of the American Board of Family Medicine,* 21(2), available: http://www.jabfm.org/content/21/2/135.long#ref-18 [accessed 18 September 2014].

Greve, J. (2011) 'New results on the effect of maternal work hours on children's overweight status: Does the quality of child care matter?', *Labour Economics,* 18(5), available: Science Direct database [accessed 20 August 2014].

Griffiths, L.J., Dezateux, C., Cole, T.J. (2007) 'Differential parental weight and height contributions to offspring birthweight and weight gain in infancy', *International Journal of Epidemiology*, 36(1), available: http://ije.oxfordjournals.org/content/36/1/104.long [accessed 09 August 2014].

Griffiths, L.J., Dezateux, C., Hill, A. (2011) 'Is obesity associated with emotional and behavioural problems in children? Findings from the Millennium Cohort Study', *International Journal of Pediatric Obesity*, 6(2-2): e423-432, available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3465802/pdf/ijpo0006-e423.pdf [accessed 09 July 2014].

Guh, D.P., Zhang, W., Bansback, N., Amarsi, Z., Birmingham, C.L., Anis, A.H. (2009) 'The incidence of co-morbidities related to obesity and overweight: A systematic review and meta-analysis', *BioMed Central Public Health,* 9(88), available: Ebscohost database [accessed 11 September 2014].

Gupta, N., Balasekaran, G., Victor, Visvasuresh Govindaswamy., Hwa Yong, Chia., Meng Shun, Lim. (2010) 'Comparison of body composition with bioelectric impedance (BIA) and dual energy X-ray absorptiometry (DEXA) among Singapore Chinese', *Journal of Science and Medicine in Sport*, 14(1), available: Science Direct database [accessed 27 June 2013].

Gunnell, D.J., Frankel, S.J., Nanchahal, K., Peters, T.J., Smith, G.D. (1998) 'Childhood obesity and adult cardiovascular mortality', *The American Journal of Clinical Nutrition*, 67(6), available: http://ajcn.nutrition.org/content/67/6/1111.full.pdf+html?sid=cdd7d826-0907-4c84-b57c-e86cc75a9d63 [16 January 2013].

Hanggi, J.M, Phillips, L.R, Rowlands, A.V. (2013) 'Validation of the GT3X ActiGraph in children and comparison with the GT1M ActiGraph', *Journal of Science and Medicine in Sport,* 16(1), available: Science Direct database [accessed 18 August 2014].

Hamlin, M.J., Fraser, M., Lizamore, C.A., Draper, N., Shearman, J.P., Kimber, N.E. (2014) 'Measurement of Cardiorespiratory Fitness in Children from Two Commonly Used Field Tests After Accounting for Body Fatness and Maturity', *Journal of Human Kinetics*, [09 April 2014], available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4096080/ [accessed 16 August 2014].

Halfron, N., Larson, K., Slusser, W. (2013) 'Associations Between Obesity and Comorbid Mental, Developmental, and Physical Health Conditions in a Nationally Representative sample of US children aged 10 to 17', *Academic Pediatrics,* 13(1), available: Science Direct database [accessed 04 July 2013].

Hands, B.P., Chivers, P.T., Parker, H.E., Beilin, L., Kendall, G., Larkin, D. (2011) 'The associations between physical activity, screen time and weight from 6 to 14 yrs: The Raine Study', *Journal of Sport and Medicine in Sport,* 14(5), available: Science Direct database [accessed 11 September 2014].

Hanley, A.J., Harris, S.B., Gittelsohn, J., Wolever T.M.S., Saksvig, B., Zinman, B. (2000) 'Overweight among children and adolescents in a Native Canadian community: prevalence and associated factors', *American Journal of Clinical Nutrition*, 71(3), available: http://ajcn.nutrition.org/content/71/3/693.full.pdf [accessed 23 August 2013].

Harding, S., Teyhan, A., Maynard, M.J., Cruickshank, J.K. (2008) 'Ethnic differences in overweight and obesity in early adolescence in the MRC DASH study: the role of adolescent and parental lifestyle', *International Journal of Epidemiology*, 37(1), available: http://ije.oxfordjournals.org/content/37/1/162.long [accessed 08 August 2014].

Harrington, D.W., Elliot, S.J. (2007) 'Weighing the importance of neighbourhood: A multilevel exploration of the determinants of overweight and obesity', *Social Science and Medicine*, 68(4), available: Science Direct database [accessed 21 August 2013].

Harris, K.C., Kuramoto, L.K., Schulzer, M., Retallack, J.E. (2009) 'Effect of school-based physical activity interventions on body mass index in children: a meta-analysis', *Canadian Medical Association Journal,* 180 (7), available: http://www.cmaj.ca/content/180/7/719.full [accessed 26 February 2013].

Harvard School of Public Health (2014) *Obesity Prevention Source* [online], available: http://www.hsph.harvard.edu/obesity-prevention-source/ [accessed 18 November 2014].

He., K., Hu, F.B., Colditz, G.A., Manson, J.E., Willett, W.C., Liu, S. (2004) 'Changes in intake of fruits and vegetables in relation to risk of obesity and weight gain among middle-aged women', *International Journal of Obesity,* 28, [5 October 2004], available: http://www.nature.com/ijo/journal/v28/n12/full/0802795a.html [accessed 17 September 2014].

He, Q-q, Wong, T-W., Duc, L., Jiang, Z-Q., Ignatius, T-S., Qiub, H., Gao, Y., Liu, W-J., Wu, J-G. (2011) 'Physical activity, cardiorespiratory fitness, and obesity among Chinese children', *Preventive Medicine,* 52(2), available: Science Direct database [accessed 11 September 2014].

Health Service Executive (2008) '*Framework for Action on Obesity*', Dublin, available: http://www.getirelandactive.ie/content/wp-content/uploads/2011/12/HSE-Framework-for-Action-on-Obesity.pdf [accessed 02 September 2013].

Health Service Executive (2013a) *Health Service Links* [online], available: http://www.hse.ie/eng/Links/Links_by_Topic/ [accessed 18 November 2014].

Health Service Executive (2013b) *National Guidelines on Physical Activity for Ireland – 'Get Ireland Active'* [online], available: http://www.hse.ie/eng/services/news/media/pressrel/newsarchive/200920082007Archive/June_2009/Get%20Ireland%20Active.html [accessed 18 November 2014].

Health Service Executive (2013c) *Say hi to Healthy Ireland* [online], available: http://www.hse.ie/eng/health/hl/hi/ [accessed 18 November 2014].

Healy, G.N., Wijndaele, K., Dunstan, D.W., Shaw, J.E., Salmon, J., Zimmet, J.Z., Owen, N. (2008) 'Objectively measured sedentary time, physical activity, and metabolic risk', *Diabetes Care*, 31(2), available: http://care.diabetesjournals.org/content/31/2/369.full.pdf+html [accessed 08 January 2014].

Hediger, M.L., Overpeck, M.D., Kuczmarski, R.J., Ruan, W.J. (2001) 'Association Between Infant Breastfeeding and Overweight in Young Children', *American Medical Association*, 285(19), available: http://www.breastfeedingor.org/wp-content/uploads/2012/10/jama-article-rosin-cited.pdf [accessed 20 August 2014].

Heinen, M.M., Murrin, C., Daly, L., O'Brien, J., Heavey, P., Kilroe, J., O'Brien, M., Scully, H., Mulhern, LM., Lynam, A., Hayes, C., O'Dwyer, U., Eldin, N., Kelleher, CC. (2014) *The Childhood Obesity Surveillance Initiative (COSI) in the Republic of Ireland: Findings from 2008, 2010 and 2012*. Dublin: Health Service Executive, available: http://www.hse.ie/eng/services/publications/topics/cosi2012.pdf [accessed 24 April 2014].

Heinig, M.J., Nommsen, L.A., Peerson, J.M., Lonnerdal, B., Dewey, K.G. (1993) 'Energy and protein intakes for breast-fed and formula-fed infants during the first year of life and their association with growth velocity: the DARLING study', *The American Journal of Clinical Nutrition*, 58(2), available: http://ajcn.nutrition.org/content/58/2/152.full.pdf+html [accessed 26 August 2013].

Heitzler, C.D., Martin, S.L., Duke, J., Huhman, M. (2006) 'Correlates of physical activity in a national sample of children aged 9–13 years', *Preventive Medicine,* 42(4), available: Science Direct database [accessed 18 September 2014].

Herman, K.M., Sabiston, C.M., Mathieu, M.E., Tremblay, A., Paradis, G. (2014) 'Sedentary behavior in a cohort of 8- to 10-year-old children at elevated risk of obesity', *Preventive Medicine,* 60(1), available: Science Direct database [accessed 11 September 2014].

Heymsfield. S.B. (2008) 'Development of imaging methods to assess adiposity and metabolism', *International Journal of Obesity*, 32(Suppl. 7), available: http://www.nature.com/ijo/journal/v32/n7s/pdf/ijo2008242a.pdf [accessed 03 September 2013].

Higgins, J.A., LaSalle, A.L., Zhaoxing, P., Kasten, M.Y., Bing, K.N., Ridzon, S.E., Witten, T.L. (2009) 'Validation of photographic food records in children: are pictures really worth a thousand words?', *European Journal of Clinical Nutrition,* 63(8), available: http://www.nature.com/ejcn/journal/v63/n8/full/ejcn200912a.html [accessed 26 September 2014].

Hill, J.O., Wyatt, H.R., Reed, G.W., Peters, J.C. (2003) 'Obesity and the environment: where do we go from here?', *Science*, 299(5608), available: http://www.ncbi.nlm.nih.gov/pubmed/12574618 [accessed 09 April 2014].

Hill, J.O., Peters, J.C. (1998) 'Environmental contributions to the obesity epidemic', *Science*, 280(1371), available: http://www.researchgate.net/publication/13679937_Environmental_contributions_to_the_obesity_epidemic [accessed 11 July 2014].

Hillier-Brown, F.C., Bambra, C.L., Cairns, J.M., Kasim, A., Moore, H.J., Summerbell, C.D. (2014) 'A systematic review of the effectiveness of individual, community and societal-level interventions at reducing socio-economic inequalities in obesity among adults', *International Journal of Obesity,* [12 May 2014], available: http://www.nature.com/ijo/journal/vaop/ncurrent/full/ijo201475a.html [accessed 19 November 2014].

Hislop, J.F., Bulley, C., Mercer, T.H. (2012) 'Comparison of Accelerometry Cut Points for Physical Activity and Sedentary Behavior in Preschool Children: A Validation Study', Pediatric Exercise Science, 24, 563-576, available: http://eresearch.qmu.ac.uk/3031/1/3031.pdf [accessed 21 July 2014].

Horikawa, C., Kodama, S., Yachi, Y., Heianza, Y., Hirasawa, R., Ibe, Y., Saito, K., Shimano, H., Yamada, N., Sone, H. (2011) 'Skipping breakfast and prevalence of overweight and obesity in Asian and Pacific regions: A meta-analysis', *Preventive Medicine,* 53(4-5), available: Science Direct database [accessed 03 September 2014].

Horne, P.J., Tapper, K., Lowe, C.F., Hardman, C.A., Jackson, M.C., Woolner, J. (2004) 'Increasing children's fruit and vegetable consumption: a peer-modelling and rewards-based intervention', *European Journal of Clinical Nutrition,* 58(12), available: http://www.nature.com/ejcn/journal/v58/n12/full/1602024a.html [accessed 24 September 2014].

Horne, P.J., Hardman C.A., Lowe, C.F., Tapper, K., Le Noury, J., Madden, P., Patel, P., Doody, M. (2009) 'Increasing parental provision and children's consumption of lunchbox fruit and vegetables in Ireland: the Food Dudes intervention', *European Journal of Clinical Nutrition,* 63(5), available: http://www.nature.com/ejcn/journal/v63/n5/full/ejcn200834a.html [accessed 24 September 2014].

Hou, X., Liu, Y., Lu, H., Ma, X., Hu, C., Bao, Y., Jia, W. (2013) 'Ten-year changes in the prevalence of overweight, obesity and central obesity among the Chinese adults in urban Shanghai, 1998--2007 ¿ comparison of two cross-sectional surveys', *BioMed Central Public Health,* 13(1064), available: Ebscohost database [accessed 25 August 2014].

Houtkooper, L.B., Lohman, T.G., Going, S.B., Howell, W.H. (1996) 'Why bioelectrical impedance analysis should be used for estimating adiposity', *The American Journal of Clinical Nutrition*, 64(3), available: http://ajcn.nutrition.org/content/64/3/436S.full.pdf+html?sid=88a4795a-a21a-4551-9ea3-62ba6420d24d [accessed 09 July 2013].

Hu, F.B., Li, T.Y., Colditz, G.A., Willett, W.C., Manson, J.E. (2003) 'Television Watching and Other Sedentary Behaviors in Relation to Risk of Obesity and Type 2 Diabetes Mellitus in Women', *The Journal of the American Medical Association,* 289(14), available: http://jama.jamanetwork.com/article.aspx?articleid=196345 [accessed 29 August 2014].

Hu, F.B., Vasanti, S.M. (2010) 'Sugar-sweetened beverages and risk of obesity and type 2 diabetes: Epidemiologic evidence', *National Institute of Health, Physiological Behaviour*,

100(1), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2862460/pdf/nihms182110.pdf [accessed 25 April 2014].

Huang, C., Huang, J., Tian, Y., Yang, X., Gu, D. (2014) 'Sugar sweetened beverages consumption and risk of coronary heart disease: A meta-analysis of prospective studies', *Atherosclerosis*, 234(1), available: Science Direct database [accessed 09 September 2014].

Humpel, N., Neville, O., Leslie, E. (2002) 'Environmental factors associated with adults'participation in physical activity: a review', *American Journal of Preventative Medicine*, 22(3), available: Ebscohost database [accessed 11 July 2014].

Hunter, C.M., Peterson, A.L., Alvarez, L.M., Poston, W.C., Brundige, A.R., Haddock, C.K., Van Brunt, D.L., Foreyt, J.P. (2008) 'Weight Management Using the Internet: A Randomized Controlled Trial', *American Journal of Preventive Medicine,* 34(2), available: Science Direct database [accessed 24 September 2014].

Illner, A.K., Freisling, H., Boeing, H., Huybrechts, I., Crispim, S.P., Slimani, N. (2012) 'Review and evaluation of innovative technologies for measuring diet in nutritional epidemiology', *International Journal of Epidemiology*, 41(4), available: http://ije.oxfordjournals.org/content/41/4/1187.full.pdf+html [accessed 26 September 2014].

International Association for the Study of Obesity (2013a) '*Extended International (IOTF) Body Mass Index Cut-Offs for Thinness, Overweight and Obesity in Children'* [online], available: http://www.iaso.org/resources/aboutobesity/child-obesity/newchildcutoffs/ [accessed 22 May 2013].

International Association for the Study of Obesity (2013b) '*Overweight children around the world'* [online], available: http://www.iaso.org/iotf/obesity/?map=children [accessed 28 June 2013].

International Association for the Study of Obesity (2013c) '*The Global Epidemic'* [online], available: http://www.iaso.org/iotf/obesity/obesitytheglobalepidemic/ [accessed 16 May 2013].

International Association for the Study of Obesity (2012) '*About Obesity*' [online], available: http://www.iaso.org/resources/aboutobesity/ [accessed 22 May 2013].

International Association for the Study of Obesity (2004) '*Obesity Reviews', Reported prevalence of child and adolescent overweight and obesity*' [online], available: http://www.iaso.org/site_media/uploads/Appendix_1.pdf [accessed 02 July 2013].

International Obesity Task Force (2013) '*Extended International (IOTF) Body Mass Index Cut-Offs for Thinness, Overweight and Obesity in Children*' [online], available: http://www.iaso.org/resources/aboutobesity/child-obesity/newchildcutoffs/ [accessed 27 June 2013].

International Obesity Task Force (2010) '*The Global Epidemic*' [online], available: http://www.iaso.org/iotf/obesity/obesitytheglobalepidemic/ [accessed 23 May 2013].

Irish Heart Foundation (2014) '*Health Promotion – Programmes – Schools'* [online], available: http://www.irishheart.ie/iopen24/schools-t-8_197_199.html [accessed 30 September 2014]

Irish Heart Foundation (2011) '*Your Health is your Wealth'* [online], available: http://www.irishheart.ie/media/pub/advocacy/Submission%20to%20public%20health%20policy.pdf [accessed 09 February 2013].

Irish Heart Foundation, Children's Right Alliance, National Youth Council of Ireland (2011) '*Food Advertising Research*' [online], available: http://www.irishheart.ie/iopen24/marketing-unhealthy-foods-children-t-38_263.html [accessed 15 May 2013].

Irish National Teacher's Organisation. (2007) '*Physical Education in the Primary School Proceedings of Consultative Conference on Education'*, Dublin 1: Irish National Teachers' Organization. available: http://www.into.ie/ROI/Publications/PhysEdinthePrimarySchool.pdf [accessed 25 September 2013].

Irish Nurses and Midwives Organisation (2012) 'Continuing Education, Child Health – Childhood obesity: time to wake up to the facts', 20(7), available: http://www.inmo.ie/tempDocs/Child%20Health%20sep12.pdf [accessed 23 April 2014].

Irish Universities Nutrition Alliance. (2011) 'National Adult Nutrition Survey: Food and Nutrient intakes, Physical Measurements, Physical Activity Patterns and Food Choice Motives. IUNA, available: http://www.iuna.net/wp-content/uploads/2010/12/National-Adult-Nutrition-Survey-Summary-Report-March-2011.pdf [accessed 03 July 2014].

Irish Universities Nutrition Alliance. (2006) 'National Children's Food Survey', IUNA, available: http://www.iuna.net/?p=27 [accessed 07 July 2014].

Irish Wheelchair Association (2013) 'Best Start: Inclusive Schools Project', available: http://www.activeschoolflag.ie/files/Best_Start_Schools_Inclusion_Project.pdf [accessed 30 September 2013].

Jackson, L.V., Nandu, T., Cole, TJ. (2007) 'Blood pressure centiles for Great Britain', British Medical Journal, 92, 298-303, available: http://adc.bmj.com/content/92/4/298.full.pdf+html [accessed 27 January 2014].

Jakicic, J.M., Otto, A.D. (2005) 'Physical activity considerations for the treatment and prevention of obesity', The *American Journal of Clinical Nutrition,* 82(1), available: http://ajcn.nutrition.org/content/82/1/226S.full [accessed 26 August 2014].

Janssen, I., Katzmarzky, P.T., Boyce, W.F., Vereecken, C., Mulvhill, C., Roberts, C., Currie, C., Pickett, W. (2005) 'Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns', The International Association for the Study of Obesity, Obesity Reviews 6, available: http://www.nuigalway.ie/hbsc/documents/janssen_et_al_or62_obesity.pdf [accessed 01 October 2013].

Jebb, S.A. (2007) 'Dietary determinants of obesity', *Obesity Reviews,* 8(Suppl 1), available: Ebscohost database [accessed 15 September 2014].

Jimmy, G. (2013) 'Comparing the Validity and Output of the GT1M and GT3X Accelerometer in 5- to 9-Year-Old Children', Measurement in Physical Education and Exercise Science, 17(3), available: Ebscohost database [accessed 18 July 2014].

Jimmy, G., Seiler, R., Mäder, U. (2013) 'Development and validation of GT3X accelerometer cut-off points in 5 to 9 year old children based on indirect calorimetry measurements',

Schweizerische Zeitschrift für Sportmedizin und Sporttraumatologie, 61 (4), 37–43, available: http://www.sgsm.ch/fileadmin/user_upload/Zeitschrift/61-2013-4/04-2013_6_Jimmy.pdf [accessed 21 July 2014].

Jimmy, G., Dössegger, A., Seiler, R., Mader, U. (2012) 'Metabolic Thresholds and Validated Accelerometer Cutoff Points for the ActiGraph GT1M in Young Children Based on Measurements of Locomotion and Play Activities', Measurement in Physical Education and Exercise Science, 16(1), available: Ebscohost database [accessed 18 July 2014].

Johnson, R.K., Apple, L.J., Brands, M., Howard, B.V., Lefevre, M., Lustig, R.H., Sacks, F., Steffen, L.M., Wylie-Rosett, J. (2009) 'Dietary sugars intake and cardiovascular health: a scientific statement from the American Heart Association', 120(11), available:http://www.champspublichealth.com/writedir/ab33Dietary%20Sugars%20Intake%20and%20Cardiovascular%20Health.pdf [accessed 25 April 2014].

Jones, R.A., Lubansb, D.R., Morgan, P.J., Okelya, A.D., Parlettac, N., Wolfendend, L., de Silva-Sanigorskie, A., Gibbse, L., Waterse, E. (2014) 'School-based obesity prevention interventions: Practicalities and considerations', *Obesity Research & Clinical Practice*, 8(5), available: Science Direct database, accessed 07 November 2014.

Juonala, M., Magnussen, C.G., Berenson, G.S., Venn, A., Burns, T.L., Sabin, M.A., D., Srinivasan, S.R., Daniels, S.R., Davis, Chen, W., Sun, C., Cheung, M., D., Viikari, J.S.A., Dwyer, T., Raitakari, O.T. (2011) 'Childhood Adiposity, Adult Adiposity, and Cardiovascular Risk Factors', *The New England Journal of Medicine*, [17 November 2011], available: http://www.nejm.org/doi/full/10.1056/NEJMoa1010112 [accessed 22 August 2014].

Kaiyala, K.J., Morton, G.J., Leroux, B.G., Ogimoto, K., Wisse, B., Schwartz, M.W. (2010) 'Identification of Body Fat Mass as a Major Determinant of Metabolic Rate in Mice', Diabetes, 59(7), available: http://diabetes.diabetesjournals.org/content/59/7/1657.long [accessed 03 September 2013].

Katz, D.L., O'Connell, M., Yeh, M-C., Nawaz, H., Njike, V., Anderson, L.M., Cory, S., Dietz, W. (2005) 'Public Health Strategies for Preventing and Controlling Overweight and Obesity in School and Worksite Settings: A Report on Recommendations of the Task Force on Community Preventive Services', *National Center for Chronic Disease Prevention and Health*

Promotion, 54(RR10), available: http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5410a1.htm [accessed 18 November 2014].

Katz, D.L., O'Connell, M., Njike, V.Y., Yeh, M.C., Nawaz, H. (2008) 'Strategies for the prevention and control of obesity in the school setting: systematic review and meta-analysis', International Journal of Obesity, 32, 1780-1789, available: http://www.nature.com/ijo/journal/v32/n12/pdf/ijo2008158a.pdf [accessed 15 March 2014].

Katzmarzyk, P.T., Barreira, T.V., Broyles, S.T., Champagne, C.M., Chaput, J-P., Fogelholm, M., Hu, G., Johnson, W.D., Kuriyan, R., Kurpad, A., Lambert, E.V., Maher, C.M., Maia, J., Matsudo, V., Olds, T., Onywera, V., Sarmiento, O.L., Standage, M., Tremblay, M.S.,Tudor-Locke, C., Zhao, P., Church, T.S. (2013) 'The International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE): design and methods', *BioMed Central Public Health,* 13(900), available: Ebscohost database [accessed 25 August 2014].

Keane, E., Kearney, P.M., Perry, I.J., Kelleher, C.C., Harrington, J.M. (2014) 'Trends and prevalence of overweight and obesity in primary school aged children in the Republic of Ireland from 2002-2012: a systematic review', *BMC Public Health,* 14(974).

Kearns, K., Dee, A., Fitzgerald, A.P., Doherty, E., Perry, I.J. (2014) 'Chronic disease burden associated with overweight and obesity in Ireland: the effects of a small BMI reduction at population level', *BioMed Central Public Health*, 14(143), available: http://www.biomedcentral.com/1471-2458/14/143 [accessed 14 May 2014].

Keaver, L., Webber, L., Dee, A., Shiely, F., Marsh, T., Balanda, K., Perry, I. (2013) 'Application of the UK Foresight Obesity Model in Ireland: The Health and Economic Consequences of Projected Obesity Trends in Ireland', PLoS ONE 8(11): e79827. doi:10.1371/journal.pone.0079827, available: http://www.plosone.org/article/fetchObject.action?uri=info%3Adoi%2F10.1371%2Fjournal.pone.0079827&representation=PDF [accessed 03 July 2014].

Kelly, C., Gavin, A., Molcho, M. & Nic Gabhainn, S. (2012). The Irish Health Behaviours in School-aged Children (HBSC) study 2010. Dublin: Department of Health, available: http://www.nuigalway.ie/hbsc/2010survey.html [accessed 09 February 2013].

Kelly, D., Goodpaster, B.H. (2001) 'Skeletal Muscle Triglyceride: An aspect of regional adiposity and insulin resistance', Diabetes Care 24:933–941, available: http://care.diabetesjournals.org/content/24/5/933.full.pdf [accessed 14 July 2014].

Kelly, L.A., Reilly, J.R., Paton, J.Y., Grant, S. (2005) 'Low Physical Activity Levels and High Levels of Sedentary Behaviour are Characteristic of Rural Irish Primary School Children', Irish Medical Journal, 98(5), 138-141, available: http://www.imj.ie/ViewArticleDetails.aspx?ArticleID=543 [accessed 14 July 2014].

Kesztyüs, D., Lauer, R., Schreiber, A.C., Kesztyüs, T., Kilian, R., Steinacke, J.M. (2014) 'Parents' willingness to pay for the prevention of childhood overweight and obesity', *Health Economics Review,* 4(20), available: http://www.healtheconomicsreview.com/content/pdf/s13561-014-0020-8.pdf [accessed 01 November 2014].

Khaled, M.A., et alia (1988). 'Electrical impedance in assessing human body composition: the BIA method', The American Journal of Clinical Nutrition, 47(5), available: http://ajcn.nutrition.org/content/47/5/789.full.pdf+html?sid=b07f7525-a5ac-421a-951f-340843ec48a4 [accessed 09 July 2013].

Kim, Y., Beetsa, M.W., Welk, G.J. (2012) 'Everything you wanted to know about selecting the "right" ActiGraph accelerometer cut-points for youth, but…: A systematic review', *Journal of Science and Medicine in Sport,* 15(4), available: Science Direct database [accessed 09 September 2014].

Kim, Y., Lee, J-M., Peters, B.P., Gaesser, G.A., Welk, G.J. (2014) 'Examination of Different Accelerometer Cut-Points for Assessing Sedentary Behaviors in Children', PLoS ONE, 9(4):, available: Ebscohost database[accessed 21 July 2014].

Kimm, S.Y.S., Barton, B.A., Obarzanek, E., McMahon, R.P., Sabry, Z.I., Waclawiw, M.A., Schreiber, G.B., Morrison, J.A., Similo, S., Daniels, S.R. (2001) 'Racial Divergence in Adiposity

during Adolescence: The NHLBI Growth and Health Study', *Pediatrics,* 107(3), available: http://pediatrics.aappublications.org/content/107/3/e34.short [accessed 22 August 2014].

Klesges, R.C., Shelton, M.L., Klesges, L.M. (1993) 'Effects of Television on Metabolic Rate: Potential Implications for Childhood Obesity', *Pediatrics,* 91(2), available: http://pediatrics.aappublications.org/content/91/2/281.short [accessed 19 August 2014].

Klein, S., Burke, L.E., Bray, G.A., Blair, S., Allison, D.B., Pi-Sunyer, X., Hong, Y., Eckel, R.H. (2004) 'Clinical Implications of Obesity with Specific Focus on Cardiovascular Disease', *American Heart Association, [2 November 2004]* available: http://circ.ahajournals.org/content/110/18/2952.long [accessed 24 August 2014].

Kohl, H.W., Fulton, J.E., Caspersen, C.J. (2000) 'Assessment of Physical Activity among Children and Adolescents: A Review and Synthesis', *Preventive Medicine,* 31(2), available: Science Direct database [accessed 23 September 2014].

Koletzko et alia. (2009) 'Lower protein in infant formula is associated with lower weight up to age 2 y: a randomized clinical trial', The American Journal of Clinical Nutrition, 89(6), available: http://ajcn.nutrition.org/content/89/6/1836.full.pdf+html [accessed 26 August 2013].

Koppe, S.W.P. (2014) 'Obesity and the liver: nonalcoholic fatty liver disease', *Translational Research,* [25 June 2014], available: Science Direct database [accessed 11 September 2014].

Kuczmarski, R.J., Flegal, KM. (2000) 'Criteria for definition of overweight transition: background and recommendations for the United States', The American Journal of Clinical Nutrition, 72(5), available: http://ajcn.nutrition.org/content/72/5/1074 [accessed 10 February 2013].

Kuczmarsk,i R.J, Ogden, C.L., Guo, S.S., et alis (2000) '2000 CDC growth charts for the United States: Methods and development', National Center for Health Statistics. Vital and Health Statistics, 11(246), available: http://www.cdc.gov/growthcharts/2000growthchart-us.pdf [accessed 05 August 2014].

Kuczmarski, R.J., Fanelli, M.T., Koch, G.G. (1987) 'Ultrasonic assessment of body composition in obese adults: overcoming the limitations of the skinfold calliper', The American Journal of

Clinical Nutrition, 45(4), available: http://ajcn.nutrition.org/content/45/4/717.short [accessed 03 September 2013].

Kushner, R.F., Foster, G.D. (2000) 'Obesity and quality of life', *Nutrition,* 16(10), available: Science Direct database [accessed 09 September 2014].

Kushner, R.F., Kunigk, A., Alspaugh, M., Andronis, PT., Leitch, C.A., Schoeller, DA. (1990) 'Validation of bioelectrical-impedance analysis as a measurement of change in body composition in obesity', The American Journal of Clinical Nutrition, 52(2), available: http://ajcn.nutrition.org/content/52/2/219.full.pdf+html?sid=88a4795a-a21a-4551-9ea3-62ba6420d24d [accessed 09 July 2013].

L'Abee, C., Henk Visser, G., Liem, E.T., Kok, D.E.G., Sauer, P.J.J., Stolk, R.P. (2009) 'Comparison of methods to assess body fat in non-obese six to seven-year-old children', Clinical Nutrition, 29, available: http://ac.els-cdn.com/S0261561409002374/1-s2.0-S0261561409002374-main.pdf?_tid=f4b6b6da-149c-11e3-8f8e-00000aacb35d&acdnat=1378215192_3741c8f4ca81a9a952c814b6fb1621f6 [accessed 03 September 2013].

Lakerveld, J., Brug, J., Bot, S., Teixeira, P.J., Rutter, H., Woodward, E., Samdal, O., Stockley, L., De Bourdeaudhuij, I., van Assema, P., Robertson, A., Lobstein, T., Oppert, J-M., Ádány, R., Nijpels, G., and on behalf of the SPOTLIGHT consortium (2012) 'Sustainable prevention of obesity through integrated strategies: The SPOTLIGHT project's conceptual framework and design', *BioMed Central Public Health,* 12:793, available: http://www.biomedcentral.com/1471-2458/12/793 [accessed 12 November 2014].

Lane, A., Harrison, M., Murphy, N. (2014) 'Screen Time Increases Risk of Overweight and Obesity in Active and Inactive 9-Year-Old Irish Children: A Cross Sectional Analysis', *Journal of Physical Activity and Health,* 11(5).

Larsson, S.C., Wolk, A. (2007) 'Overweight, obesity and risk of liver cancer: a meta-analysis of cohort studies', *British Journal of Cancer,* 97(7), available: Ebscohost database [accessed 11 September 2014].

Laskarzewski, P., Morrison, JA., Khoury, P., Kelly, K., Glatfelter, L., Larsen, R., Glueck, C. (1980) 'Parent-child nutrient intake interrelationships in school children ages 6 to 19: The Princeton School District Study', American Journal of Clinical Nutrition, 33, available: http://ajcn.nutrition.org/content/33/11/2350.full.pdf [accessed 23 August 2013].

Lawlor, DA., Davey Smith, G., O'Callaghan, M., Alati, R., Mamun, AA., Williams, GM., Najman, JM. (2006) 'Epidemiologic Evidence for the Fetal Overnutrition Hypothesis: Findings from the Mater-University Study of Pregnancy and Its Outcomes', American Journal of Epidemiology, 165(4), available; http://aje.oxfordjournals.org/content/165/4/418.full.pdf+html [accessed 22 August 2013].

Layte, R., McCrory, C. (2011) 'Growing up in Ireland', National Longitudinal Study of Children, Dublin 4: Government Publications, Dublin, available: http://www.growingup.ie/fileadmin/user_upload/documents/Second_Child_Cohort_Reports/Growing_Up_in_Ireland_-_Overweight_and_Obesity_Among_9-Year-Olds.pdf [accessed 02 September 2013].

Leary, J.M., Lillyb, C.L., Dino, G., Loprinzi, P.D., Cottrelle, L. (2013) 'Parental influences on 7–9 year olds' physical activity: A conceptual model', *Preventive Medicine,* 56(5), available: Science Direct database [accessed 18 September 2014].

Lebow, J., Sim, L.A., Kransdorf, L.N. (2014) 'Prevalence of a History of Overweight and Obesity in Adolescents With Restrictive Eating Disorders', *Journal of Adolescent Health,* [18 July 2014], available: Science Direct database [accessed 18 September 2014].

Lee, C.D., Blair, S.N. , Jackson, A.S. (1999) 'Cardiorespiratory fitness, body composition, and all-cause and cardiovascular disease mortality in men', *American Journal of Clinical Nutrition,* 69(3), available: Ebscohost database [accessed 09 September 2014].

Lee, I.-M , Shiroma, E.J., Lobelo, F., Puska, P., Blair, S.N., Katzmarzyk, P.T., Alkandari, J.R., Andersen, L.B., Bauman, A.E., Brownson, R.C., Bull, F.C., Craig, C.L., Ekelund, U., Goenka, S., Guthold, R., Hallal, P.C., Haskell, W.L., Heath, G.W., Inoue, S., Kahlmeier, S., Kohl III, H.W., Lambert, E.V., Leetongin, G., Sarmiento, O.L., Wells, J.C. (2012) 'Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life

expectancy', *The Lancet,* 380(9838), available: Ebscohost database [accessed 09 September 2014].

Lee, S.Y., Gallagher, D. (2008) 'Assessment methods in human body composition', Current Opinion in Clinical Nutrition and Metabolic Care, 11(5), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2741386/?report=reader [accessed 18 September 2013].

Leech, R.M. (2014) 'The clustering of diet, physical activity and sedentary behavior in children and adolescents: a review', *BioMed Central Public Health,* 11(4), available: Ebscohost database [accessed 25 August 2014].

Levitsky, D.A., Youn, T. (2004) 'The More Food Young Adults Are Served, the More They Overeat', *The Journal of Nutrition,* 134(10), available: http://jn.nutrition.org/content/134/10/2546.abstract [accessed 18 September 2014].

Li, L., Law, C., Lo Conte, R., Power, C. (2009) 'Intergenerational influences on childhood body mass index: the effect of parental body mass index trajectories', The American Journal of Clinical Nutrition, 89(2), available: http://ajcn.nutrition.org/content/89/2/551.short [accessed 23 August 2013].

Lin, B-H., Guthrie, J. (1999) 'Quality of Children's Diets At and Away From Home: 1994-96.', *Food Review,* 22(1), available: Ebscohost database [accessed 21 August 2014].

Lindquist, C.H., Reynolds, K.D., Goran, M. (1999) 'Sociocultural Determinants of Physical Activity among Children', *Preventive Medicine,* 29(4), available: Science Direct database [accessed 25 August 2014].

Liou, Y.M., Liou, T.H., Chang, L.C. (2010) 'Obesity among adolescents: sedentary leisure time and sleeping as determinants', *Journal of Advanced Nursing,* 66(6), available: Ebscohost database [accessed 08 August 2014].

Little Steps (2014) *Little Steps…..to eating well and being active* [online], available: https://www.littlesteps.eu/little-steps/about/ [accessed 04 August 2014].

Liu, E., Hsiao, C., Matsumoto, T., Chou, S. (2009) 'Maternal full-time employment and overweight children: Parametric, semi-parametric, and non-parametric assessment', *Journal of Econometrics,* 152(1), available: Science Direct database [accessed 20 August 2014].

Liverpool John Moores University (2013) *CHANGE! (Children's Health, Activity and Nutrition: Get Educated!)* [online], available: http://www.ljmu.ac.uk/paexchange/projects/102611.htm [accessed 12 November 2014].

Livingstone, M.B.E., Robson, P.J., Wallace, J.M.W., McKinley, M.C. (2003) 'How active are we? Levels of routine physical activity in children and adults, *Proceedings of the Nutrition Society,* 62, available: https://www.okkioallasalute.it/docs/review_physical_activity.pdf [accessed 09 September 2014].

Livingstone, M.B.E., Robson, P.J., Wallace, J.M.W. (2004) 'Issues in dietary intake assessment of children and adolescents', *British Journal of Nutrition,* 92(2), available: http://journals.cambridge.org/download.php?file=%2FBJN%2FBJN92_S2%2FS0007114504002326a.pdf&code=7ff160cac0e94d3a13924f0d065b8fde [accessed 26 September 2014].

Lob-Cozilius, T (2007), 'Overweight and obesity in Childhood – A special challenge for public health', International Journal of Hygiene and Environmental Health, 210(5), Science Direct, available: http://www.sciencedirect.com/science/article/pii/S1438463907001198 [accessed 21 August 2013].

Lobstein, T., Baur, L., Uauy, R. (2004) 'Obesity in children and young people: a crisis in public health', *Obesity Reviews*, 5 (Suppl. 1), available: http://onlinelibrary.wiley.com/doi/10.1111/j.1467-789X.2004.00133.x/pdf [accessed 20 August 2013].

Lobstein, T., Frelut, M.L. (2003) 'Prevalence of overweight among children in Europe', Obesity Reviews (2003) **4,** 195-200, available: http://easo.org/docs/report70.pdf [accessed 09 April 2014].

Loprinzi, P.D., Trost, S.G. (2010) 'Parental influences on physical activity behaviour in preschool children', *Preventive Medicine,* 50(3), available: Science Direct database [accessed 18 September 2014].

Loprinzi, P.D., Cardinal, B.J. (2011) Measuring children's physical activity and sedentary behaviours', *Journal of Exercise Science and Fitness,* 9(1), available: Science Direct database [accessed 23 September 2014].

Lowe, C.F., Horne, P.J., Tapper, K., Bowdery, M., Egerton, C. (2004) 'Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children', *European Journal of Clinical Nutrition,* 58(3), available: http://www.nature.com/ejcn/journal/v58/n3/full/1601838a.html [accessed 24 September 2014].

Ludwig, D.S., Peterson, K.E., Gortmaker, S.L. (2001) 'Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis', *The Lancet,* [17 February 2001] available: http://www.commercialalert.org/candp/lancet.pdf [accessed 21 August 2014].

Lukaski, Henry. (1987) 'Methods for the assessment of human body composition: traditional and new', The American Journal of Clinical Nutrition, 46, available: http://naldc.nal.usda.gov/download/47357/PDF [accessed 27 June 2013].

Luppino, F.S., de Wit, L.M., Bouvy, P.F., Stijnen, T., Cuijpers, P., Penninx, B.W.J.H., Zitman, F.G. (2010) 'Overweight, Obesity, and Depression. A Systematic Review and Meta-analysis of Longitudinal Studies', *Archives of General Psychiatry,* 67(3), available: http://archpsyc.jamanetwork.com/article.aspx?articleid=210608 [accessed 03 September 2014].

Lynam, A. (2012) *Tackling Obesity in Ireland,* 17th May 2012, Galway, available: http://www.galway.ie/en/media/Tackling%20Obesity%20in%20Ireland%20-%20A%20Lynam%20HSE.pdf [accessed 19 November 2014]

Ma, S., Frick, K.D. (2011) 'A simulation of affordability and effectiveness of childhood obesity interventions', *Academic Pediatrics,* 11(4), available: http://www.academicpedsjnl.net/article/S1876-2859(11)00113-6/abstract [accessed 27 October 2014].

Ma, Y., Yang, Y., Wang, F., Zhang, P., Shi, C., Zou, Y., Qin, H. (2014) 'Obesity and Risk of Colorectal Cancer: A Systematic Review of Prospective Studies', *PLoS ONE,* 18(1), available: Ebscohost database [accessed 11 September 2014].

Maes, M.M., Neale, M.C., Eaves, LJ. (1997) 'Genetic and Environmental Factors in Relative Body Weight and Human Adiposity', Behaviour Genetics, 27(4), available: http://www.broadinstitute.org/~eliana/Papers/BMI/maes_genetic_enviroumental_factors_adiposity.pdf [accessed 22 August 2013].

Maffeis, C. (2000) 'Aetiology of overweight and obesity in children and adolescents', *European Journal of Pediatrics,* 159(1), available: http://link.springer.com/article/10.1007/PL00014361#page-2 [accessed 27 October 2014].

Mahut, B., Beydon, N., Delclaux, C. (2012) 'Overweight is not a comorbidity factor during childhood asthma: the GrowthOb study', *European Respiratory Journal,* 39(5), available: http://erj.ersjournals.com/content/39/5/1120.long [accessed 22 August 2014].

Malik, A.H., Akram, Y., Shetty, S., Malik, S.S., Njike, V.Y. (2014) 'Impact of Sugar-Sweetened Beverages on Blood Pressure', *The American Journal of Cardiology,* 113(9), available: Science Direct database [accessed 11 September 2014],

Malik, VS., Schulze, MB., Hu FB. (2006) 'Intake of sugar-sweetened beverages and weight gain: a systematic review', American Journal of Clinical Nutrition, 84(2):274-288, available; http://ajcn.nutrition.org/content/84/2/274.full.pdf+html [accessed 25 April 2014].

Maloney, M.J., Mc Guire, J., Daniels, S.R., Specker, B. (1989) 'Dieting behaviour and eating attitudes in children', Pediatrics (84), available: http://pediatrics.aappublications.org/content/84/3/482.full.pdf+html [accessed 19 August 2013].

Mann, T., Tomiyama, A.J.,Westling, E., Lew, A-M., Samuels, B., Chatman, J. (2007) 'Medicare's search for effective obesity treatments: Diets are not the answer', *American Psychologist,* 62(3), available: Ebscohost database [accessed 15 September 2014].

Manson, J.E., Willett, W.C., Stampfer, M.J., Colditz, G.A., Hunter, D.J., Hankinson, S.E., Hennekens, C.H., Speizer, F.E. (1995) 'Body Weight and Mortality Among Women', *The New*

England Journal of Medicine, 333(11), available: http://www.andsonmenezes.com.br/artigos/Body%20weight%20and%20mortality.pdf [accessed 22 August 2014].

Martin, C.K., Newton, R.L., Anton, S.D., Raymond Allen, H., Alfonso, A., Han, H., Stewart, T., Sothern, M., Williamson, D.A. (2007) 'Measurement of children's food intake with digital photography and the effects of second servings upon food intake', *Eating Behaviours, 8(2),* available: Science Direct database [accessed 26 September 2014].

Martins, B.E., Carvalho, M.S. (2006) 'Association between birth weight and overweight in childhood: a systematic review', Bull World Health Organisation, 22 (11), available: Ebscohost database [accessed 22 August 2013].

Mattocks, C., Tilling, K., Ness, A., Riddoch, C. (2008) 'Improvements in the Measurement of Physical Activity in Childhood Obesity Research; Lessons from Large Studies of Accelerometers', Clinical Medical Pediatrics, , 27-36, available: file:///C:/Users/R00015773/Downloads/f_CMPed-2-Mattocks-et-al_1622.pdf [accessed 21 July 2014].

Mattocks, C., Leary, S., Ness, A., Deere, K., Saunders, J., Tillling, K., Kirkby, J., Blair, S.N., Riddoch, C. (2007) 'Calibration of an accelerometer during free-living activities in children', International Journal of Pediatric Obesity, 2, 218-226, available: Ebscohost database [accessed 21 July 2014].

Mazess, R.B., Barden, H.S., Bisek, J.P., Hanson, J. (1990) 'Dual-energy x-ray absorptiometry for toal-body and regional bone-mineral and soft-tissue composition', The American Journal of Clinical Nutrition, 51(6), available: http://ajcn.nutrition.org/content/51/6/1106.full.pdf+html [accessed 19 September 2013].

Metcalf, B., Voss, L., Jeffery, A., Perkins, J., Wilkin, T.J. (2004) 'Physical activity cost of the school run: impact on schoolchildren of being driven to school (EarlyBird 22)', *The British Medical Journal*, 329(7470), available: http://www.bmj.com/content/329/7470/832 [accessed 08 September 2014].

McCarthy, H.D., Cole, T.J., Fry, T., Jebb, S.A., Prentice, A.M. (2006) 'Body fat reference curves for children', International Journal of Obesity, 30, 598-602, available: http://www.tanita.co.in/uploads/media/Body_Fat_Reference_Curves_for_Children.pdf [accessed 27 January 2014].

McCrindle, B.W. (2014) 'Cardiovascular Consequences of Childhood Obesity', *Canadian Journal of Cardiology,* [23 August 2014] available: Science Direct database [accessed 03 September 2014].

McCrory, C., Layte, R. (2012) 'Breastfeeding and risk of overweight and obesity at nine years of age', Social Science and Medicine, 75, Science Direct, available: http://www.sciencedirect.com/science/article/pii/S0277953612002353# [accessed 23 August 2013].

McLaren, L. (2007) 'Socioeconomic Status and Obesity', Epidemiologic Reviews, 29(1), available: http://epirev.oxfordjournals.org/content/29/1/29.full.pdf+html [accessed 28 August 2013].

McMurray, R.G., Harrell, J.S., Deng, S., Bradley, C.B., Cox, L.M., Bangdiwala, S.I. (2012) 'The influence of physical activity, socio economic status, and ethnicity on the weight status of adolescents', Obesity Research, 8(2), available: http://onlinelibrary.wiley.com/doi/10.1038/oby.2000.14/pdf [accessed 23 August 2013].

McPherson, R.S., Hoelscher, D.M., Alexander, M., Scanlon, K.S., Serdula, M.K. (2000) 'Dietary Assessment Methods among School-Aged Children: Validity and Reliability', *Preventive Medicine,* 31(2), available: Science Direct database [accessed 29 September 2014].

Miller, C.N., Kauffman, T.G., Cooney, P.T., Ramseur, K.R., Brown, L.M. (2010) 'Comparison of DEXA and QMR for assessing fat and lean body mass in adult rats', Physiology and Behaviour, 103 (1), available: Science Direct database [accessed 03 September 2013].

Min, J., Chiu, D.T., Wang, Y. (2013) 'Variation in the heritability of body mass index based on diverse twin studies: a systematic review', *Obesity Reviews,* 14(11), available: Ebscohost database [accessed 29 August 2014].

Ministry of Education (2007) '*Physical Activity for Healthy Confident Kids'*, Wellington, New Zealand, available: file:///C:/Users/R00015773/Downloads/Physical+activity+for+healthy+confident+kids-guidelines%20(2).pdf [accessed 01 October 2013].

Misra, M. (2008) 'Long-Term Skeletal Effects of Eating Disorders with Onset in Adolescence', *Annals of the New York Academy of Sciences,* 1135, available: Ebscohost database [accessed 18 September 2014].

Mitchell, G.L., Farrow, C., Haycraft, E., Meyer, C. (2013) 'Parental influences on children's eating behaviour and characteristics of successful parent-focussed interventions', *Appetite,* 60(1), available: Science Direct database [accessed 29 August 2014].

Motl, R.W, McAuley, E., Snook, E.M., Scott, J.A. (2005) 'Accuracy of two electronic pedometers for measuring steps taken under controlled conditions among ambulatory individuals with multiple sclerosis', *Mult Scler,* 11(3), available: Ebscohost database [accessed 23 September 2014].

Muller, M.J., Koetzinger, I., Mast, M., Langnase, K., Grund, A. (2000) 'Physical activity and diet in 5 to 7 years old children', Public Health Nutrition, 3(1), available: http://www.ncbi.nlm.nih.gov/pubmed/10610085 [accessed 23 August 2013].

Mulvihill, C., Quigley, R. (2003) '*The management of obesity and overweight: An analysis of reviews of diet, physical activity and behavioural approaches'*. Evidence briefing. 1st edition. NHS Health Development Agency, available: http://prevenzione.ulss20.verona.it/com/file/upload/71obesity_evidence_briefing%5B1%5D.pdf [accessed 29 September 2014].

Mumford, S.L., Siega-Riz, A.M., Herring, A., Evenson, K.R. (2008) 'Dietary Restraint and Gestational Weight Gain', *Journal of the American Dietetic Association,* 108(10), available: Science Direct database [accessed 15 September 2014].

Murrin, C.M., Kelly, G.E., Tremblay, R.E., Kelleher, C.C. (2012) 'Body Mass Index and Height over three generations: evidence from the Lifeways cross-generational cohort study',

BioMed Central Public Health, 12:81, available: http://www.biomedcentral.com/1471-2458/12/81 [accessed 22 August 2013].

Must, A., Barish, E.E., Bandini, L.G. (2009) 'Modifiable risk factors in relation to changes in BMI and fatness: what have we learned from prospective studies of school-aged children?', *International Journal of Obesity,* 33(7), available: http://www.nature.com/ijo/journal/v33/n7/full/ijo200960a.html [accessed 18 August 2014].

Must, A., Spadano, J., Coakley, E.H., Field, A.E., Colditz, G., Dietz, W.H. (1999) 'The Disease Burden Associated with Overweight and Obesity', *The Journal of the American Medical Association,* 282(16), available: http://jama.jamanetwork.com/article.aspx?articleid=192030 [accessed 24 August 2014].

Must, A., Tybor, D.J. (2005) 'Physical activity and sedentary behaviour: a review of longitudinal studies of weight and adiposity in youth', International Journal of Obesity, 29, available: http://www.nature.com/ijo/journal/v29/n2s/pdf/0803064a.pdf [accessed 27 August 2013].

Nadeau, K., Kolotkin, R.L., Boex, R., Witten, T., McFann, K.K., Zeitler, P., Walders-Abramson, N. (2011) 'Health-Related Quality of Life in Adolescents with Comorbidities Related to Obesity', *Journal of Adolescent Health,* 49(1), available: Science Direct database [accessed 11 September 2014].

National Council for Curriculum and Assessment. (2013) '*Physical Education'*, available: http://www.curriculumonline.ie/en/Primary_School_Curriculum/Physical_Education/ [accessed 28 May 2013].

National Institutes of Health Technology Assessment Conference Statement. (1994) '*Bioelectrical Impedance analysis in body composition measurement: National Institutes of Health Technology Assessment Conference Statement'*, U.S Department of Health and Human Services, available: http://consensus.nih.gov/1994/1994BioelectricImpedanceBodyta015PDF.pdf [accessed 18 September 2013].

National Task Force on Obesity. (2005) *'Obesity - The Policy Challenges - The Report of the National Taskforce on Obesity'*, Department of Health and Children, Dublin 2: The Stationary Office, Dublin, available: http://www.hse.ie/eng/health/child/healthyeating/taskforceonobesity.pdf [accessed 06 February 2013].

Neuman, M., Kawachi, I., Gortmaker, S., Subramanian, S.V. (2014) 'National Economic Development and Disparities in Body Mass Index: A Cross-Sectional Study of Data from 38 Countries', Plos One, 9(6), available: Ebscohost database [accessed 08 August 2014].

Newby, P.K., Peterson, K.E., Berkey, C.S., Leppert, J., Willett, W.C., Colditz, G.A. (2004) 'Beverage consumption is not associated with changes in weight and body mass index among low-income preschool children in North Dakota', *Journal of the American Diet Association,* 104(7), available: Science Direct database [accessed 22 August 2014].

Newman, A.B., Foster, G., Givelber, R., Nieto, F.J., Redline, S., Young, T. (2005) 'Progression and Regression of Sleep-Disordered Breathing with Changes in Weight', *Archives of International Medicine,* 165(20), available: http://archinte.jamanetwork.com/article.aspx?articleid=486784 [accessed 24 August 2014].

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N. et alia (2014) 'Global, regional, and national prevalence of overweight and obesity in children and adults during 1980—2013: a systematic analysis for the Global Burden of Disease Study 2013', *The Lancet,* 384(9945), available: http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(14)60460-8/abstract [accessed 25 July 2014].

Ngo, J., Engelen, A., Molag, M., Roesle, J., Garcı´a-Segovia, P., Serra-Majem, L. (2009) 'A review of the use of information and communication technologies for dietary assessment', *British Journal of Nutrition,* 101(2), available: file:///C:/Users/R00015773/Downloads/Br-J-Nutr_2009-101-Suppl-2-S102-12.pdf [accessed 26 September 2014].

NicGabhainn, S., Kelly, C., Molcho, M. (2007) '*The Irish Health Behaviour in School-aged Children Study 2006', Health Promotion Research Centre, National University of Ireland, Galway*, Department of Health and Children, Government of Ireland, Dublin, available:

http://www.nuigalway.ie/hbsc/documents/hbsc_2006_english_version.pdf [accessed 15 July 2014].

Niehues, J.R., Gonzales, A.I., Lemos, R.R., Bezerra, P.P., Haas, P. (2014) 'Prevalence of Overweight and Obesity in Children and Adolescents from the Age Range of 2 to 19 Years Old in Brazil', *International Journal of Pediatrics,* [2 May 2014], available: http://www.hindawi.com/journals/ijpedi/2014/583207/ [accessed 29 September 2014].

Nielsen, S.J., Popkin, B.M. (2004) 'Changes in beverage intake between 1977 and 2001', *American Journal of Preventive Medicine*, 27(3), available: Ebscohost database [accessed 25 April 2014].

Niemeier, H.M., Raynor, H.A., Lloyd-Richardson, E.E., Rogers, M.L., Wing, R.R. (2006) 'Fast Food Consumption and Breakfast Skipping: Predictors of Weight Gain from Adolescence to Adulthood in a Nationally Representative Sample', *Journal of Adolescent Health,* 39(6), available: Science Direct database [accessed 09 September 2014].

Nilsson, A., Yngve, A., Sjöström, M. (2002) 'Assessing physical activity among children with accelerometers using different time sampling intervals and placements', *Pediatric Exercise Science,* 14(1), available: http://www.diva-portal.org/smash/record.jsf?pid=diva2:135393 [accessed 29 August 2014].

Nixon, J.P., Zhang, M., Wang, C., Kushowski, M., Novak, C.M., Levine, J.A., Billington, C.J., Kotz, C.M. (2010) 'Evaluation of a quantitative magnetic resonance imaging system for whole body composition analysis in rodents', *Obesity (Silver Spring)* 18(8), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2919581/pdf/nihms221979.pdf [accessed 03 September 2013].

Noonan, C.W., Brown, B.D, Bentley, B., Conway, K., Corcoran, M., FourStar, K., Freide, P., Hemlock, B., Wagner, S., Wilson, T. (2010) 'Variability in childhood asthma and body mass index across Northern Plains American Indian communities', *Journal of Asthma,* 47(5), available: Science Direct database [accessed 22 August 2014].

Obarzanek, E., Schreiber, G.B., Crawford, P.B., Goldman, S.R., Barier, P.M., Frederick, M.M., Lakatos, E. (1994) 'Energy intake and physical activity in relation to indexes of body fat: the

National Heart, Lung, and Blood Institute Growth and Health Study', *The American Journal of Clinical Nutrition,* 60(1), available: http://ajcn.nutrition.org/content/60/1/15.long [accessed 25 August 2014].

Oireachtas Library and Research Obesity (2011) '*Obesity- a growing problem?,* Spotlight No.6. Dublin: Houses of the Oireachtas, available: http://www.oireachtas.ie/parliament/media/housesoftheoireachtas/libraryresearch/spotlights/spotObesity071111_150658.pdf [accessed 16 May 2013].

Olivera, M., Schofielda, G.M., Kolta, G.S., Schlutera, P.J. (2007) 'Pedometer accuracy in physical activity assessment of preschool children', *Journal of Science and Medicine in Sport,* 10(5), available: Science Direct database [accessed 23 September 2014].

Oliveria, S.A., Curtis Ellison, R., Moore, L.L., Gillman, M.W., Garrahie, E.J., Singer, M.R. (1992) 'Parent-child relationships in nutrient intake: the Framingham Children's Study', *The American Journal of Clinical Nutrition*, 56(3), available: http://ajcn.nutrition.org/content/56/3/593.full.pdf+html [accessed 23 August 2013].

Olsen, C.M., Green, A.C., Whiteman, D.C., Sadeghi, S., Kolahdooz, F., Webb, P.M. (2007) 'Obesity and the risk of epithelial ovarian cancer: A systematic review and meta-analysis, *European Journal of Cancer,* 43(4), available: Science Direct database [accessed 09 September 2014].

O'Loughlin, G., Cullen, S.J., McGoldrick, A., O'Connor, S., Blain, R., O'Malley, S., Warrington, G.D (2013) 'Using a Wearable Camera to Increase the Accuracy of Dietary Analysis', *American Journal of Preventive Medicine,* 44(3), available: Science Direct database [accessed 26 September 2014].

O'Neill, J.L., Mc Carthy, S.N., Burke, S.J., Hannon, E.M., Kiely, M., Flynn, A., Flynn, M., Gibney, M.J. (2007) 'Prevalence of overweight and obesity in Irish school children using four different definitions', *European Journal of Clinical Nutrition*, 61(6), available: http://www.nature.com/ejcn/journal/v61/n6/pdf/1602580a.pdf [accessed 15 March 2014].

Ong, C.W., O'Driscolla, D.M., Trubyc, H., Naughtond, M.T., Hamiltona, G.S. (2013) 'The reciprocal interaction between obesity and obstructive sleep apnoea', *Sleep Medicine Reviews,* 17(2), available: Science Direct database [accessed 03 September 2014].

Ong, K.K., Preece, M.A., Emmett, P.M., Ahmed, M.L., Dunger, D.B. (2002) 'Size at birth and early childhood growth in relation to Maternal Smoking, Parity and Infant Breast-Feeding: Longitudinal Birth Cohort Study and Analysis', *Pediatric Research*, 52(6), available: http://www.nature.com/pr/journal/v52/n6/pdf/pr2002265a.pdf [accessed 26 August 2013].

Oude Luttikhuis, H., Baur, L., Jansen, H., Shrewsbury, V.A., O'Malley, C., Stolk, R.P., Summerbell, CD. (2009) 'Interventions for targeting obesity in children (Review)', The Cochrane Collaboration, *The Cochrane Library,* Issue 1, available: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD001872.pub2/pdf [accessed 23 June 2014].

Owen, N., Healy, G.N., Matthews, C.E., Dunstan, D.W. (2010) 'Too Much Sitting: The Population-Health Science of Sedentary Behavior', *Exercise and Sport Science Reviews,* 38(3), 105-113, available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3404815/ [accessed 15 July 2014].

Pallant, J. (2013) *A step by step guide to data analysis using IBMSPSS, SPSS Survival Manual,* 5th ed., England: Open University Press.

Parizkova, J., Hills, A. (2006) 'Childhood Obesity: Prevention and Management', *The American Journal of Clinical Nutrition,* 83(1), available: http://ajcn.nutrition.org/content/83/1/175.1.full.pdf+html [accessed 14 May 2013].

Park, W., Lee, V.J., Ku, B., Tanaka, H. (2014) 'Effect of walking speed and placement position interactions in determining the accuracy of various newer pedometers', *Journal of Exercise and Science Fitness,* 12(1), available: Science Direct database [accessed 23 September 2014].

Park, M.H., Falconer, C., Viner, R.M., Kinra, S. (2012) 'The impact of childhood obesity on morbidity and mortality in adulthood: a systematic review', *Etiology and Pathophysiology,* 13(11), available: Ebscohost database [accessed 09 September 2014].

Parsons, T.J., Power, C., Logan, S., Summerbell, C.D. (2003) 'Childhood predictors of adult obesity: A systematic review', *International Journal of Obesity Related Metabolic Disorders,* 23(Suppl 8), available: Science Direct database [accessed 18 September 2014].

Pate, R.R., O'Neill, J.R., Lobelo, F. (2008) 'The Evolving Definition of ''Sedentary'', Exercise Sport Science, Review, *Exercise and Sport Science Reviews,* 36(4), available: http://www.sph.sc.edu/usc_cparg/pdf/Sedentary2008.pdf [accessed 15 July 2014].

Pateyjohns, I.R., Brinkworth, G.D., Buckley, J.D., Noakes, M., Clifton, P.M. (2012) 'Comparison of Three Bioelectrical Impedance Methods with DXA in Overweight and Obese Men', Obesity, 14(11), available: http://onlinelibrary.wiley.com/doi/10.1038/oby.2006.241/pdf [accessed 19 September 2013].

Pearce, M.J., Boergers, J., Prinstein, M.J. (2002) 'Adolescent Obesity, Overt and Relational Peer Victimization, and Romantic Relationships', *Obesity Research,* 10(5), available: http://mitch.web.unc.edu/files/2013/10/Pearce-et-al-2002.pdf [accessed 29 August 2014].

Pears, S.L., Jackson, M.C., Bertenshaw, E.J., Horne, P.J., Fergus Lowe, C., Erjavec, M. (2012) 'Validation of food diaries as measures of dietary behaviour change', *Appetite,* 58(3), available: Science Direct database [accessed 26 September 2014].

Pearson, N., Biddle, S.J.H. (2011) 'Sedentary Behavior and Dietary Intake in Children, Adolescents, and Adults: A Systematic Review', *American Journal of Preventive Medicine,* 41(2), available: Science Direct database [accessed 19 August 2014].

Peeters, A., Barendregt, J.J., Willekens, F., Mackenbach, J.P., Mamun, A.A., Bonneux, L. (2003) 'Obesity in Adulthood and Its Consequences for Life Expectancy: A Life-Table Analysis', *Annals of Internal Medicine,* 138(1), available: file:///C:/Users/R00015773/Downloads/12513041.pdf [accessed 22 August 2014].

Penpraze, V., Reilly, J.J., MacLean, C.M., Montgomery, C., Kelly, L.A., Paton, J.Y., Aitchison, T., Grant, S. (2006) 'Monitoring of Physical Activity in Young Children: How Much Is Enough?', *Pediatric Exercise Science,* 18(4), available:

http://fitnessforlife.org/AcuCustom/Sitename/Documents/DocumentItem/6277.pdf [accessed 15 September 2014].

Pereira, M.A., Kartashov, A.I., Ebbeling, C.B., Van Horn, L., Slattery, M.L., Jacobs Jr, D.R., Ludwig, D.S. (2005) 'Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis', *The Lancet,* 365(9453), available: Science Direct database [accessed 18 September 2014].

Perry, I.J et alia (2010) '*The Cost of Overweight and Obesity on the Island of Ireland'*, Safe Food, available: http://www.safefood.eu/Publications/Research-reports/The-cost-of-overweight-and-obesity-on-the-island-o.aspx [accessed 16 February 2013].

Perry, I.J., Whelton, H., Harrington, J., Cousins, B. (2009) 'The heights and weights of Irish children from the post-war era to the Celtic Tiger', *Journal of epidemiology and community health*, 63(3), available: https://cora.ucc.ie/bitstream/handle/10468/115/Perry_et_al_2009.pdf?sequence=1 [accessed 19 September 2014].

Perusse, L., Tremblay, A., Leblanc, C., Cloninger, R.C., Reich, T., Rice, J., Bouchard, C. (1988) 'Familial resemblance in energy intake: contribution of genetic and environmental factors', *American Journal of Clinical Nutrition,* 47(4), available: http://ajcn.nutrition.org/content/47/4/629.full.pdf [accessed 23 August 2013].

Phillips, L.R.S., Parfitt, G., Rowlands, A.V. (2013) 'Calibration of the GENEA accelerometer for assessment of physical activity intensity in children', *Journal of Science and Medicine in Sport,* 16(2), available: Science Direct database [accessed 15 July 2014].

Pillar, G., Shehadeh, N. (2008) 'Abdominal Fat and Sleep Apnea: the Chicken or the Egg?', *Diabetes Care,* 31(7), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2453667/ [accessed 24 August 2014].

Piper, M.D.W., Selman, C., Speakman, J.R., Partridge, L. (2014) 'Using Doubly-Labeled Water to Measure Energy Expenditure in an Important Small Ectotherm Drosophila melanogaster', *Journal of Genetics and Genomics,* 41(9), available: Science Direct [accessed 23 August 2014].

Pi-Sunyer, X. (2009) 'The Medical Risks of Obesity', *Postgrad Medicine,* 121(6), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2879283/#R75 [accessed 24 August 2014].

Poston, L. (2012) 'Maternal obesity, gestational weight gain and diet as determinants of offspring long term health', *Best Practice & Research Clinical Endocrinology & Metabolism*, 26(5), available: Science Direct database [accessed 29 August 2014].

Pouliou, T., Elliott, S.J. (2010) 'Individual and socio-environmental determinants of overweight and obesity in Urban Canada', *Health & Place,* 16(2), available: Science Direct database [accessed 28 August 2013].

Power, C., Lake, J.K., Cole, T.J. (1997) 'Measurement and long-term health risks of child and adolescent fatness'. *International Journal Obesity and Related Metabolic Disorders*, 21(7), available: http://europepmc.org/abstract/MED/9226480 [accessed 03 July 2014].

Prynne, C.J., Paul, A.A., Price, G.M., Day, K.C., Hilder, W.S., Wadsworth, M.E.J. (1999) 'Food and nutrient intake of a national sample of 4-year-old children in 1950: comparison with the 1990s', *Public Health Nutrition,* 2(4), available: Ebscohost database [accessed 22 August 2014].

Public Health Intelligence (2008) '*Protocol for Collecting Height, Weight and Waist Measurements in New Zealand Health Monitor (NZHM) Surveys'*, Ministry of Health, Wellington, New Zealand, available: http://www.moh.govt.nz/notebook/nbbooks.nsf/0/e846bf606184f2cdcc257487007eb4e8/$FILE/protocols-for-collecting-height-weight-waist-measurements.pdf [accessed 06 March 2014].

Pugliese, J., Tinsley, B. (2007) 'Parental socialization of child and adolescent physical activity: A meta-analysis', *Journal of Family Psychology*, 21(3), available: Ebscohost database [accessed 18 September 2014].

Puhl, R., Luedicke, J., Peterson, J.L. (2013) 'Public Reactions to Obesity-Related Health Campaigns A Randomized Controlled Trial', *American Journal of Preventive Medicine,* 45(1), available:

http://www.yaleruddcenter.org/resources/upload/docs/what/bias/PublicPerceptionsObesityCampaigns_AJPM_6.13.pdf [accessed 16 October 2014].

Pulgaron, E.R. (2013) 'Childhood Obesity', A Review of Increased Risk for Physical and Psychological Comorbidites', *Clinical Therapeutics,* 35(1), available: Science Direct database [accessed 26 September 2014].

Pulsford, R.M., Cortina-Borja, M., Rich, C., Kinnafick, F.E., Dezateux, C., Griffiths, L.J. (2011) 'ActiGraph Accelerometer-Defined Boundaries for Sedentary Behaviour and Physical Activity Intensities in 7 Year Old Children', PLoS ONE, 6(8), available: Ebscohost database [accessed 18 July 2014].

Rabec, C., de Lucas Ramos, P., Vealec, D. (2011) 'Respiratory Complications of Obesity', *Archives Bronconeumol* (English version), 47(5), available: Science Direct database [accessed 03 September 2014].

Raychaudhuri,M., Sanyal, D. (2012) 'Childhood obesity: Determinants, evaluation, and prevention', *Indian Journal of Endocrinology and Metabolism,* 16(2) available: Ebscohost database [accessed 08 August 2014].

Reilly, J.J. (2005) 'Descriptive epidemiology and health consequences of childhood obesity', *Best Practice & Research Clinical Endocrinology & Metabolism,* 19(3), available: Science Direct database [accessed 22 August 2014].

Reilly, J.J. (2005b) 'Early life risk factors for obesity in childhood: cohort study', *British Medical Journal,* 330(7504), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC558282/ [accessed 29 September 2014].

Reilly, J.J., Dorosty, A.R. (1999) 'Epidemic of obesity in UK children', *The Lancet*, 354(9193), available: Science Direct database [accessed 31 July 2014].

Reilly J.J., Methven, E., McDowell, Z.C., Hacking, B., Alexander, D., Stewart, L., Kelnar, C.J.H. (2003) 'Health consequences of obesity', *Archives of Disease in childhood,* 88(9), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1719633/pdf/v088p00748.pdf [accessed 14 May 2014].

Rennie, K.L., Johnson, L., Jebb, S.A. (2005) 'Behavioural determinants of obesity', *Best Practice & Research Clinical Endocrinology & Metabolism*, 19(3), available: Science Direct database [accessed 22 August 2014].

Resta, O., Foschino-Barbaro, M.P, Legari, G., Talamo, S., Bonfitto, P., Palumbo, A., Minenna, A., Giorgino, R., De Pergola, G. (2001) 'Sleep-related breathing disorders, loud snoring and excessive daytime sleepiness in obese subjects', *International Journal of Obesity Related Metabolic Disorders,* 25(5), available: Ebscohost database [accessed 24 August 2014].

Rey-Lopez, J.P., Vicente-Rodriguez, G., Biosca, M., Moreno, LA. (2008) 'Sedentary behaviour and obesity development in children and adolescents', *Nutrition, Metabolism and Cardiovascular diseases*, 18(3), available: Science Direct database [accessed 27 August 2013].

Rhee, K.E., Phelan, S., McCaffery, J. (2012) 'Early Determinants of Obesity: Genetic, Epigenetic, and In Utero Influences', *International Journal of Pediatrics,* [26 March 2012], available: http://www.hindawi.com/journals/ijpedi/2012/463850/ [accessed 27 October 2014].

Richardson, D., Cavill, N., Roberts, K., Ells, L. (2011) '*Measuring diet and physical activity in weight management interventions: a briefing paper'*, Oxford: National Obesity Observatory, available: http://www.noo.org.uk/uploads/doc/vid_10414_Assessment%20Tools%20160311%20FINAL%20MG.pdf [accessed 19 March 2014].

Riddoch, C.J., Mattocks, C., Deere, K., Saunders, J., Kirkby, J., Tilling, K., Leary, S.D., Blair, S.N., Ness, A.R. (2007) 'Objective measurement of levels and patterns of physical activity', *Archives of Disease in Childhood,* 92(11), available: *http://adc.bmj.com/content/92/11/963.full [accessed 26 August 2014].*

Roberts, K., Flaherty, S.J. (2010) '*Review of dietary assessment methods in public health'*, Oxford: National Obesity Observatory, available: http://www.noo.org.uk/uploads/doc/vid_7237_Review_new.pdf [accessed 19 Match 2014].

Roberts, R.E., Kaplan, G.A., Shema, S.J., Strawbridge, W.J. (2000) 'Are the Obese at Greater Risk for Depression?', *American Journal of Epidemiology,* 152(2), available: http://aje.oxfordjournals.org/content/152/2/163.long [accessed 29 August 2014].

Robinson, P. (2014) 'Obesity and its impact on the respiratory system', *Paediatric Respiratory Reviews,* 15(3), available: Science Direct database [accessed 03 September 2014].

Robinson, P.J., Bell, R.J., Davis, S.R. (2014) 'Obesity is associated with a poorer prognosis in women with hormone receptor positive breast cancer', *Maturitas*, [18 July 2014], available: Science Direct database [accessed 09 September 2014].

Robinson, T.N. (2001) 'Television viewing and childhood obesity', *Pediatric Clinics of North America,* 48(4), available: Science Direct database [accessed 19 August 2014].

Robinson, T.N., Killen, J.D. (1995) 'Ethnic and Gender Differences in the Relationships between Television Viewing and Obesity, Physical Activity, and Dietary Fat Intake', *Journal of Health Education,* 26(2), available: Ebscohost database [accessed 18 August 2014].

Rodrigo, C.P. (2013) 'Current mapping of obesity', *Nutrición Hospitalaria*, 28(5), available: Ebscohost database accessed 08 August 2014].

Rolls, B.J., Drewnowski, A., Ledikwe, J.H. (2005) 'Changing the Energy Density of the Diet as a Strategy for Weight Management', *Journal of the American Dietetic Association,* 105(5), available: Science Direct database [accessed 18 September 2014].

Rolls, B.J., Roe, L.S., Meengs, J.S. (2006) 'Larger Portion Sizes Lead to a Sustained Increase in Energy Intake over 2 Days', *Journal of the American Dietetic Association*, 106(4), available: Science Direct database [accessed 18 September 2014].

Rosenbaum, M., Leibel, R.L. (1998) 'The physiology of body weight regulation: Relevance to the etiology of obesity in children', *Pediatrics,* 101(525), available: http://www.pediatricsdigest.mobi/content/101/Supplement_2/525.full.pdf [accessed 04 July 2013].

Rosner, B., Prineas, R., Loggie, J., Daniels, S.R. (1998) 'Percentiles for body mass index in U.S. children 5 to 17 years of age', *The Journal of Pediatrics*, 132(2), available: Science Direct database [accessed 24 September 2013].

Rowlands, A.V. (2007) 'Accelerometer assessment of physical activity in children: an update', *Pediatric Exercise & Science,* 19(3), available: Ebscohost database [accessed 26 August 2014].

Rudolf, M.C.J., Cole, T.J., Krom, A.J., Sahota, P., Walker, J. (2000) 'Growth of primary school children: a validation of the 1990 references and their use in growth monitoring', *Archives of Disease in Childhood*, 83(4), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1718523/pdf/v083p00298.pdf [accessed 31 July 2014].

Rush, E., Coppinger, T., Obolonkin, V., Hinckson, E., McGratha, L., McLennan, S., David, G. (2012) 'Use of pedometers to identify less active children and time spent in moderate to vigorous physical activity in the school setting', *Journal of Science and Medicine in Sport,* 15(3), available: Science Direct database [accessed 23 September 2014].

Rush, E., Reed, P., Mc Lennan, S., Coppinger, T., Simmons, D., Graham, D. (2011a) 'A school-based obesity control programme: Project Energize. Two-year outcomes', *British Journal of Nutrition,* 107(4), available: http://www.ncbi.nlm.nih.gov/pubmed/21733268 [accessed 18 January 2013].

Rush, E., Coppinger, T., Obolonkin, V., Hinckson, E., McGrath, L., McLennan, S., Graham, G. (2011b) 'Use of pedometers to identify less active children and time spent in moderate to vigorous physical activity in the school setting', *Journal of Science and Medicine in Sport*, 15(3), available: Science Direct database [accessed 11 July 2014].

Rush, E.C., Crowley, J., Freitas, I.F., Luke, A. (2006) 'Validity of Hand-to-Foot Measurement of Bioimpedance: Standing Compared with Lying Position', *Obesity*, 14(2), available: http://onlinelibrary.wiley.com/doi/10.1038/oby.2006.32/pdf [accessed 22 July 2014].

Rush, E.C., Puniani, K., Valencia, M.E., Davies, P.S.W., Plank, L.D. (2003) 'Estimation of body fatness from body mass index and bioelectrical impedance: comparison of New Zealand

European, Maori and Pacific Island children', *European Journal of Clinical Nutrition*, 57(11), available: http://www.nature.com/ejcn/journal/v57/n11/pdf/1601701a.pdf [accessed 22 July 2014].

Safe Food (2014) *Campaigns* [online], available: http://www.safefood.eu/Utility/About-Us/Campaigns.aspx [accessed 18 November 2014]

Sahota, P., Rudolf, M.C.J., Dixey, R., Hill, A.J., Barth, J.H., Cade, J. (2001) 'Randomised controlled trial of primary school based intervention to reduce risk factors for obesity', *British Medical Journal,* 323(7320), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC59381/pdf/1029.pdf [accessed 14 October 2014].

Sallis, J.F., Prochaska, J.J., Taylor,W.C. (2000) 'A review of correlates of physical activity of children and adolescents', *Epidemiology,* 32(5), available: file:///C:/Users/R00015773/Downloads/AFS%20Sallis%20et%20al%202000%20(1).pdf [accessed 25 August 2014].

Sallis, J.F., McKenzie, T.L., Alcaraz, J.E., Kolody, B., Faucette, N., Hovell, M.F. (1997) 'The effects of a 2-year physical education programme (SPARK) on physical activity and fitness in elementary school students', *The American Journal of Public Health,* 87(8), available: http://www.sparkpe.org/resultsSallis3.pdf [accessed 14 October 2014].

Salmon, J., Salmon, L., Crawford, D.A., Hume, C., Timperio, A. (2007) 'Associations Among Individual, Social, and Environmental Barriers and Children's Walking or Cycling to School', *American Journal of Health Promotion*, 22(2), available: http://www.ajhpcontents.com/doi/abs/10.4278/0890-1171-22.2.107?journalCode=hepr [accessed 27 October 2014].

Sandercock, G.R.H., Oqunleye, A., Voss, C. (2014) 'Screen Time and Physical Activity in Youth: Thief of Time or Lifestyle Choice?', *Journal of Physical Activity and Health,* 9(7), available: Ebscohost database [accessed 12 January 2015].

Sanders, T., Cliff, D.P., Lonsdale, C. (2014) 'Measuring Adolescent Boys' Physical Activity: Bout Length and the Influence of Accelerometer Epoch Length', *PLoS ONE,* 9(3), available: Ebscohost database [accessed 25 August 2014].

Santaliestra-Pasías, A.M., Mouratidou, T., Verbestel, V., Huybrechts, I., Gottrand, F., Le Donne, C., Cuenca-García, M., Díaz, L.E., Kafatos, A., Manios, Y., Molnar, D., Sjöström, M., Widhalm, K., De Bourdeaudhuij, I., Moreno, L.A.(2012) 'Food Consumption and Screen-Based Sedentary Behaviors in European Adolescents: The HELENA Study', *Archives of Pediatrics & Adolescent Medicine,* 166(11), available: http://archpedi.jamanetwork.com/article.aspx?articleid=1355389&utm_campaign=twitter_111212&utm_medium=twitter&utm_source=@archpediatrics [accessed 18 August 2014]

Santiago, S., Zazpe, I., Marti, A., Cuervo, M., Martinez, J.A. (2013) 'Gender differences in lifestyle determinants of overweight prevalence in a sample of Southern European children', *Obesity Research & Clinical Practice,* 7(5), available: Science Direct database [accessed 20 August 2014].

Sarma, S., Zaric, G.S., Campbell, K.M., Gilliland, J. (2014) 'The effect of physical activity on adult obesity: Evidence from the Canadian NPHS panel', *Economics & Human Biology,* 14(1), available: Science Direct database [accessed 09 September 2014].

Sasaki, J.E., John, D., Freedson, P.S (2011) 'Validation and comparison of ActiGraph activity monitors', *Journal of Science and Medicine in Sport*, 14(5), available: Science Direct database [accessed 21 July 2014].

Sasson, M., Lee, M., Jan, C., Fontes, F., Motta, J. (2014) 'Prevalence and Associated Factors of Obesity among Panamanian Adults', *PLoS ONE,* 9(3), accessed: Ebscohost database [accessed 25 August 2014].

Saxena, S., Van Ommeren, M., Tang, K.C., Armstrong, T.P. (2005) 'Mental health benefits of physical activity', *Journal of Mental Health,* 14(5), available: http://informahealthcare.com/doi/abs/10.1080/09638230500270776 [accessed 18 September 2014].

Sen, S., Carpenter, A.H., Hochstadt, J., Huddleston, J.Y., Kustanovich, V., Reynolds, A.A, Roberts, S. (2012) 'Nutrition, weight gain and eating behaviour in pregnancy: A review of experimental evidence for long-term effects on the risk of obesity in offspring', *Physiology and Behaviour*, 107(1), available: Science Direct database [accessed 28 August 2013].

Seo, D-C,. Sa, J. (2010) 'A meta-analysis of obesity interventions among U.S. minority children', *Journal of adolescent Health*, 46(4), Science Direct, available: http://www.sciencedirect.com.ezproxy.cit.ie:2048/science/article/pii/S1054139X09006260# [accessed 05 August 2014].

Sergentanis, T.N., Antoniadis, A.G., Gogas, H.J., Antonopoulos, C.N., Adami, H-O., Ekbom, A., Petridou, E.T. (2013) 'Obesity and risk of malignant melanoma: A meta-analysis of cohort and case–control studies', *European Journal of Cancer,* 49(3), available: Science Direct database [accessed 09 September 2014].

Schembre, S.M., Wen, C.K., Davis, J.N., Shen, E., Nguyen-Rodriguez, S.T., Belcher, B.R., Hsu, Y-W., Weigensberg, M.J., Goran, M.I., Spruijt-Metz, D. (2013) 'Eating breakfast more frequently is cross-sectionally associated with greater physical activity and lower levels of adiposity in overweight Latina and African American girls', *The American Journal of Clinical Nutrition,* 98(2), available: http://ajcn.nutrition.org/content/98/2/275.full.pdf+html [accessed 09 September 2014].

Schoeppe, S., Duncan, M.J., Badland, H., Oliver, M., Curtis, C. (2013) 'Associations of children's independent mobility and active travel with physical activity, sedentary behaviour and weight status: A systematic review', *Journal of Science and Medicine in Sport,* 16(4), available: Science Direct database [accessed 08 September 2014].

Shafer, K.J., Siders, W.A., Johnson, L.K., Lukaski, H.C. (2009) 'Validity of segmental multiple-frequency bioelectrical impedance analysis to estimate body composition of adults across a range of body mass indexes', *Nutrition,* 25(1), available: http://naldc.nal.usda.gov/download/22872/PDF [accessed 18 September 2013].

Sharp, D.B., Allman-Farinelli, M. (2014) 'Feasibility and validity of mobile phones to assess dietary intake', *Nutrition,* [13 March 2014], available: Science Direct database [accessed 26 September 2014].

Shephard, R., Vuillemin, A. (2003) 'Limits to the measurement of habitual physical activity by questionnaires', *British Journal of Sports Medicine,* 37(3), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1724653/ [accessed 08 August 2014].

Shrewsbury, V., Wardle, J. (2008) 'Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005', *Obesity,* 16(2), available: http://onlinelibrary.wiley.com/doi/10.1038/oby.2007.35/pdf [accessed 19 August 2014].

Simmons, R.K., Wareham, N.J (2006) 'Commentary: Obesity is not a newly recognised problem – a commentary of Breslow's 1952 paper on 'public health aspects of weight control', *International Journal of Epidemiology,* 35(14), available: http://ije.oxfordjournals.org/content/35/1/14.full.pdf+html [accessed 03 July 2014].

Sims, S.T., Larson, J.C., Lamonte, M.J., Michael, Y.L., Martin, L.W., Johnson, K.C., Sarto, G.E., Stefanick, M.L. (2012) 'Physical activity and body mass: changes in younger versus older postmenopausal women', *Medical Science, Sport and Exercise,* 44(1), available: http://www.ncbi.nlm.nih.gov/pubmed/21659897 [accessed 15 July 2014].

Singhal, A., Lanigan, J. (2007) 'Breastfeeding, early growth and later obesity', *Obesity Reviews*, 8(Suppl. 1), available: http://onlinelibrary.wiley.com/doi/10.1111/j.1467-789X.2007.00318.x/pdf [accessed 26 August 2013].

Sirard, J.R., Kubik, M.Y., Fulkerson, J.A., Arcan, C. (2008) 'Objectively Measured Physical Activity in Urban Alternative High School Students', *Medicine and Science in Sports and Exercise,* 40(12), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2872077/ [accessed 15 September 2014].

Sirard, J.R., Pate, R.R. (2001) 'Physical Activity Assessment in Children and Adolescents', *Sports Medicine,* 31(6), available: http://mbamman.huntingdon.edu/sspe415/article8.pdf [accessed 23 September 2014].

Skidmore, P.M.L., Yarnell, J.W.G. (2004) 'The obesity epidemic: prospects for prevention', *An International Journal of Medicine,* 97(12), available: http://qjmed.oxfordjournals.org/content/97/12/817 [accessed 18 September 2014].

Skinner, (1999) ‘Fruit Juice Intake Is Not Related to Children's Growth’, *Pediatrics,* 103(1), available: Science Direct database [accessed 22 August 2014].

Smith, K.J., Gall, S.L., McNaughton, S.A., Blizzard, L., Dwyer, T., Venn, A.J. (2010) ‘Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the Childhood Determinants of Adult Health Study’, *The American Journal of Clinical Nutrition,* 92(6), available: http://ajcn.nutrition.org/content/92/6/1316.full.pdf+html [accessed 09 September 2014].

Smith, M.M., Lifshitz, F. (1994) ‘Excess fruit juice consumption as a contributing factor in nonorganic failure to thrive’, *Pediatrics*, 93(3), available: http://www.ncbi.nlm.nih.gov/pubmed/8115203 [accessed 25 April 2014].

Song, H.R., Parkb, H.S., Yunb, K.E., Choc, S.H., Choid, E.Y., Leee, S.Y., Kimf, J.H., Sungf, H.N., Kimg, J.H., Choih, S.I., Yoona, Y.S., Leea, E.S., Hani, J.H., Shinj, C.I., Changk, M.H., Bael, S.C. (2010) ‘Gender and age differences in the impact of overweight on obesity-related quality of life among Korean adults’, *Obesity Research & Clinical Practice,* (4)1, available: Science Direct database [accessed 21 August 2014].

Spadano, J.L., Bandini, L.G., Must, A., Dallal, G.E., Dietz, W.H. (2005) ‘Longitudinal changes in energy expenditure in girls from late to childhood through midadolescence’, *American Journal of Clinical Nutrition*, 81(5), available: http://ajcn.nutrition.org/content/81/5/1102.full.pdf [accessed 27 August 2013].

Spittaels, H., Cauwenberghe, E.V., Verbestel, V., De Meester, F., Van Dyck, D., Verloigne, M., Haerens, L., Deforche, B., Cadron, G., De Bourdeaudhuij, I. (2012) ‘Objectively measured sedentary time and physical activity time across the lifespan: a cross-sectional study in four age groups’, *International Journal of Behavioural Nutrition and Physical Activity*, 9(149), available: http://www.ijbnpa.org/content/pdf/1479-5868-9-149.pdf [accessed 08 January 2014].

Sport Waikato (2014) *Background: What is Project Energize?* [online], available: http://www.sportwaikato.org.nz/background.cfm [accessed 01 October 2014].

Sport Waikato and the Auckland University of Technology (2011) '*An evaluation of nutrition and physical activity in Waikato primary schools. Project Energize: June 2008 to June 2011, Executive Summary'*, Waikato District Health Board and the Ministry of Health, Healthy Eating Healthy Action Evaluation Fund, Waikato, New Zealand, available: http://www.parliament.nz/resource/0000250374 [accessed 28 January 2014].

Springer, F., Machann, J., Claussen, C.D., Schick, F., Schwenzer, N.F. (2010) 'Liver fat content determined by magnetic resonance imaging and spectroscopy', *World Journal of Gastroenterology*, 16(13), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2848364/pdf/WJG-16-1560.pdf [accessed 14 July 2014].

Strauss, R.S., Pollack, H.A. (2003) 'Social Marginalization of Overweight Children', *Archives of Pediatrics & Adolescent Medicine,* 157(8), available: http://archpedi.jamanetwork.com/article.aspx?articleid=481398 [accessed 22 August 2014].

Stettler, N., Signer, T.M., Suter, PM. (2004) 'Electronic Games and Environmental Factors Associated with Childhood Obesity in Switzerland', *Obesity Research*, 12(6), available: http://onlinelibrary.wiley.com/doi/10.1038/oby.2004.109/pdf [accessed 27 August 2013].

Stevens, G.A., Singh, G.M., Lu, Y., Danaei, G., Lin, J.K., Finucane, M.M., Bahalim, A.N., McIntire, R.K., Gutierrez, H.R., Cowan, M., Paciorek, C.J., Farzadfar, F., Riley, L., Ezzati, M. (2012) 'National, regional, and global trends in adult overweight and obesity prevalences', *Population Health Metrics*, 10(22), available: http://www.biomedcentral.com/content/pdf/1478-7954-10-22.pdf [accessed 08 August 2014].

Stewart, Laura. (2011) 'Childhood Obesity', *Medicine,* (39)1, available: Science Direct database [accessed 01 July 2013].

Stone, M.R., Rowlands, A.V.,Eston, R.G. (2009) 'Relationships between accelerometer-assessed physical activity and health in children: impact of the activity-intensity classification method', *Journal of Sports Science & Medicine,* 8(1), available: Ebscohost database [accessed 26 August 2014].

Story, M., Faulkner, P. (1990) 'The prime time diet: a content analysis of eating behavior and food messages in television programme content and commercials', *American Journal of Public Health,* 80(6), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1404738/ [accessed 19 August 2014].

Sturm, R., Datar, A. (2005) 'Body mass index in elementary school children, metropolitan area food prices and food outlet density', *Public Health,* 119(12), available: Ebscohost database [accessed 17 September 2014].

Stunkard, A.J., Sørensen, T.I.A., Hanis, C., Teasdale, T.W., Chakraborty, R., Schull, W.J., Schulsinger, F. (1986) 'An Adoption Study of Human Obesity', *The New England Journal of Medicine,* 314(4), available: Ebscohost database [accessed 29 August 2014].

Stunkard, A.J., Harris, J.R., Pedersen, N.L., McClearn, G.E. (1990) 'The Body-Mass Index of Twins Who Have Been Reared Apart', *The New England Journal of Medicine,* 322(21), available: http://www.nejm.org/doi/full/10.1056/NEJM199005243222102#t=articleTop [accessed 29 August 2014].

Svensson, A., Waling, M., Bäcklund, C., Larsson, C. (2012) 'Overweight and Obese Children's Ability to Report Energy Intake Using Digital Camera Food Records during a 2-Year Study', *Journal of Nutrition and Metabolism,* [12 June 2012], available: http://www.hindawi.com/journals/jnme/2012/247389/#B3 [accessed 26 September 2014].

Swartz, A.M., Bassett, D.R., Moore, J.B., Thompson, D.L., Strath, S.J. (2003) 'Effects of Body Mass Index on the Accuracy of an Electronic Pedometer', *International Journal of Sports Medicine,* 24(8), available: https://www.thieme-connect.com/DOI/DOI?10.1055/s-2003-43272 [accessed 23 September 2014].

Swift, D.L., Johannsen, N.M., Lavie, C.J., Earnest, C.P., Church, T.S. (2014) 'The Role of Exercise and Physical Activity in Weight Loss and Maintenance', *Progress in Cardiovascular disease,* 56(4), available: Science Direct database [accessed 08 September 2014].

Swinburn, B., Egger, G., Raza, F. (1999) 'Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental

Interventions for Obesity', *Preventive Medicine,* 29(6), available: Science Direct database [accessed 09 July 2015].

Sylvia, L.G, Bernstein, E.E., Hubbard, J.L., Keating, L., Anderson, E.J. (2014) 'Practical Guide to Measuring Physical Activity', *Journal of the Academy of Nutrition and Dietetics*, 114(2), available: Science Direct database [accessed 23 September 2014].

Taras, H.L., Sallis, J.F, Patterson, J.L., Nader, P.R, Nelson, J.A. (1989) 'Television's Influence on Children's Diet and Physical Activity', *Journal of Developmental Behavioural Pediatrics,* 10(4), available: Ebscohost database [accessed 19 August 2014].

Taylor, A.E., Ebrahim, S., Ben-Shlomo, Y., Martin, R.M., Whincup, PH., Yarnell, J.W., Goya Wannamethee, S., Lawlor, DA. (2010) 'Comparison of the associations of body mass index and measures of central adiposity and fat mass with coronary heart disease, diabetes, and all-cause mortiality: a study using from 4 UK cohorts', *The American Journal of Clinical Nutrition,* 91(3) ,available: http://ajcn.nutrition.org/content/91/3/547.full.pdf+html [accessed 22 August 2013].

Taylor, V.H., Forhan, M., Vigod, S.M., McIntyre, R.S., Morrison, K.M. (2013) 'The impact of obesity on quality of life', *Best Practice & Research Clinical Endocrinology & Metabolism,* 27(2), available: Science Direct database [accessed 09 September 2014].

Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., Raitakari, O. (2005) 'Physical activity from childhood to adulthood: A 21-year tracking study', *American Journal of Preventive Medicine,* 28(3), available: Science Direct database [accessed 18 September 2014].

Telama, R., Yang, X., Laakso, L., Viikari, J. (1997) 'Physical activity in childhood and adolescence as predictor of physical activity in young adulthood', *American Journal of Preventive Medicine,* 13(4), available: Science Direct database [accessed 18 September 2014].

Teran, J.C., Sparks, K.E., Quinn, L.M., Fernandez, B.S., Krey, S.H., Steffee, W.P. (1991) 'Percent body fat in obese white females predicted by anthropometric measurements', *The American Journal of Clinical Nutrition*, 53(1), available: http://ajcn.nutrition.org/content/53/1/7.long [accessed 03 September 2013].

The American Journal of Clinical Nutrition (1996) 'Bioelectrical impedance analysis in body composition measurement: National Institutes of Health Technology Assessment Conference Statement', *The American Journal of Clinical Nutrition,* 64(3), available: http://ajcn.nutrition.org/content/64/3/524S.long [accessed 14 July 2014].

The Lancet (2011) 'Urgently needed: a framework convention for obesity control', 378(9793), *The Lancet,* 378(9793), available: http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(11)61356-1/fulltext [accessed 09 April 2014].

The Lancet (2009) 'Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies', *The Lancet,* 373(9669), available: http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(09)60318-4/fulltext?_eventId=login [accessed 22 August 2014].

The University of Auckland (2010) '*A National Survey of Children and Young People's Physical Activity and Dietary Behaviours in New Zealand: 2008/09 Key Findings'*, available: http://www.health.govt.nz/publication/national-survey-children-and-young-peoples-physical-activity-and-dietary-behaviours-new-zealand-2008 [accessed 28 January 2014].

Thomas, J.R., Nelson, J.K., Silverman, S.J. (2005) *Research Methods in Physical Activity,* 5th ed.,USA : Human Kinetics.

Tremblay, M. (2012) 'Letter to the Editor: Standardized use of the terms "sedentary" and "sedentary behaviours", Sedentary Behaviour Research Network, available: http://www.sedentarybehaviour.org/wp-content/uploads/2012/05/Letter-APNM-2012.pdf [accessed 08 January 2014].

Tremblay, M.S., Warburton, D.E.R., Janssen, I., Paterson, D.H., Latimer, A.E., Rhodes, R.E., Kho, M.E., Hicks, A., LeBlanc, A.G., Zehr, L., Murumets, K., Duggan, M. (2011) 'Nouvelles Directives canadiennes en matière d'activité physique (English version)', *Applied Physiology, Nutrition and Metabolism,* 36(1), available: http://www.nrcresearchpress.com/doi/abs/10.1139/H11-010#.VBm7f_ldX9s [accessed 18 September 2014].

Treuth, M.S, Hou, N., Young. D.R., Maynard, M.L. (2012) 'Accelerometry-Measured Activity or Sedentary Time and Overweight in Rural Boys and Girls', *Obesity Research,* 13(9), available: http://onlinelibrary.wiley.com/doi/10.1038/oby.2005.197/pdf [accessed 08 January 2013].

Treuth, M.S., Catellier, D.J., Schmitz, K.H., Pate, R.R., Elder, J.P., McMurray, R.G., Blew, R.M., Yang, S., Webber, L. (2007) 'Weekend and Weekday Patterns of Physical Activity in Overweight and Normal-weight Adolescent Girls', *Obesity (Silver Spring),* 15(7), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2289771/ [accessed 15 September 2014].

Troiano, R.P., Berrigan, D., Dodd, K.W., Masse, L.C., Tilert, T., McDowell, M. (2008) 'Physical Activity in the United States Measured by Accelerometer', *Medicine and Science in Sports and Exercise,* 40(1), available: http://www.ncbi.nlm.nih.gov/pubmed/18091006 [accessed 03 November 2014].

Trost, S.G., Sallis, J.F., Pate, R.R., Freedson, P.S., Taylor, W.C., Dowda, M. (2003) 'Evaluating a model of parental influence on youth physical activity', *American Journal of Preventive Medicine,* 25(4), available: Science Direct database [accessed 18 September 2014].

Trost, S.G., Pate, R.R., Sallis, J.F., Freedson, P.S., Taylor, W.C., Dowda, M., Sirard, J. (2002) 'Age and gender differences in objectively measured physical activity in youth', *Medicine and Science in Sports and Exercise*, 34(2), available: http://europepmc.org/abstract/MED/11828247 [accessed 15 July 2014].

Trost, S.G., Way, R., Okely, A.D. (2006) 'Predictive Validity of Three ActiGraph Energy Expenditure Equations for Children', *Medicine and Science in Sports and Exercise,* 38(2), available: file:///C:/Users/R00015773/Downloads/Trost-Pred-Validity-ActiGraph-Eqns-MSSE-061.pdf [accessed 15 September 2014].

Truong, K.D., Sturm, R. (2005) 'Weight Gain Trends Across Sociodemographic Groups in the United States', *American Journal of Public Health,* 95(9), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1449404/ [accessed 19 August 2014].

Tsai, A.G., Williamson, D.F., Glick, H.A (2012) 'Direct medical cost of overweight and obesity in the United States: a quantitative systematic review', Obesity Reviews, 12(1), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2891924/ [accessed 09 August 2014].

Tucker, S.J. (2009) 'Parents as agents of change for childhood obesity prevention: a clinical nursing research programme', *Paediatrics and Child Health,* 19(Suppl. 2), available: Science Direct database [accessed 19 August 2014].

Tuomilehto, H., Seppä, J., Uusitupa, M. (2013) 'Obesity and obstructive sleep apnea – Clinical significance of weight loss', *Sleep Medicine Reviews,* 17(5), available: Science Direct

Turner-McGrievy, G.M., Beets, M.W., Moore, J.B., Kaczynski, A.T., Barr-Anderson, D.J., Tate, D.F (2013) 'Comparison of traditional versus mobile app self-monitoring of physical activity and dietary intake among overweight adults participating in an mHealth weight loss programme', *Journal of the American Medical Informatics Association,* 20(3) , available: http://jamia.bmj.com/content/20/3/513.full.pdf+html [accessed 25 September 2014].

Ul-Haq, Z., Mackay, D.F., Fenwick, E., Pell, J.P. (2013) 'Meta-Analysis of the Association between Body Mass Index and Health-Related Quality of Life among Children and Adolescents, Assessed Using the Pediatric Quality of Life Inventory Index', *The Journal of Pediatrics,* 162(2), available: Science Direct database [accessed 09 September 2014].

U.S. Department of Health and Human Services (2008) '*2008 Physical Activity Guidelines for Americans Be Active, Healthy and Happy',* The Secretary of Health and Human Services, Washington D.C., 20201, available: http://www.health.gov/paguidelines/pdf/paguide.pdf [accessed 01 October 2013].

U.S. Department of Health and Human Services (1996) '*Physical Activity and Health. A report of the Surgeon General',* Atlanta, GA: U.S. Dept of Health and Human Services, 1996. *Pediatric Exercise Science*, 13, available: http://journals.humankinetics.com/AcuCustom/Sitename/Documents/DocumentItem/12043.pdf [accessed 28 January 2014].

van Baal, P.H.M., Polder, J.J., de Wit,G.A., Hoogenveen, R.T., Feenstra,T.L., Boshuizen, C.H., Engelfriet,P.M., Brouwer, W.B.F. (2008) 'Lifetime Medical Costs of Obesity: Prevention No

Cure for Increasing Health Expenditure', *PLoS Med,* 5(2), available: http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.0050029 [accessed 18 August 2014].

Van de Horst, K., Oenema, A., van de Looij-Jansen, P., Brug, J. (2008) 'The ENDORSE study: Research into environmental determinants of obesity related behaviours in Rotterdam children', *BioMed Central Public Health*, **8**:142, available: http://www.biomedcentral.com/content/pdf/1471-2458-8-142.pdf [accessed 09 March 2014].

Vandewater, E.A., Shim, M-S., Caplovitz, A.G. (2004) 'Linking obesity and activity level with children's television and video game use', *Journal of Adolescents,* 27(1), available: Science Direct database [accessed 19 August 2014].

Vartanian, LR., Schwartz, MB., Brownell, KD. (2007) 'Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis', *American Journal of Public Health*, 97(4), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1829363/pdf/0970667.pdf [accessed 25 April 2014].

Verduin, P., Agarwal, S., Waltman, S. (2005) 'Solution to obesity: perspectives from the food industry', *The American Journal of Clinical Nutrition,* 82(1), available: http://ajcn.nutrition.org/content/82/1/259S.full.pdf+html?sid=e4dee7ba-ac13-40da-a0d5-51a8eef66e16 [accessed 24 July 2013].

Verhulst, S.L., Schrauwen, N., Haentjens, D., Suys, B., Rooman, R.P., Van Gaal,L., De Backer, W.A., Desager, K.N. (2007) 'Sleep-disordered breathing in overweight and obese children and adolescents: prevalence, characteristics and the role of fat distribution', *Archives of Disease in Childhood*, 92(3), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2083395/ [accessed 10 August 2014].

Veugelers, P.J., Fitzgerald, A.L. (2005) 'Effectiveness of school programmes in preventing childhood obesity: a multilevel comparison', *American Journal of Public Health,* 95(3), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1449197/pdf/0950432.pdf [accessed 14 March 2014].

Vgontzas, A.N., Papanicolaou, D.A., O. Bixler, E., Hopper, K., Lotsikas, A., Lin, H-M., Kales, A., Chrousos, G.P. (2000) 'Sleep Apnea and Daytime Sleepiness and Fatigue: Relation to Visceral Obesity, Insulin Resistance, and Hypercytokinemia', *The Journal of clinical Endocrinology & Metabolism,* 85(3), available: http://press.endocrine.org/doi/abs/10.1210/jcem.85.3.6484 [accessed 09 September 2014].

Vignolo, M., Silvestri, M., Parodi, A., Pistorio, A., Battistini, E., Rossi, G.A., Aicardi, G. (2005) 'Relationship between body mass index and asthma characteristics in a group of Italian children and adolescents', *Journal of Asthma,* 42(3), available: Ebscohost database [accessed 22 August 2014].

Vogel, T., Brechat, P-H., Leprêtre, P-M., Kaltenbach, G., Berthel, M., Lonsdorfer, J. (2009) 'Health benefits of physical activity in older patients: a review', *The International Journal of Clinical Practice,* 63(2), available: Science Direct database [accessed 18 September 2014].

Vollmer, R.L., Mobley, A.R. (2013) 'Parenting styles, feeding styles, and their influence on child obesogenic behaviors and body weight. A review', *Appetite,* 71(1), available: Science Direct database [accessed 29 August 2014].

von Hinke Kessler Scholder, S. (2007) 'Maternal Employment and Overweight Children: Does Timing Matter?', *Health Economics,* 17(8), available: http://www.bristol.ac.uk/cmpo/publications/papers/2007/wp180.pdf [accessed 20 August 2014].

Wang, C. Y., McPherson, K., Marsh, T., Gortmaker, S.L., Brown, M. (2011) 'Health and economic burden of the projected obesity trends in the USA and the UK', *The Lancet*, 378(9793), available: http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(11)60814-3/abstract [accessed 19 September 2014].

Wang, Y., Wang, J.Q. (2002) 'A comparison of international references for the assessment of child and adolescent overweight and obesity in different populations', *European Journal of Clinical Nutrition*, 56(10), available: http://www.nature.com/ejcn/journal/v56/n10/pdf/1601415a.pdf [accessed 31 July 2014].

Wang, Y. (2001) 'Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status', *International Journal of Epidemiology,* 30(5), available: http://www.bvsde.paho.org/texcom/nutricion/1129.pdf [accessed 03 July 3013].

Wang, Y., Lobstein, T. (2006) 'Worldwide trends in childhood overweight and obesity', *International Journal of Pediatric Obesity*, 1(1), available: http://www.iaso.org/site_media/uploads/March_2006_IOTF_childhood_obesity_global_forecast_for_2010.pdf [accessed 12 June 2013].

Wang, J., Gallagher, D., Thornton, J.C., Yu, W., Weil, R., Kovac, B., Xavier Pi-Sunyer, F. (2007) 'Regional Body Volumes, BMI, Waist Circumference, and Percentage Fat in Severely Obese Adults', *Obesity (Silver Spring),* 15(11), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2741388/pdf/nihms-132171.pdf [accessed 03 September 2013].

Wang, S., Mao, Q., Lin, Y., Wu, J., Wang, X., Zheng, X., Xie, L. (2012) 'Body mass index and risk of BPH: a meta-analysis', *Prostate Cancer and Prostatic Disease,* 15(3), available: Ebscohost database [accessed 04 September 2014].

Wang, Y., Wu, Y., Wilson, R.F., Bleich, S., Cheskin, L., Weston, C., Showell, N., Fawole, O., Lau, B., Seqal, J. (2013) 'Childhood Obesity Prevention Programmes: Comparative Effectiveness Review and Meta-Analysis', *Comparative Effectiveness Reviews,* 115, available: http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0057623/ [accessed 16 March 2014].

Wang, Y., Monteiro, C., Popkin, B.M. (2002) 'Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia', *The American Journal of Clinical Nutrition,* 75(6), available: http://bvs.per.paho.org/texcom/nutricion/971.pdf [accessed 29 September 2014].

Ward, D.S., Evenson, K.R., Vaughn, A., Rodgers, A.B., Troiano, R.P. (2005) 'Accelerometer use in physical activity: best practices and research recommendations', *Medicine and Science in Sport and Exercise,* 37(11), available: Science Direct database [accessed 18 September 2014].

Wardle, J. (1995) 'Parental influences on children's diets', *Proceedings of the Nutrition Society,* 54, available: http://journals.cambridge.org/download.php?file=%2FPNS%2FPNS54_03%2FS0029665195000772a.pdf&code=600c690ad55c80a6cc1b3917051f9ad5 [accessed 17 July 2014].

Waters, E., de Silva-Sanigorski, A., Burford, B.J., Brown, T., Campbell, KJ., Gao, Y., Armstrong, R., Prosser, L., Summerbell, CD. (2011) 'Interventions for preventing obesity in children (Review), The Cochrane Collaboration, *The Cochrane Library*, Issue 12, available: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD001871.pub3/pdf [accessed 23 June 2014].

Westerterp, K.R. (2009) 'Assessment of physical activity: a critical appraisal', *European Journal of Applied Physiology,* 105(6), available: http://link.springer.com/article/10.1007/s00421-009-1000-2/fulltext.html [accessed 08 September 2014].

Welk, G.J. (2005) 'Principles of Design and Analyses for the Calibration of Accelerometry-Based Activity Monitors', *Medicine & Science in Sports & Exercise,* 31(11), available: Ebscohost database [accessed 29 August 2014].

Wells, J.C.K., Fewtrell, M.S (2006) 'Measuring body composition', *Archives of Disease in Childhood*, 91(7), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2082845/ [accessed 14 July 2014].

Wells, J.C.K. (2000) 'A Hattori chart analysis of body mass index in infants and children', *International Journal of Obesity & Related Metabolic Disorders*, 24(3), available: Ebscohost database [accessed 16 August 2014].

Welsh, J.A., Cogswell, M.E., Rogers, S., Rockett, H., Mei, Z. and Grummer-Strawn, L. M. (2005) 'Overweight among low-income preschool children associated with the consumption of sweet drinks: Missouri, 1999- 2002', *Pediatrics,* 115(2), available: http://pediatrics.aappublications.org/content/115/2/e223.full.pdf+html [accessed 25 April 2014].

Wenig, C.M., Knopf, H., Menn, P. (2011) 'Juvenile obesity and its association with utilisation and costs of pharmaceuticals – results from the KiGGS study', *BioMed Central Public Health, Health Services Research,* 11(340) available: http://www.biomedcentral.com/content/pdf/1472-6963-11-340.pdf [accessed 08 August 2014].

Whelton, H., Harrington, J., Crowley, E. Kelleher, V., Cronin, M. Perry, I.J. (2007) 'Prevalence of overweight and obesity on the island of Ireland: results from the North South Survey of Children's Height, Weight and Body Mass Index, 2002, *BioMed Central Public Health*, 7(187), available: http://www.biomedcentral.com/content/pdf/1471-2458-7-187.pdf [accessed 24 April 214].

Whitaker, R.C., Wright, J.A., Pepe, M.S., Seidel, K.D., Dietz, W.D. (1997) 'Predicting obesity in young adult from childhood and parental obesity', *The New England Journal of Medicine*, 337(13), available: http://www.hawaii.edu/hivandaids/Predicting%20Obesity%20in%20Young%20Adulthood%20from%20Childhood%20and%20Parental%20Obesity.pdf [accessed 22 August 2013].

Wickens, K., Barry, D., Friezema, A., Rhodius, R., Bone, N., Purdie, G., Crane, J. (2005) 'Obesity and asthma in 11–12 year old New Zealand children in 1989 and 2000', *British Medical Journal,* 60(1), available: http://thorax.bmj.com/content/60/1/7.full.pdf+html [accessed 22 August 2014].

Williams, B., Poulter, N.R., Brown, M.J., Davis, M., McInnes, G.T., Potter, J.F., Sever, P.S., Thom, S. (2004) 'British Hypertension Society guidelines for hypertension management 2004 (BHS-IV): summary', *British Medical Journal*, 328(7440), available: http://www.bhsoc.org/pdfs/Summary%20Guidelines%202004.pdf [accessed 22 July 2014].

Withrow, D., Alter, D.A. (2011) 'The economic burden of obesity worldwide: a systematic review of the direct costs of obesity', *Obesity Reviews*, 12(2), available: http://www.ncbi.nlm.nih.gov/pubmed/20122135 [accessed 25 April 2014].

Woodcock, J., Aldred, R. (2008) 'Cars, corporations, and commodities: Consequences for the social determinants of health', *Emerging Themes in Epidemiology*, 5(1), available: Ebscohost database [accessed 18 August 2014].

Wooding, A.E., Rehman, I. (2014) 'Obesity and prostate cancer: Is there a link?', *e-SPEN Journal,* 9(3), available: Science Direct database [accessed 09 September 2014].

Woods,C.B., Moyna,N., Quinlan,A., Tannehill,D., Walsh.J. (2010) '*The Children's Sport Participation and Physical Activity Study (CSPPA Study)'*, Research Report No.1 School of Health and Human Performance, Dublin City University and Irish Sports Council, Dublin, Ireland.

World Health Organisation. (2014a) '*Obesity and Overweight'*, [online], available: http://www.who.int/mediacentre/factsheets/fs311/en/ [accessed 30 June 2014].

World Health Organisation, (2014b) '*Chronic diseases and health promotion' Part Two. The urgent need for action'*, [online], available: http://www.who.int/chp/chronic_disease_report/part2_ch1/en/index16.html [accessed 09 May 2014].

World Health Organisation. (2014c) Regional Office for Europe '*WHO European Childhood Obesity Surveillance Initiative (COSI*)', [online], available: http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/activities/monitoring-and-surveillance/who-european-childhood-obesity-surveillance-initiative-cosi [accessed 07 July 2014].

World Health Organisation/Europe. (2014d) '*Policy*', [online], available: http://www.euro.who.int/en/health-topics/noncommunicable-diseases/obesity/policy [accessed 15 July 2014].

World Health Organisation. (2014e) '*What is Moderate-intensity and Vigorous-intensity Physical Activity?,' Global Strategy on Diet, Physical Activity and Health'*, [online], available: http://www.who.int/dietphysicalactivity/physical_activity_intensity/en/ [accessed 15 July 2014].

World Health Organisation. (2014f) '*Nutrition*', [online], available: http://www.who.int/topics/nutrition/en/ [accessed 15 July 2014].

World Health Organisation. (2014g) '*Global Database on Child Growth and Malnutrition – Description - The Z-score or standard deviation classification system'*, [online], available:

http://www.who.int/nutgrowthdb/about/introduction/en/index4.html [accessed 08 August 2014].

World Health Organisation. (2014h) '*Growth Reference 5-19 years', Growth Reference Data for 5-19 years'*, [online], available: http://www.who.int/growthref/en/ [accessed 16 August 2014].

World Health Organisation. (2014i) '*Controlling the global obesity epidemic*', [online], available: http://www.who.int/nutrition/topics/obesity/en/ [accessed 14 October 2014].

World Health Organisation. (2014j) '*FAO/WHO e-forum',* [online], available: http://www.who.int/nutrition/obesity_FAOWHO_eforum/en/ [accessed 14 October 2014].

World Health Organisation. (2014k) '*Commission on Ending Childhood Obesity',* [online], available: http://www.who.int/end-childhood-obesity/about/en/ [accessed 07 November 2014].

World Health Organisation. (2013a) '*Obesity*', [online], available: http://www.who.int/gho/ncd/risk_factors/obesity_text/en/ [accessed 28 June 2013].

World Health Organisation. (2013b) '*Childhood overweight and obesity on the rise'* [online], available: http://www.who.int/dietphysicalactivity/childhood/en [accessed 16 January 2013].

World Health Organisation. (2013c) '*Growth Reference 5-19 years, BMI-for-age (5-19 years)*', [online], available: http://www.who.int/growthref/who2007_bmi_for_age/en/index.html [accessed 02 July 2013].

World Health Organisation. (2011a) '*WHO Global Infobase: Data for saving lives',* [online], available: https://apps.who.int/infobase/Comparisons.aspx [accessed 30 June 2014].

World Health Organisation. (2011b) '*Overweight Obesity 2008, Prevalence of Obesity, ages 20+, aged standardised: Both sexes'*, [online], available: http://gamapserver.who.int/gho/interactive_charts/ncd/risk_factors/overweight_obesity/atlas.html?indicator=i1&date=Both sexes [accessed 08 July 2013].

World Health Organisation (2010) '*Global status report on non-communicable diseases'*, Geneva, World Health Organization, available: http://www.who.int/nmh/publications/ncd_report2010/en/ [accessed 10 May 2013].

World Health Organisation (2009) '*Population-based prevention strategies for childhood obesity, report of WHO forum and technical meeting'*, Geneva, World Health Organisation.

World Health Organisation (2009) '*Global Health Risks: Mortality and burden of disease attributable to selected major risks'*, Geneva, World Health Organation, available: http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf [accessed 22 May 2013].

World Health Organisation (2008) '*The Extent, Nature and Effects of Food Promotion to Children, A Review of the Evidence to December 2008'*, Geneva: World Health Organisation, available: http://whqlibdoc.who.int/publications/2009/9789241598835_eng.pdf [accessed 15 May 2013].

World Health Organisation. (2003) '*Fact sheet on Obesity and Overweight'*, [online], available: http://www.who.int/mediacentre/factsheets/fs311/en/ [accessed 16 January 2013].

World Health Organisation. (2000) '*Obesity: preventing and managing the global epidemic Report of a WHO Consultation'*, WHO Technical Report Series 894, available: http://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/ [accessed 07 November 2014].

World Health Organisation. (1995) '*Physical Status: The use and interpretation of anthropometry'*, [online], available: http://www.who.int/childgrowth/publications/physical_status/en/ [accessed 27 June 2013].

World Health Organisation/Food and Agriculture Organisation (2003) 'Diet, Nutrition, and the Prevention of Chronic Diseases', WHO Technical Report Series, 916, Geneva, available: http://www.who.int/dietphysicalactivity/publications/trs916/en/gsfao_introduction.pdf [accessed 22 August 2014].

World Obesity. (2014) '*Obesity: The global epidemic'*, [online], available; http://www.worldobesity.org/iotf/obesity/obesitytheglobalepidemic/ [accessed 16 March 2014].

Wright, C.M., Sherriff, A., Ward, S.C.G., McColl, J.H., Reilly, J.J., Ness, A.R. (2008) 'Development of bioelectrical impedance-derived indices of fat and fat-free mass for assessment of nutritional status in childhood', *European Journal of Clinical Nutrition*, 62(2), available: Ebscohost database [accessed 14 July 2014].

Wright, C.M., Booth, I.W., Buckler, J.M.H., Cameron, N., Cole, T.J., Healy, M.J.R., Hulse, J.A., Preece, M.A., Reilly, J.J., Williams, A.F. (2002) 'Growth reference charts for use in the United Kingdom', *Archives of Disease in Childhood*, 86(1), available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1719041/pdf/v086p00011.pdf [accessed 31 July 2014].

Wu, DM., Hong, Y., Sun, CA., Sung, PK., Rao, DC., Chu, FU. (2003) 'Familial resemblance of adiposity-related parameters: Results from a health check-up population in Taiwan', *European Journal of Epidemiology*, 18(3), available: http://link.springer.com/article/10.1023/A:1023337917377#page-1 [accessed 27 August 2013].

Xie, B., Chou, C-P., Spruijt-Metz, D., Liu, C., Xia, J., Gong, J., Li, Y., Johnson, C.A. (2005) 'Effects of perceived peer isolation and social support availability on the relationship between body mass index and depressive symptoms', *International Journal of Obesity,* 29(9), available: http://www.nature.com/ijo/journal/v29/n9/full/0803006a.html#bib5 [accessed 29 August 2014].

Xie, B., Ishibashib, K., Lina, C., Petersona, D.V., Susmanc, E.J. (2013) 'Overweight trajectories and psychosocial adjustment among adolescents', *Preventive Medicine,* 57(6), available: Science Direct database [accessed 29 August 2014].

Xua, Q., Anderson, D., Lurie-Beck, J. (2011) 'The relationship between abdominal obesity and depression in the general population: A systematic review and meta-analysis', *Obesity Research & Clinical Practice,* 5(4), available: Science Direct database [accessed 03 September 2014].

Yang, P., Zhou, Y., Chen, B., Wan, H-W., Jia, G-Q., Bai, H-L., Wu, X-T. (2009) 'Overweight, obesity and gastric cancer risk: Results from a meta-analysis of cohort studies', *European Journal of Cancer,* 45(16), available: Science Direct database [accessed 04 September 2014].

Ziegler, B., Fetters, L., Patterson, J. (2008) 'Validity of Field Measurements For Body Composition', Proceedings of the 4th Annual GRASP Symposium, Wichita State University, 2008, available: http://soar.wichita.edu/bitstream/handle/10057/1341/grasp-2008-09.pdf?sequence=1 [accessed 06 October 2014].

Zhu, A. (2007) 'The Effect of Maternal Employment on the Likelihood of a Child Being Overweight', *School of Economics*, University of New South Wales, 2007/17, available: Ebscohost database [accessed 20 August 2014].

Appendices

Appendix	Documents/Resources
A	School recruitment letter
B	Lesson plans Tip sheet Nuggets
C	Project Spraoi recording sheet Project Spraoi Questionnaire at mid-point: Teachers Project Spraoi Questionnaire at intervention end: Teachers Project Spraoi Questionnaire for additional school staff
D	Information letter for the intervention and control school Information sheet Consent form
E	Protocol for conducting anthropometric and physiological tests Accelerometer information letter
F	Project Spraoi Questionnaire for parents/guardians for one child Project Spraoi Questionnaire for parents/guardians for two or four children Project Spraoi Questionnaire for parents/guardians for three or five children
G	Data Analysis and Results (please find enclosed a compact disc)

Appendix A

School recruitment letter

'An intervention to increase physical activity levels, reduce sedentary time and improve nutritional intake in school children'

The Exercise and Health Research Cluster at Cork Institute of Technology are currently recruiting schools for involvement in Project Spraoi. ***'Project Spraoi'***, aims to reduce levels of overweight and obesity by increasing physical activity, decreasing sedentary time and improving knowledge of healthy eating amongst primary school children in Cork.

'Project Spraoi' is based on a similar, successful health promotion project from New Zealand – '*Project Energize*'. '*Project Energize'* engages directly with 44,000 children from 244 primary schools and has successfully reduced levels of overweight and obesity by increasing physical activity levels and improving dietary intake. While globally there are thousands of examples of health promotion interventions targeting primary school children, Project Energize is one of only a few proven to effect change in children's weight and fitness (Rush et al, 2011). Project Spraoi will adapt and implement the '*Project Energize'* approach to Cork primary schools.

We are writing to invite you to participate in '*Project Spraoi*'. Becoming a Project Spraoi school involves a whole school commitment to engage with our researchers for the coming academic year. We will engage with class teachers to deliver tried and tested methods to improve physical activity and healthy eating and to decrease sedentary time.

If you are interested in gaining further information we will travel to meet you at your school in the next week. Should you sign up to Project Spraoi we will draw up a Memorandum of Understanding covering areas such as consent, ethics, insurance and so on.

Thank you for taking the time to read this letter. As a follow up we will contact you by phone before the end of this week. Should you wish to contact us please feel free to do so.

Yours sincerely,

Appendix B

Example of a lesson plan

Example of a tip sheet

Example of some nuggets

Lesson plans

Junior Cycle

Option: Indoor (hall) & outdoor based activities.

Activity 1 (warm up, indoors and outdoors)

Big steps, small steps

- Children move freely around the area/desks at a walk or jog pace.
- On whistle and call from teacher "Big steps", all children change and begin moving with long strides.
- On whistle and call from teacher "Small steps", children continue moving but with very small steps. Repeat several times.
- Children can walk on their heels, toes, with arms above their head etc.

Activity 2 (indoors and outdoors)

Whistle blow

- Children walk freely around the area or stay behind their desks and perform the activities on the spot.
- On one whistle blow from teacher children must do an exercise on the spot i.e. jumping jacks, skip, knee to hip etc. On two whistles blows from the teacher children must perform the activity at a faster pace.
- Teacher can ask children to gradually speed up and jog/run.

Activity 3 (indoors - classroom)

Freeze

- Children walk or jog around the desks or on the spot depending on the layout of the room.
- When the teachers says ''freeze'', all children "freeze" on the spot.
- Any children who move or who are slow to stop have to do 10 jumping jacks.
- Repeat several times – include exercises such as jumping jacks, rope climb,

or

Cat and mouse (outdoors and hall/scout den)

- Children – hands linked in a circle. One child is the cat and stays outside the circle; another child is the mouse and stays inside the circle.
- The cat tries to get into the circle to catch the mouse, who can "duck" in and out under the arms of the children in the circle.
- The children in the circle try to keep the cat out and protect the mouse.
- When the mouse is caught, another 2 players become the cat and the mouse. Can have two cats and two mice to vary the game if necessary.

Activity 4 (Cool down)

- Stretches
- Deep breaths in and out

Senior Cycle

Option: Indoor (hall) & outdoor based activities.

Activity 1 (warm up)

Outside (outdoors or hall)

- Jog from one boundary to another i.e. jog from top of the court yard to bottom of the court yard.
- Repeat numerous times until pupils are warming up.
- Ask pupils to do a variety of exercises after they reach top/bottom of the boundary e.g. five jumping jacks, heel to bum, jump and then touch the floor with your hands etc.

or

Classroom

- Jog on the spot or if possible jog around the tables/classroom.
- On the spot ask pupils to do a variety of exercises e.g. jumping jacks, heel to bum, high jumps, knees to hip height while jogging on the spot etc.

Activity 2 (outdoors or hall)

There and back relay requires cones or hoops as markers. If you have 4 teams, need 4 markers.

- Children in 2s, 3s, or 4s lined up one behind the other at the starting line, facing the boundary cone or mark.
- Number 1 travels to the boundary in the way designated by teacher – around the marker and back to team or partner – tags the next person in line who repeats the sequence.
- Number 1 goes to the back of the line.
- Repeat until whole team has had a turn.

Activity 3 (outdoors or hall)

Couple tag/Chains

- Taggers keep hands joined and chase the free players.
- If tagged, the free player now joins onto the couple to form a chain of three.
- If a fourth person is tagged the chain must break into two chains.
- Continue for several minutes or until everyone is tagged.

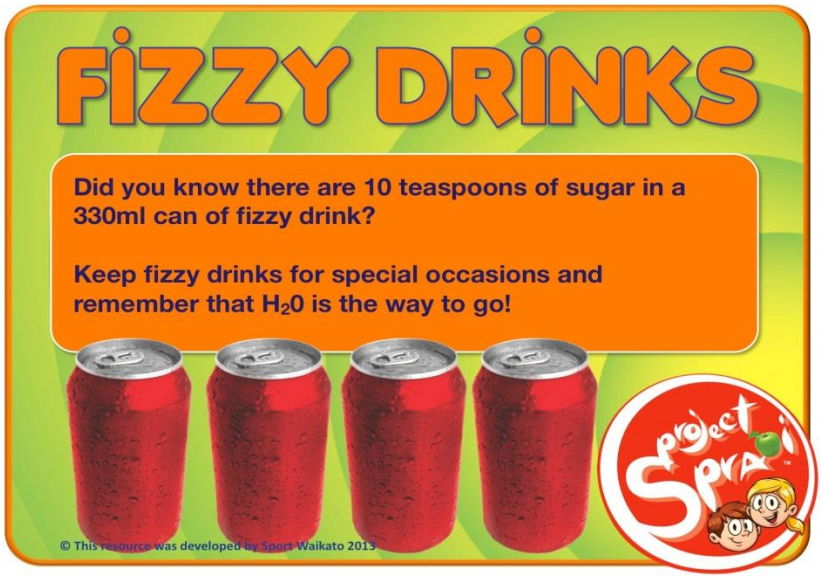
Activity 4 (Cool down)

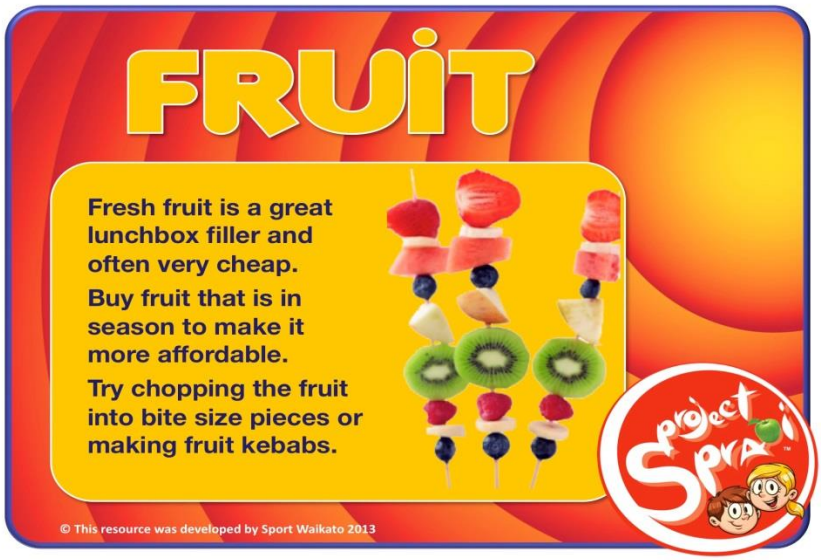
- Stretches and breathing exercises

Tipsheet


KICKSTART YOUR DAY WITH BREAKFAST!
project Spark
Eating breakfast every day boosts your energy levels and provides your body and brain with the fuel to keep you going throughout the day.
TIP! The best breakfast is one eaten at home. Breakfast doesn't have to be boring or expensive. It can cost as little as 50c a serve and be ready in 2 minutes!
toast
marmite
cheese
MOUSE TRAPS
rolled oats
yoghurt
dried fruit
PORRIDGE
weetbix
banana
milk
WEETBIX
banana
canned fruit
milk
FRUIT SMOOTHIE
toast
spread
milk
TOAST & MILK
© This resource was developed by Sport Waikato 2013

Nuggets


FIZZY DRINKS
Did you know there are 10 teaspoons of sugar in a 330ml can of fizzy drink?
Keep fizzy drinks for special occasions and remember that H_20 is the way to go!
© This resource was developed by Sport Waikato 2013


FRUIT
Fresh fruit is a great lunchbox filler and often very cheap.
Buy fruit that is in season to make it more affordable.
Try chopping the fruit into bite size pieces or making fruit kebabs.
© This resource was developed by Sport Waikato 2013

Appendix C

Project Spraoi recording sheet

Project Spraoi Questionnaire at mid-point: Teachers

Project Spraoi Questionnaire at intervention end: Teachers

Project Spraoi Questionnaire for additional school stakeholders

Project Spraoi recording sheet

Spraoi in your classroom!

Please fill in the duration of each category for each day of the week.

Class: **Dates:**

	Monday	Tuesday	Wednesday	Thursday	Friday	Notes/Comments
Fitness i.e. Huff n' Puff						
Physical Education						
Other (please specify)						

	Monday	Tuesday	Wednesday	Thursday	Friday	Notes/Comments
Fitness i.e. Huff n' Puff						
Physical Education						
Other (please specify)						

	Monday	Tuesday	Wednesday	Thursday	Friday	Notes/Comments
Fitness i.e. Huff n' Puff						
Physical Education						
Other (please specify)						

Project Spraoi mid-point teacher questionnaire

Project Spraoi Questionnaire

Name: _____

Class: _____

Please indicate your level of agreement with the following statements;

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. Project Spraoi is having a positive impact in the school with regards to physical activity	1	2	3	4	5
2. I am confident in delivering the huff n' puff lessons to my class	1	2	3	4	5
3. Delivering daily huff n' puff sessions for 20 minutes is manageable	1	2	3	4	5
4. Pupils are enjoying the huff n' puff games	1	2	3	4	5
5. Pupils are aware that Project Spraoi is also focused on promoting healthy eating	1	2	3	4	5
6. Parents are supportive of Project Spraoi	1	2	3	4	5
7. The school will continue to implement Project Spraoi after the intervention	1	2	3	4	5
8. I am happy to deliver huff n' puff without further assistance from the Energizer	1	2	3	4	5

9. Please provide any other feedback or thoughts you have on Project Spraoi at (school).

_____

_____

_____

Project Spraoi intervention end teacher questionnaire

Project Spraoi Questionnaire

Name: _____ Class: _____

Please indicate your level of agreement with the following statements;

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. Project Spraoi had a positive impact on increasing pupils physical activity (PA) levels	1	2	3	4	5
2. Project Spraoi had a positive impact on decreasing pupils sedentary time	1	2	3	4	5
3. Project Spraoi had a positive impact on improving pupils nutritional knowledge	1	2	3	4	5
4. Delivering the physical activity sessions every day for 20 minutes was manageable	1	2	3	4	5
5. After I delivered 'Spraoi' my class were more attentive in class than usual	1	2	3	4	5
6. After I delivered Spraoi my class were more boisterous in class than usual	1	2	3	4	5
7. I actively participated in the Spraoi activities while I was delivering Spraoi to my class	1	2	3	4	5
8. As a result of Project Spraoi I am more aware of the importance of PA	1	2	3	4	5
9. I am more physically active as a result of Project Spraoi	1	2	3	4	5
10. As a result of being involved in Project Spraoi my attitude towards PA have positively changed	1	2	3	4	5

11. The nutrition presentations were informative	1	2	3	4	5
12. I will continue to deliver Spraoi next year without a Spraoi Energizer	1	2	3	4	5
13. The school will continue to implement Project Spraoi for the next academic year after the intervention has finished	1	2	3	4	5

14. What barriers limited you in fulfilling the 20 minutes of Spraoi?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

15. What changes would you recommend for Project Spraoi?

_____

_____

_____

_____

_____

_____

_____

Project Spraoi intervention end school stakeholder questionnaire

Project Spraoi Questionnaire

Dear Board of Management,

As you may recall X School has been involved in Project Spraoi over the past academic year. The project is now at the evaluation stage and I would appreciate it if you could complete this short questionnaire. Please note that your response will be treated with complete confidentiality.

Please answer the questions honestly and email them back to (email address) before Friday 27th June.

Kind regards,

(Name)

Project Spraoi Questionnaire

Q1: In your opinion what are the goals of Project Spraoi?

_____
_____
_____
_____
_____
_____

Q2: What impact has Project Spraoi had in X School?

_____
_____
_____
_____
_____
_____
_____

Appendix D

Information letter for the intervention and control school

Information sheet

Consent form

Parent/Guardian Information Letter
(Intervention school)

Dear Parents/Guardians,

Cork Institute of Technology, in conjunction with your child's school, is working together on a research project called "Project Spraoi". This project is investigating if a school based health promotion intervention can improve healthy lifestyle habits in children.

Please find attached an **information sheet** outlining Project Spraoi and what's involved. We would be extremely grateful if you could take the time to read the information sheet and if there is anything you do not understand, or if you would like more information, please do not hesitate to contact me (contact details can be found below).

It is completely up to you to decide whether you and your child take part in this study. You may withdraw from the study at any time, without giving a reason.

Please find attached the following:

1. *Parent/Guardian Information Sheet*
2. *Consent Forms*

If you and your child would like to participate please **complete the consent forms** for yourself and your child, and **return them** to your child's school in the **envelope attached**.

Thanking you in advance,

Name

Dept. of Sport, Leisure & Childhood Studies,
Cork Institute of Technology,
Bishopstown,
Email:

Parent/Guardian Information Letter
(Control school)

Dear Parents/Guardians,

Cork Institute of Technology, in conjunction with your child's school, is working together on a research project called "Project Spraoi". This project is investigating if a school based health promotion intervention can improve healthy lifestyle habits in children. Your child's school has been selected as a Control School upon agreement with the School Principal and faculty.

Please find attached an **information sheet** outlining Project Spraoi and what's involved. We would be extremely grateful if you could take the time to read the information sheet and if there is anything you do not understand, or if you would like more information, please do not hesitate to contact me (contact details can be found below).

It is completely up to you to decide whether you and your child take part in this study. You may withdraw from the study at any time, without giving a reason.

Please find attached the following:

1. *Parent/Guardian Information Sheet*
2. *Consent Forms*

If you and your child would like to participate please **complete the consent forms** for yourself and your child, and **return them** to your child's school in the **envelope attached**.

Thanking you in advance,

Name

Dept. of Sport, Leisure & Childhood Studies,
Cork Institute of Technology,
Bishopstown,
Cork
Email:

Parent/Guardian Information Sheet

Study title: Project Spraoi

Background:

The project began as Project Energize in New Zealand in 2004. Project Energize is a school based intervention programme and has proven to have a positive effect on school children. The aim of Project Energize is to improve children's physical activity and nutrition, and ultimately to improve their overall health.

Purpose:

School based interventions which focus on increasing children's activity time, reducing sedentary time and improving nutritional behaviour has shown many benefits. We are looking to extend this work to see if Project Spraoi can demonstrate a difference in Cork schoolchildren.

Why has my child been chosen?

Your child's school has been chosen to take part due to the principals and teachers enthusiasm and their commitment to the project.

Who is organising the study?

This study is being organised by the Exercise and Health Research Cluster at Cork Institute of Technology (CIT).

My child is in senior infants/fourth class. What is involved if I agree to my child taking part in this project & how often will he/she be measured?

If you allow your child to participate they will have their height, weight, waist circumference, blood pressure and body fat measured. This will take about 30 minutes. They will also participate in a 550m run, this usually takes 10 minutes.

Your child will be asked a few short questions on food, physical activity & health. This process will take approximately five minutes and will be carried out during school time.

Your child will also be asked to wear an accelerometer for seven days. The accelerometer is small and light (about the size of a matchbox) and is worn on an adjustable elastic belt around the child's waist. It will cause no inconvenience to them and after a short while, they will probably not be aware of it at all. Your child will be asked to wear the accelerometer at all times during the day except when they are swimming or bathing.

Your child will be measured twice. Once in October 2013 and again in June 2014. We will notify you the dates of these measurements closer to the time.

What are the possible risks of taking part?

There are no risks for your child as a result of taking part in this study.

What are the possible benefits of taking part?

It is hoped that the information we get may help to advance the study of healthy lifestyle interventions that take place in school settings. We also hope that this data will support funding the continuation of the project to other schools both within Munster and Ireland.

Are there any restrictions on my child during the project?

There are no restrictions placed on your child, other than that we ask them to wear their accelerometer during all waking hours for seven days and to remove it when swimming or bathing. In all other respects, your child will not be restricted in any way

What if something goes wrong?

Participating in this study carries no risk of harm for your child. Should your child lose or break the accelerometer, we will take full responsibility and neither your child, yourself nor the school will be required to replace it. However, these are expensive pieces of equipment so we would ask that you child takes good care of them.

Will the information collected by confidential?

Yes. All information collected about your child during the course of the research will be kept strictly confidential and will be kept safe. Any information that is collected will be anonymised so that your child cannot be recognised from it.

Who has reviewed the study?

The study has received ethical approval from Cork Institute of Technology.

What is required of me?

We would like you to fill in a short Food & Drink Survey. This survey will help us to obtain a global picture of your child's current lifestyle behaviours. This survey will be given to your child during school hours for them to bring home. Return dates will be confirmed closer to the time.

What will happen to the results of the study?

The results will be used in a MA Thesis with the hope of being published in scientific literature at a later date. If requested, the school will be informed as to the results and the outcomes of the study when the thesis is complete. Each child who takes part will be given a certificate of participation.

Thank you for taking the time to read this.

Consent Forms for Parents/Guardians and Child

Parent/Guardian Consent

(Complete if you are a parent, caregiver or relative and you consent to your child taking part in this study).

As a parent/caregiver of _____ (child's name),

I hereby consent to my child taking part in this study.

Signed: _____

Child Consent

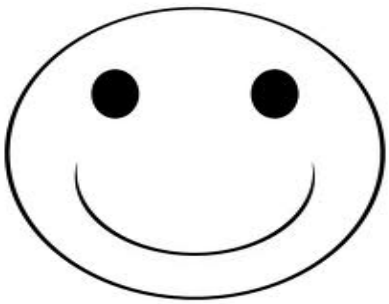
(Complete if you are the child and if you wish to take part in this study)

I _____ (child's name), agree to take part in the above study

Child Signature: _____

OR

Colour the face: Happy for **yes** Sad for **no**



Parent/Guardian Signature:

Sign: _____ Date: _____

Parent/Guardian - If you would like to receive texts to remind your child to wear their activity monitor please provide a text number here: _____

If you require further information please contact:

Name of researcher
Researcher
Dept of Sport, Leisure & Childhood Studies,
Cork Institute of Technology
Contact details

Name of supervisors
Supervisors
Dept of Sport, Leisure & Childhood Studies,
Cork Institute of Technology
Contact details

Appendix E

Protocol for conducting anthropometric and physiological tests

Accelerometer information letter

Testing protocol

Anthropometric and physiological measurements

All measurements were recorded twice and where a pre-determined tolerance was exceeded a third measurement was taken.

Height

The stadiometer was placed on a flat surface, against a wall. Pupils were asked to stand on the centre of the base with their heels, upper and lower back touching the stadiometer, feet together, and head in the Frankfurt Plane. Pupils were instructed to inhale; the headboard was then lowered until it reached the top of their head (vertex). The measurement was observed at eye level and recorded. Pupils were advised to exhale and to step off the stadiometer.

Weight

The scales were placed on a flat surface and kept at a distance from all of the other stations to ensure privacy. The digital display screen was covered to prevent pupils from observing their weight. Pupils stood in the centre of the scales, weight distributed evenly on both feet, arms by their sides and head facing forward.

Waist circumference

Waist circumference was measured 'as the circumference of the abdomen at its narrowest point between the lower costal (10th rib) border and the top of the iliac crest, perpendicular to the long axis of the trunk' (Public Health Intelligence 2008, p.9). This measurement was taken over light clothing rather than against the skin.

Pupils were asked to stand upright in a relaxed manner, feet comfortably apart, weight evenly balanced on both feet and with their arms by their sides. Pupils were asked to hold the measuring tape on the right hand side of their waist and to turn fully around. If required the measuring tape was then adjusted to ensure it was parallel and not indented. The tape was then gently pulled together whilst not compressing the skin. Pupils were then asked to inhale and then exhale. The measurement was recorded when pupils fully exhaled.

Bioelectrical Impedance Analysis

It is recommended that BIA measurements should be taken under the following conditions;

- Measure participants three hours after they wake up
- Measure participants three hours or more after last eating
- Measure twelve hours or more after vigorous exercise
- Remove bodily fluids before the measurement.

Bioelectrical Impedance Analysis machine

Figure 11: Tanita BC 418 MA

These conditions are recommended as impedance can vary due to changes in the quantity and distribution of body water. However due to the testing environment no attempt was made to compose these recommendations.

Pupils were advised to remove their socks, jewellery/metal objects worn around the wrist or ankle prior to having their body composition measurements taken. The display screen was covered to ensure pupils remained unaware of their measurements. Each pupil's gender, age and height details were entered, on the ready mark pupils were instructed to step onto the Tanita, ensuring their heels and toes were touching the posterior and anterior

electrodes, with their hands hanging by their sides, holding the grip handles. Pupils were advised that this would take a few seconds to complete and to remain still.

Blood Pressure

Suitable cuff sizes were placed on pupil's left arm (small to medium: 17-32cm; medium to large: 22-42cm) ensuring the skin was not pinched and the arm was kept at heart level with palm facing up. The bottom of the cuff was placed 2cm above the elbow with the BP tube in line with the middle finger. Pupils were asked to remain still and quiet until the test was complete.

Knowledge and Attitude survey

The survey was completed in a quiet area in the same room as the other measurements. Pupils were questioned on an individual basis by a member of the Project Spraoi team about their knowledge and attitudes towards healthy eating (Sport Waikato and Auckland University of Technology, 2011). The questionnaire did not exceed five minutes to complete.

550m run

Preparing the fitness test

Prior to commencing the intervention a rope > 110m was sourced for outlining the course of 550m run. The rope was cut with an excess of 3cm as a precaution, the 110m mark was clearly marked on the rope. The run was constructed as an oval shaped course to avoid tight corners and allow a good wide straight at the start to reduce the possibility of pupils stumbling (Sport Waikato and the Auckland University of Technology, 2011).

Height and width dimensions of the oval were based on the size guide provided by Project Energize (h26.5m, w42.5m). After measuring the height and width of the oval two pieces of different coloured rope were cut at the 26.5m and 42.5m mark respectively. These two separate pieces of rope were used as measuring guides for constructing the oval shaped course. All measurements were conducted using a trundle wheel and were repeated three times on a flat surface area from a specified start point.

Completing the 550m run

Groups of six to eight pupils from the evaluation cohort were taken to complete the run. As part of the warm up pupils completed two laps of the course led by a member of the Project Spraoi team. Pupils walked the first lap of the course followed by a light jog for the second lap. The CIT member remained in front of the pupils at all times to ensure pupils did not over-exert themselves during the warm up. Pupils completed full body stretches for the remainder of the warm up upon completing the two laps.

Pupils were given different coloured bibs to identify them while completing the run. Pupils lined up at the start line and were instructed to complete five laps of the 110m course as fast as they could. Pupils were informed that they would be notified how many laps were remaining after each lap was completed. Pupils could walk, slow down, and stop at any stage. How fast pupils completed the 550m run, measured by the time they took, provided an indirect measure of their cardiovascular fitness (Sport Waikato and the Auckland University of Technology, 2011).

One recording was made for each pupil on a recording sheet (copyright). Pupils who did not finish the run were not forced to complete the course. Pupils performed cool down stretches for two minutes after completing the run. On returning these pupils to class, another group of pupils were then called out to complete the run.

Accelerometer information sheet

1. What does it do?

Tell us how active you are while you wear it.

2. How do I wear it?

You can wear it underneath your clothes and school uniform.

3. When do I wear it?

When you get up in the morning and until you go to bed at night. You can also wear them while playing loads of fun games!

4. **When do I not wear it?**

5. **How long do I wear it?**

Days

6. **What happens if I forget to wear it?**

Put it on when you do remember to wear it and let me know that you forgot. You will not get in trouble so don't worry

7. **What happens if I lose it?**

Ring me as soon as possible. You will not get in trouble. I will help you try to find it. (Mobile number)

Appendix F

Project Spraoi Questionnaire for parents/guardians for one child (a)

Project Spraoi Questionnaire for parents/guardians for two or four children (b)

Project Spraoi Questionnaire for parents/guardians for three or five children (c)

Project Spraoi Questionnaire (a)

To answer type 'Yes' into the box that best describes your level of agreement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. I am aware of Project Spraoi and its goals					
2. Project Spraoi has had a positive impact on my child's physical activity (PA) levels					
3. Project Spraoi has had a positive impact on decreasing my child's sedentary time					
4. Project Spraoi had a positive impact on improving my child's nutritional knowledge					
5. As a result of Project Spraoi my child's attitudes towards PA has positively changed					

Q.6 Did you attend any of the nutritional presentations? _____

If yes skip to Question 7.

If no, skip to Question 8.

Q. 7 (a) Which presentations did you attend? Sugary drinks ☐

Breakfast and Four food groups ☐

(b) Did you find the nutritional presentations informative? _____

Please provide feedback

_____

_____

_____

(c) Did you make any changes to your grocery shopping after attending the presentations? _____

Please provide feedback

_____

_____

_____

Q.8 Can you tick a box that best describes a reason why you were unable to attend the presentations.

Time/date was not suitable ☐

Work commitments ☐

Topic did not interest me ☐

Other: _____

Q.9 Did you find the nutritional magnets 'tip sheets' useful? _____

Please provide feedback

_____

_____

_____

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Q.10 I hope the school will continue to implement Project Spraoi for the next academic year					

Please write down any feedback you may have regarding Project Spraoi.

_____

_____

_____

_____

_____

_____

_____

Thank you!

Project Spraoi Questionnaire (b)

How many children do you have attending X School? _____

Note: If you have two/four children attending X please consider your 'middle' child when completing this questionnaire.

To answer type 'Yes' into the box that best describes your level of agreement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. I am aware of Project Spraoi and its goals					
2. Project Spraoi has had a positive impact on my youngest child's physical activity (PA) levels					
3. Project Spraoi has had a positive impact on my oldest child's physical activity (PA) levels					
4. Project Spraoi has had a positive impact on decreasing my youngest child's sedentary time					
5. Project Spraoi has had a positive impact on decreasing my oldest child's sedentary time					
6. Project Spraoi had a positive impact on improving my youngest child's nutritional knowledge					
7. Project Spraoi had a positive impact on improving my oldest child's nutritional knowledge					
8. As a result of Project Spraoi my child's attitudes towards PA has positively changed					

Q.9 Did you attend any of the nutritional presentations? _____

If yes skip to Question 10.

If no, skip to Question 11.

Q. 10 (a) Which presentations did you attend? Sugary drinks ☐

Breakfast and Four food groups ☐

(b) Did you find the nutritional presentations informative? _____

Please provide feedback

_____

(c) Did you make any changes to your grocery shopping after attending the presentations? _____

Please provide feedback

_____

_____

_____

Q.11 Can you tick a box that best describes a reason why you were unable to attend the presentations.

Time/date was not suitable ☐

Work commitments ☐

Topic did not interest me ☐

Other: _____

Q.12 Did you find the nutritional magnets 'tip sheets' useful?

_____

Please provide feedback

_____

_____

_____

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Q.13 I hope the school will continue to implement Project Spraoi for the next academic year					

Please write down any feedback you may have regarding Project Spraoi.

_____
_____
_____
_____
_____
_____
_____

Thank you!

Project Spraoi Questionnaire (c)

How many children do you have attending X School? _____

Note: If you have three/five children attending X please consider your 'middle' child when completing this questionnaire.

To answer type 'Yes' into the box that best describes your level of agreement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. I am aware of Project Spraoi and its goals					
2. Project Spraoi has had a positive impact on my youngest child's physical activity (PA) levels					
3. Project Spraoi has had a positive impact on my oldest child's physical activity (PA) levels					
4. Project Spraoi has had a positive impact on decreasing my youngest child's sedentary time					
5. Project Spraoi has had a positive impact on decreasing my oldest child's sedentary time					
6. Project Spraoi had a positive impact on improving my youngest child's nutritional knowledge					
7. Project Spraoi had a positive impact on improving my oldest child's nutritional knowledge					
8. As a result of Project Spraoi my child's attitudes towards PA has positively changed					

Q.9 Did you attend any of the nutritional presentations? _____

If yes skip to Question 10.

If no, skip to Question 11.

Q. 10 (a) Which presentations did you attend? Sugary drinks ☐

Breakfast and Four food groups ☐

(b) Did you find the nutritional presentations informative? _____

Please provide feedback _____

(c) Did you make any changes to your grocery shopping after attending the presentations? _____

Please provide feedback

_____

_____

_____

Q.11 Can you tick a box that best describes a reason why you were unable to attend the presentations.

Time/date was not suitable ☐

Work commitments ☐

Topic did not interest me ☐

Other: _____

Q.12 Did you find the nutritional magnets 'tip sheets' useful? _____

Please provide feedback

_____

_____

_____

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Q.13 I hope the school will continue to implement Project Spraoi for the next academic year	1	2	3	4	5

Please write down any feedback you may have regarding Project Spraoi.

_____
_____
_____
_____
_____
_____
_____

Thank you!

Appendix G

Data Analysis and Results

(Please find enclosed a compact disc)