Project Spraoi: The implementation and outcomes of a process evaluation of a school-based health promotion intervention

Yvonne Larrissa O’Byrne
Department of Sport, Leisure and Childhood Studies, Munster Technological University, Cork, Ireland, yvonne.obyrne@mycit.ie

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Project Spraoi: The implementation and outcomes of a process evaluation of a school-based health promotion intervention

Yvonne O’Byrne
Department of Sport, Leisure and Childhood Studies
PhD

Candidate Supervisors: Dr Tara Coppinger and Joan Dinneen
Submitted to Munster Technological University in January 2022
Author’s declaration

I (Yvonne O’Byrne) 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 Munster Technological University’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.

Signed: ____________________________  Date: 13/01/2022

Yvonne O’ Byrne (Candidate)

Signed: ____________________________  Date: 13/01/2022

Dr Tara Coppinger (Supervisor)

Signed: ____________________________  Date: 13/01/2022

Joan Dinneen (Supervisor)
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Finally, I’d like to dedicate this work to my mum. Although you’re not here with me as I come to the end of my journey, your support for me when I began this study is not forgotten and I hope you will look down and be proud of what I’ve achieved.
Project Spraoi: The implementation and outcomes of a process evaluation of a school-based health promotion intervention

Yvonne O’ Byrne

Abstract

Large multi-site school-based interventions are challenging to implement and difficult to evaluate due to the complex adaptive nature of schools as a research setting. This study focused on implementing a comprehensive process evaluation of a multicomponent primary school-based health promotion called Project Spraoi (PS), alongside intervention delivery, to aid the translation of outcomes and understand the moderating role of contextual factors on intervention delivery.

PS is led by a physical activity (PA) specialist known as an Energizer and aims to improve children’s PA levels and reduce sedentary time by delivering 20 minutes extra daily moderate to vigorous PA (MVPA) during the school day, alongside implementing healthy eating lessons to improve children’s nutritional knowledge. The methods for process evaluation used in this study were guided by the three themes outlined by Moore et al., (2015); (i) implementation, (ii) context and (iii) mechanisms of impact. Themes were further subcategorised into six evaluation dimensions; (i) barriers and facilitators, (ii) adaptations, (iii) fidelity, (iv) dose delivered, (v) activities, and (vi) interactions. A variety of evaluation tools developed for PS were piloted and refined in one school (school A) during the first year of this study (2014/15), before being applied to all active intervention schools (n=5) in the following academic year (2015/16). Triangulation of findings was achieved by using multiple tools to measure the same evaluation dimension and the inclusion of a large sample of diverse stakeholders, including teachers (n=74), school support staff (n=30), Energizers (n=5), and children (n=582).

This study found that there was significant variability in how PS was delivered across schools and that fidelity to PS was generally low with the mean amount of extra daily MVPA delivered by teachers varying between 10.39 and 16.22 minutes/day. Contextual factors including a lack of time due to curriculum constraints and limited access to facilities inhibited the delivery of PS, while the Energizer was recognised as having a moderating role as the main facilitator to PS. Most importantly, the learnings from this study contribute to the literature a set of guidelines and support tools to aid future researchers in planning and implementing a robust process evaluation in a primary school setting.
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<th>Description</th>
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<tr>
<td>ASF</td>
<td>Active School Flag</td>
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<td>AST</td>
<td>Active School Transport</td>
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<tr>
<td>Be Active ASAP</td>
<td>Be Active After School Activity Programme</td>
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<td>BF</td>
<td>Body Fat</td>
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<td>BMI</td>
<td>Body Mass Index</td>
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<td>BP</td>
<td>Blood Pressure</td>
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<td>BPM</td>
<td>Beats Per Minute</td>
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<tr>
<td>CAQDAS</td>
<td>Computer Assisted Qualitative Data Analysis Software</td>
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<td>CARA</td>
<td>Contextual Action-Oriented Research Approach</td>
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<tr>
<td>CDC</td>
<td>Centre for Disease Control and Prevention</td>
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<tr>
<td>CHANGE</td>
<td>Children’s Health, Activity, Nutrition: Get Educated</td>
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<td>CIT</td>
<td>Cork Institute of Technology</td>
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<td>COSI</td>
<td>Childhood Obesity Surveillance Initiative</td>
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<td>CRF</td>
<td>Cardiorespiratory Fitness</td>
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<td>CSO</td>
<td>Central Statistics Office</td>
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<td>CSPPA</td>
<td>Children’s Sport Participation and Physical Activity Study</td>
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<td>CVD</td>
<td>Cardiovascular Disease</td>
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<td>DEIS</td>
<td>Delivering Equality of Opportunity in Schools</td>
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<tr>
<td>DES</td>
<td>Department of Education and Skills (Ireland)</td>
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<tr>
<td>DEXA</td>
<td>Dual Energy X-ray Absorptiometry</td>
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<tr>
<td>DHC</td>
<td>Department of Health and Children (Ireland)</td>
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<td>DI</td>
<td>Dietary Intake</td>
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<td>DOH</td>
<td>Department of Health (Ireland)</td>
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<td>Acronym</td>
<td>Description</td>
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<tr>
<td>EU</td>
<td>European Union</td>
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<td>FFM</td>
<td>Fat Free Mass</td>
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<td>FM</td>
<td>Fat Mass</td>
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<td>FMS</td>
<td>Fundamental Movement Skills</td>
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<td>FRAME</td>
<td>Framework for Reporting Adaptations Modifications-Expanded</td>
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<td>GUI</td>
<td>Growing Up in Ireland</td>
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<td>HBSC</td>
<td>Health Behaviour in School Aged Children</td>
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<td>HSE</td>
<td>Health Service Executive</td>
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<td>IOTF</td>
<td>International Obesity Task Force</td>
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<td>IHF</td>
<td>Irish Heart Foundation</td>
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<td>ITT</td>
<td>Intention to Treat Principle</td>
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<td>IUNA</td>
<td>Irish Universities Nutrition Alliance</td>
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<td>LBM</td>
<td>Lean Body Mass</td>
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<td>METs</td>
<td>Metabolic Equivalents</td>
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<td>MOU</td>
<td>Memorandum of Understanding</td>
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<td>MRI</td>
<td>Magnetic Resonance Imaging</td>
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<td>MRC</td>
<td>Medical Research Council</td>
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<td>MVPA</td>
<td>Moderate to Vigorous level of Physical Activity</td>
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<td>NCHS</td>
<td>National Center for Health Statistics</td>
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<td>NHPS</td>
<td>National Health Promotion Strategy</td>
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<td>NI</td>
<td>Northern Ireland</td>
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<td>NK</td>
<td>Nutritional Knowledge</td>
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<td>NPT</td>
<td>Normalisation Process Theory</td>
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<td>NTFO</td>
<td>National Task Force on Obesity</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>PA</td>
<td>Physical Activity</td>
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<td>PAAC</td>
<td>Physical Activity Across the Curriculum</td>
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<td>PE</td>
<td>Physical Education</td>
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<td>PS</td>
<td>Project Spraoi</td>
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<td>PENZ</td>
<td>Project Energize New Zealand</td>
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<tr>
<td>RCT</td>
<td>Randomised Control Trial</td>
</tr>
<tr>
<td>RE-AIM</td>
<td>Reach, Efficacy, Adoption, Implementation, Maintenance</td>
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<tr>
<td>RoI</td>
<td>Republic of Ireland</td>
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<tr>
<td>RPE</td>
<td>Rating of Perceived Exertion</td>
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<td>SES</td>
<td>Socio Economic Status</td>
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<tr>
<td>SOFIT</td>
<td>System for Observing Fitness Instruction Time</td>
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<tr>
<td>SPARK</td>
<td>Sports, Play, and Active Recreation for Kids</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
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<td>SSBs</td>
<td>Sugar Sweetened Beverages</td>
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<td>ST</td>
<td>Sedentary Time</td>
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<tr>
<td>StarRI</td>
<td>Standards of Reporting Implementation Studie</td>
</tr>
<tr>
<td>WAVES</td>
<td>West Midland ActiVe lifestyle and healthy Eating in School</td>
</tr>
<tr>
<td>WCHt</td>
<td>Waist Circumference to Height ratio</td>
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<tr>
<td>WDHB</td>
<td>Waikato District Health Board</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
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<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>Activities</td>
<td>Specific intervention components implemented to achieve the intervention’s goals.</td>
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<tr>
<td>Adaptations</td>
<td>Changes made to the design or delivery of interventions, whether deliberately and proactively, or in reaction to unanticipated challenges that arise in a given session or context.</td>
</tr>
<tr>
<td>Barriers</td>
<td>Problems encountered in implementing intervention components and reaching participants.</td>
</tr>
<tr>
<td>Complex interventions</td>
<td>A programme of multiple interconnected components, which may be delivered or implemented in a variety of ways.</td>
</tr>
<tr>
<td>Context</td>
<td>Anything external to an intervention that may act as a barrier or facilitator to its implementation or its effects.</td>
</tr>
<tr>
<td>Dose</td>
<td>The amount of intervention delivered and the extent to which participants responded to it.</td>
</tr>
<tr>
<td>Drift</td>
<td>Implementation that compromises or does not align to an intervention’s core components or theories of change.</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>The extent to which an intervention’s objectives were achieved, or are expected to be achieved, taking into account their relative importance.</td>
</tr>
<tr>
<td>Energizer</td>
<td>A trained physical activity and nutrition change agent, who works with intervention schools to achieve goals based on delivering quality daily physical activity and healthier eating.</td>
</tr>
<tr>
<td>Facilitators</td>
<td>Elements that promote the successful implementation of intervention components and/or reaching participants.</td>
</tr>
<tr>
<td>Fidelity</td>
<td>The extent to which an intervention was delivered as intended.</td>
</tr>
<tr>
<td>Health Promotion</td>
<td>Process of enabling people to increase control over, and to improve, their health. It moves beyond a focus on individual behaviour towards a wide range of social and environmental interventions.</td>
</tr>
<tr>
<td>Implementation</td>
<td>A composite score of fidelity, dose and reach.</td>
</tr>
<tr>
<td><strong>Innovation</strong></td>
<td>Skilled implementers actively attempting to make an intervention better fit their population or setting.</td>
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<tr>
<td><strong>Interactions</strong></td>
<td>How participants relate and react to intervention activities.</td>
</tr>
<tr>
<td><strong>Intervention</strong></td>
<td>A combination of programme activities or strategies which attempt to positively disrupt the prior functioning of a system and/or positively influence population behaviours.</td>
</tr>
<tr>
<td><strong>Mechanisms of Impact</strong></td>
<td>How a delivered intervention produces change.</td>
</tr>
<tr>
<td><strong>Moderators of implementation</strong></td>
<td>Effectiveness of strategies to facilitate implementation e.g. how effectively resources are applied.</td>
</tr>
<tr>
<td><strong>Process Evaluation</strong></td>
<td>Evaluations used to explain how complex interventions work.</td>
</tr>
<tr>
<td><strong>Reach</strong></td>
<td>The proportion of the target population that participated in an intervention.</td>
</tr>
<tr>
<td><strong>Subversion</strong></td>
<td>Implementers actively choose not to adopt aspects of an intervention which conflict with their values or theories of change.</td>
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Chapter 1: Introduction
1.1 Introduction

Multi-component school-based health promotion interventions are challenging to implement and often difficult to evaluate (Schneider et al., 2009), given the complex nature of the school setting and the unpredictable interplay of the diverse actors such as teachers, students, parents and other stakeholders involved (Keshavarz et al., 2010). Unlike many other research trials which are delivered under controlled conditions, public health interventions in schools are subject to a diverse range of real-life factors which can influence the overall study outcomes (Keshavarz et al., 2010; Moore et al., 2015). However, many such studies have omitted from their planned data collection any systematic evaluation of how the intervention was delivered and/or received in context (Armstrong et al., 2008), often leaving gaps in the interpretation of outcomes. A previous systematic review of school-based interventions reported that only three out of ten long-term (at least 12 months) randomised childhood obesity prevention intervention studies reported information that might be used to explain the success or failure of the intervention (Brown et al., 2009).

The existing literature provides evidence to suggest successful outcomes of health promotion interventions depend not only on the existence of the different intervention components needed to achieve behaviour change but also on the extent to which they are implemented in their intended setting (Durlak and DuPre, 2008). Therefore, a greater understanding of context and how and to what extent interventions are implemented to ensure system-wide sustainability is required. Within the school setting, a meta-synthesis of 18 qualitative studies, which explored the views of parents, school staff and students on the overall role of the primary school in preventing childhood obesity, concurred that the school is an important setting for obesity prevention, in promoting and providing opportunities for healthy eating and physical activity and the need for schools to work with parents (Clarke et al., 2013). An Irish review of two school-based interventions (Food Dudes and Green Schools Travel) concluded that successful implementation and scale up of anti-obesity interventions in schools is dependent on good contextual fit, engagement and leadership at multiple levels, and secure funding (Hayes et al., 2019). However, the study by Hayes et al. (2019) was limited in that it only included the perspectives of implementers of the intervention programmes (teachers and project coordinators) and failed to consider the insights of participants (children)). This study adds to that of Hayes et al., (2019) by considering the perspectives of both implementers and participants of PS.
Process evaluation adds value to the analysis of multicomponent school-based interventions by documenting characteristics of the intervention delivered, and by eliciting information about barriers to and/or facilitators of the intervention and its components in specific contexts (Schneider et al., 2009; Hall et al., 2014). Such data enables policy makers and implementers to fine-tune intervention activities as they transfer intervention theory to practice, or to new contexts, and design new health promotion interventions targeting children in a similar environment.

1.2 Purpose and methods of this study
In order to aid the transparency of implementation, the translation of findings and to identify what factors acted as key barriers and facilitators to the implementation of PS in diverse contexts, this study’s primary focus was to implement a comprehensive process evaluation alongside intervention delivery. The methodology for process evaluation developed for PS during this study was piloted and refined in one school (school A) during the first year of this study (2014/15) before being applied to all active intervention schools (n=5) in the following academic year (2015/16).

The methods for process evaluation used in this study were guided by the three themes for process evaluation outlined by Moore et al., (2015): (i) implementation, (ii) context and (iii) mechanisms of impact. These three themes were then further sub-categorised into six evaluation dimensions: (i) fidelity, (ii) dose delivered, (iii) adaptations, (iv) barriers and facilitators, (v) activities and (vi) interactions. A combination of suitable quantitative and qualitative data collection tools was identified from the literature, piloted and refined for PS. Triangulation of findings was achieved by using multiple tools including surveys, PA logs, reflective journals, and write and draw and semi-structured interviews to measure the same evaluation dimension (Griffin et al., 2014). The inclusion of a large sample of diverse stakeholders was also used to triangulate findings and improve the reliability of qualitative data (Carter et al., 2014; Shenton et al., 2004). Over the course of two years, this study evaluated the varying contributions of teachers (n=74), school support staff (n=30), Energizers (n=5), and children (n=582) across six intervention schools. This sample provided a comprehensive, multi-perspective understanding of the delivery of the PS intervention from the primary actors involved, capturing the challenges faced by the different school contexts, and suggesting innovations to aid the translation of PS into a real-world setting.
This study will contribute to the literature as the first comprehensive process evaluation of an Irish multi-component school-based health promotion intervention. Furthermore, the process evaluation data collected during this study will provide policy makers with an insight into the Irish primary school context and the challenges faced by schools when trying to implement health promoting changes. The findings from this study will help in the planning, design, implementation and evaluation of future school-based multi-component health promotion interventions.

As implementation science is an emerging area in PA research (Naylor et al., 2015), this study sought, secondly, to investigate the effectiveness of a step-back approach to the delivery of PS in which, over the course of three years, the Energizer gradually reduced contact time with the intervention school and gave class teachers increased autonomy over intervention delivery to simulate a less controlled, real life context. This approach intended to evaluate the sustainability of PS, while also examining the moderating role of the ‘Energizer’ in the delivery of intervention activities and their impact on pre-specified health markers in a targeted child cohort. This information will enable the transfer of PS from a research context to reality.

1.3 Rationale for intervention
Childhood obesity is a serious public health concern both globally (Nittari et al., 2019) and in Ireland (Mitchell et al., 2020; Bel-Serrat et al., 2017). Despite encouraging evidence to suggest the stabilising of childhood obesity rates (O Donnell et al., 2020; Mitchell et al., 2020; Keane et al., 2014), current rates of overweight and obesity in Ireland remain high among the childhood population (20%) (Jennings et al., 2018). Data from the Childhood Obesity Surveillance Initiative (COSI) report in Ireland, indicated that approximately one in five primary school children are overweight or obese (Mitchell et al., 2020). This is cause for concern given the negative long-term health and social consequences of childhood obesity (Jennings et al., 2018), with its adverse health impacts also likely to continue into adolescence and adulthood (Nittari et al., 2019; Reilly and Kelly, 2011). Establishing healthy behaviours at an early age is important as they may help to improve children’s health and wellbeing and can have a long-lasting influence on their health status into adolescence and later in life (Jennings et al., 2018).

Intervention strategies are widely used in an attempt to prevent and reduce the prevalence of overweight and obesity in children (Bleich et al. 2018). Studies have shown positive
outcomes from interventions that target the promotion of both PA and healthy eating among children (Dabravolskaj et al., 2020; Brown et al. 2016; Wang et al. 2015). The literature is saturated with systematic reviews demonstrating the effectiveness of school-based approaches (Naylor et al., 2015; Dobbins et al., 2013; Van Sluijs et al., 2007; Dudley et al., 2011; Kriemler et al., 2011; Lai et al., 2014), and highlighting the importance of multi-component models (Naylor et al., 2015; Kriemler et al., 2011; Van Sluijs et al., 2007). School-based interventions with combined diet and physical activity components have been reported to have the greatest effect at tackling childhood overweight and obesity (Bleich et al., 2018). Although findings support programmes delivered in the school environment (Bleich et al. 2018), prior to Project Spraoi, there were no multicomponent interventions being delivered in Ireland that aimed to simultaneously improve both PA and nutritional knowledge and attitudes among children.

In New Zealand (NZ), one such intervention has been in existence since 2004. ‘Project Energize’ (PENZ) (https://www.sportwaikato.org.nz/programmes/team-energize.aspx) is a fully evaluated school-based health promotion intervention (Project Energize, Sport Waikato, and Auckland University of Technology 2015). The PENZ intervention has reported positive effects on the fitness, nutritional behaviour and the prevalence of children categorised as being overweight and/or obese (Project Energize, Sport Waikato, and Auckland University of Technology, 2015).

In response to the success of this programme, and the need for intervention among Irish children, in 2013, a school-based health promotion programme, based on PENZ, was developed. This intervention, named ‘Project Spraoi’ (www.cit.ie/projectspraoi), aimed to improve the health status of Irish primary school children by promoting increased daily PA and improving nutrition knowledge and behaviours.

1.3.1 Background of Project Spraoi
‘Project Spraoi’ is a specialist-led multicomponent school-based health promotion intervention which was developed by a research team in the Department of Sport, Leisure and Childhood Studies at Munster Technological University, previously known as Cork Institute of Technology. Implemented as a randomised control trial (RCT) (reg: ISRCTN92611015), Project Spraoi promoted PA and healthy eating habits in primary schools through an ‘Energizer’ led intervention that was delivered in Cork, Ireland. Since its initiation
in 2013, the larger Project Spraoi RCT, has included 11 primary schools in its evaluation. Within the context of the larger RCT, a team of 9 researchers working with Project Spraoi have each conducted distinct research projects investigating children’s PA levels, nutritional knowledge and attitudes, dietary intake, sedentary behaviour and fundamental movement skills (O’Leary et al., 2018; Bolger et al., 2018; Merrotsy et al., 2018).

Central to the delivery of PS was each researcher’s ability to act as an ‘Energizer’ and to be an ‘agent of change’ within their intervention school(s) (Coppinger et al., 2016). This included leading healthy lifestyle initiatives, modelling PA and healthy eating classes, and providing resources on PA and healthy eating to help teachers achieve the intervention goals of delivering 20 minutes extra daily moderate-vigorous physical activity (MVPA) to students during the school day and improving student’s nutritional knowledge and behaviours (Coppinger et al., 2016). As advocated for in the literature (Naylor et al., 2015; Egan et al., 2018; Bleich et al., 2018), a whole school approach to intervention delivery was adopted by PS, with all classes (n=11) in the school receiving equal contact time with the Energizer each week. On the days when the Energizer was not present, each teacher was responsible for delivering 20 minutes MVPA to all students in their class to meet the requirements of the intervention.

As outlined in Chapter 3 (Table3.3), each Energizer had a specific research focus which was decided before the commencement of the intervention. The research focus of each Energizer was decided in consultation with the wider PS research team based in MTU and in response to feedback from schools, with topics assigned based on researcher’s individual interests and competencies. Evaluations of PS to date have reported positive impacts on the prevalence of overweight and obesity, as well as a wide range of health markers including waist circumference, cardio-respiratory fitness, PA levels, fundamental movement skills and dietary behaviours of Irish primary school children (O’Leary et al., 2018; Bolger et al., 2018; Merrotsy et al., 2018). Furthermore, PS has been found to positively impact the school context and those who interact with it, including teachers, parents and pupils (O’Leary et al., 2019).
1.3.2 Research focus of this study
The current study fills a gap within the larger PS RCT by implementing a rigorous methodology to evaluate the process by which PS operated to achieve its intended effects. This included:

1. Examining the moderating role of the school context on the extent to which the PS intervention was implemented as intended across multiple schools.
2. Evaluating a step-back approach of the PS intervention in a rural mixed gender school over the course of three academic years (2013-2016).
3. Evaluating the moderating role of the ‘Energizer’ on the outcomes of PS.

1.4 Thesis overview
This thesis is presented in 6 chapters, a summary of which is provided below.

Chapter 1 contains a brief introduction to the PhD study, outlining the background of PS and the gap that this study fills within the literature and the larger research group. The research questions that this study aims to answer are outlined and a brief overview of the contribution the research will make to the field is provided.

Chapter 2 provides the reader with an in-depth review of the literature surrounding the process evaluation of complex interventions in the school and other contexts. A review of literature on the determinants of overweight and obesity, contributors to the creation of an obesogenic environment and health promoting strategies to tackle the problem, is also provided. The chapter concludes with a review of a number of case studies of similar school-based intervention strategies.

Chapter three presents the methodology used throughout this study. It begins by describing the study timeline and detailing the multifaceted evaluation, including the rigorous pilot of the chosen methodology for process evaluation in School A and the expansion of these methods in the following year to all evaluation schools (n=7). This chapter also provides a brief summary of the methodology used to evaluate the longitudinal impact of a step-back approach to PS in School A. A more detailed description of the methods for impact evaluation used in PS has been published elsewhere; this thesis will refer to that publication throughout (Coppinger et al., 2016).

Chapters four and five present the outcomes of this study as stand-alone academic papers, each structured with an introduction, methodology, results, discussion and conclusion.
Chapter four, has been submitted and is under review by the Journal of Irish Educational Studies. It describes the outcomes of the step-back approach to the implementation of PS, alongside the piloted methods for process evaluation at a rural, mixed gender primary school, known throughout the thesis as School A. Chapter five, which is currently being prepared for submission to an academic journal, presents the findings of the expanded process evaluation of PS to all active PS intervention (n=5) and control schools (n=2).

Chapter six, the final chapter of this thesis, summarises the key findings of this study and details the practical implications of these findings in order to provide recommendations for future research; including a proposed framework for planning and implementing comprehensive process evaluations. The considerations for future researchers described in this chapter are based on the learnings of the tailored methodology for process evaluation of PS implemented during this study.
Chapter 2: Literature Review
2.1 Introduction

This chapter aims to provide the reader with an in-depth review of the literature surrounding the process evaluation of complex interventions in the school and other contexts. A review of the literature discussing the determinants of overweight and obesity, contributors to the creation of an obesogenic environment and health promoting strategies to tackle the problem is also provided. The structure of this chapter is presented in five distinct, but related, sections:

1. Section 2.2 – What process evaluation is and its relevance within complex interventions. This section includes an overview of the different process evaluation frameworks and data collection tools commonly reported in school-based health promotion literature.
2. Section 2.3 - The complexity of the primary school environment and summary of the challenges faced within the school context. Specifically, this section discusses how complex interventions are introduced and sustained in the school environment, and critically examines the suitability of schools as a setting for intervention.
3. Section 2.4 - Overview of both the national and global overweight and obesity statistics, including its trends and prevalence among Irish children and the determinants of overweight and obesity identified in the literature.
4. Section 2.5 - Global and national strategies taken to tackle overweight and obesity. In addition to policy and surveillance initiatives, this section also examines the role that physical activity and sedentary time play in tackling childhood overweight and obesity.
5. Section 2.6 - The effectiveness of both PA and multicomponent interventions on improving a variety of health markers in children. It also outlines a variety of different process evaluation methodologies previously used in school-based health promotion interventions.

For this literature review, recent and relevant studies were identified by searching the following electronic databases: ScienceDirect, PubMed and SPORT Discus. The reference lists of identified articles were also screened for additional relevant papers or articles, which were also included. Key terms used in the search included: process evaluation, implementation, health promotion, children, youth, intervention, primary school, elementary school, qualitative, barriers, facilitators. Following the search, duplicates were removed and the title
and abstract of the remaining retrieved files screened. Relevant books, book chapters and unpublished theses were also included in the literature review.

2.2 Process Evaluation

A significant challenge faced by public health researchers is to understand if, why and how an intervention has worked in a real-world context, and to explain how research that has demonstrated effectiveness in one context may or may not be effective in another context or setting (Peters et al., 2013). Process evaluation provides a means for researchers to understand and translate the outcomes resulting from complex interventions that often have nonlinear implementation processes (Limbani et al., 2019). Most studies are designed to investigate and report whether an intervention is effective in relation to one, or more, measurable outcomes, such as PA levels. Process evaluations aid this investigation by providing additional information on the implementation process, how different structures and resources were used, the role, participation and reasoning of different stakeholders, contextual factors, and how all these might have impacted the pre-defined outcomes (Oakley et al., 2006; Moore et al., 2015).

Several authors have argued that in complex interventions, process measures used to examine the success of the implementation strategy, should be conducted separate from outcome measures that assess the success of the intervention itself (e.g., Moore et al., 2015). This opinion is further consolidated by the Standards of Reporting Implementation Studies (StarRI) (Pinnock et al., 2017).

2.2.1 Process Evaluation Frameworks

This section includes several key frameworks that highlight important aspects for consideration in the development of process evaluation methods for complex interventions. However, currently there is little consensus on frameworks for such evaluation and no gold-standard has been widely accepted to constitute best practice (Limbani et al., 2019). Whilst there is some overlap between the process evaluation frameworks described in the literature presented in this section (Dane et al., 1998; Glasgow et al., 1999; Linnan et al., 2002, Carrol et al., 2007), there are also distinct traits within each framework that distinguish them from one another (Griffin et al., 2014). Combining elements from each of these frameworks provides a comprehensive approach to the measurement of processes and fidelity of implementation in complex interventions (Moore et al., 2015).
2.2.1 (a) RE-AIM (Glasgow et al., 1999)
One of the most commonly used process evaluation frameworks, the RE-AIM framework (Glasgow et al., 1999), presents public health impact as a result of an intervention’s reach (proportion of the target population that participated in the intervention), effectiveness (success rate), adoption (proportion of eligible settings that adopt the intervention), implementation (extent to which the intervention is implemented as intended) and maintenance (extent to which the intervention is maintained over time). The language of this framework somewhat favours quantitative data, with a ‘public health impact score’ perceived as the product of the five dimensions (Glasgow et al., 2006). The RE-AIM framework focuses attention on capturing the extent to which dimensions including implementation are achieved in the short or longer term, though less emphasis is placed on the processes through which this occurs (Moore et al., 2015).

2.2.1 (b) Linnan and Steckler (2002)
Another commonly used framework, outlined by Baranowski and Stables (2000) and refined by Linnan and Steckler (2002), includes seven key dimensions to be evaluated:

➢ Context (environmental aspects of the intervention setting)
➢ Reach (the proportion of participants that received the intervention)
➢ Fidelity (whether the intervention was delivered as planned)
➢ Dose delivered and dose received (the amount of intervention delivered and the extent to which participants responded to it)
➢ Implementation (a composite score of reach, dose and fidelity)
➢ Recruitment (methods used to attract participants)

Linnan and Steckler (2002) emphasise the importance of identifying potential factors that may influence intervention delivery prior to the commencement of the trial, rather than working in retrospect. This framework overlaps to some extent with the five dimensions outlined in the RE-AIM framework above (Glasgow et al., 1999).

2.2.1 (c) Implementation fidelity (Dane and Schneider, 1998)
Fidelity is a component discussed in the process evaluation framework by Linnan and Steckler (2002) and resembles the ‘implementation’ dimension within the RE-AIM framework (Glasgow et al., 1999). However, Dane and Schneider (1998) identified it as an independent
concept to be monitored during interventions. They used the term ‘implementation fidelity’ and defined five dimensions that should be considered in its assessment:

- Adherence (how well the intervention followed recommended methods)
- Exposure (the amount of intervention received by the participants)
- Quality of delivery of the intervention
- Participant Responsiveness (how the participants responded to the different intervention components)
- Programme Differentiation (identifying whether certain aspects of the intervention were more effective than others)

2.2.1 (d) Carroll et al. (2007)
Carroll et al. (2007) propose a conceptual framework that defines fidelity as a combination of content, frequency and duration of delivery, and coverage. Though using different terminology, this definition is almost indistinguishable from what Linnan and Steckler (2002) defined as ‘implementation’ (a combination of fidelity, dose and reach). However, the Carroll et al. (2007) framework goes further in that it invites researchers to examine the processes or ‘moderators of implementation’, such as how effectively resources are applied. The authors highlight the need to consider matters such as intervention complexity, comprehensiveness of the intervention’s description, effectiveness of strategies to facilitate implementation, and how a participant’s response to the intervention moderates delivery. A modification to this framework by Hasson (2010) also adds context and recruitment as moderators of implementation.

2.2.1 (e) Contextual Action-Oriented Research Approach (CARA)
Unlike the frameworks previously described, CARA focuses on generating knowledge and experiences on how to deal with health promotion in complex systems, such as schools (Bartelink et al., 2018). Traditionally, many researchers in school interventions have followed a cycle of needs analysis, intervention development, implementation, monitoring, and evaluation of change (Mertler, 2016). However, the limitation of following these steps is they imply that a logical, causal process exists in schools. In reality, it can be difficult to identify these causal links in a complex school intervention (Bartelink et al., 2018), where agents such as children, teachers, and other school staff are continually interacting with each other and with other contextual aspects of the school (Moore et al., 2015; Rutter et al., 2017).
Basic properties of CARA are its specific focus on contextual differences, and the use of ongoing monitoring and feedback loops to both support and evaluate the process of change (Bartelink et al., 2018). Within this framework, researchers contribute to the process of change by giving feedback throughout and providing schools with a menu of possibilities for additional changes (Bartelink et al., 2018). The approach is centred around four key questions: (1) What is the pre-existing context of each school?; (2) How does the process of change in each school evolve and which factors affect this process?; (3) How can research contribute to the process of change?; and (4) Do children’s health and health behaviours improve as a result of the health promoting changes? (Bartelink et al., 2018).

Although this framework does not recognise the importance of strictly assessing implementation fidelity, it does identify when and how adaptations take place, and which factors prove to be crucial for sustained changes. This specific research focus is based on the idea that even small changes may produce large effects in a specific context at what is termed a ‘tipping’ point (Patton, 2011; Van Kann et al., 2015), and that better implementation of a change or higher fidelity does not always mean greater effect (Moore et al., 2015).

2.2.1 (f) British Medical Research Council (MRC) guidance for process evaluation of complex interventions (Moore et al., 2015)

The MRC (2015) guidance for process evaluation of complex interventions presents one of the most comprehensive frameworks for process evaluation in the current literature. This framework outlines a systematic approach to designing and implementing a process evaluation of a complex intervention and builds upon the three key themes for process evaluation previously outlined in a 2008 MRC publication; intervention implementation, causal mechanisms, and the impact of contextual factors (Moore et al., 2015; Craig et al., 2008).

Although many frameworks and definitions for process evaluation are reported in the literature, quite simply, most researchers who undertake process evaluations are striving to understand what works, for who, under what circumstances and why. In this study, the framework presented by Moore et al., (2015) was adopted and the planned process evaluation for PS was framed under the three themes identified and described in section 2.2.2 below. Under the implementation theme, this study aimed to discover ‘what works’, while the mechanisms of impact aided the interpretation of ‘who the intervention worked for and
why’. Finally, through understanding the individual school contexts, we were able to evaluate ‘under what circumstances’ PS was effective. However, in addition to the three themes identified in the MRC framework (Moore et al., 2015), elements of PS also resembled the CARA framework (2.2.1 e), with the Energizer directly involved as a researcher in the implementation process, providing ongoing monitoring and feedback loops to both support and evaluate the process of change.

2.2.2. Themes for process evaluation

2.2.2 (a) Implementation

In order to enable conclusions about ‘what works’, process evaluation will normally aim to capture ‘fidelity’ (whether the intervention was delivered as intended) and ‘dose’ (the quantity of intervention delivered). Process evaluations of intervention implementation also commonly investigate the ‘reach’ of interventions (Glasgow et al., 1999). However, the assessment of reach has been excluded by past studies that report interventions implemented under controlled conditions such as schools, where students are not given the opportunity to ‘opt out,’ due to the intervention being delivered to entire class groups through the school environment (Schneider et al., 2009).

Currently, there is no consensus on how best to divide the study of implementation into key subcomponents (such as fidelity, dose, and reach). This may be due to the many combinations of varying subcomponents and different terminology included in the evaluation of implementation across the different process evaluation frameworks and the wide range of differing process evaluation methods reported in trials (Grant et al., 2013).

Analysing the intervention that was delivered and received by stakeholders can help to interpret the linkages between expected and observed intervention outcomes (Griffin et al., 2014). The limited effectiveness of a complex intervention may be attributed to weaknesses in its design or because of improper implementation (Linnan et al., 2002). In contrast, positive intervention outcomes can sometimes be achieved even when an intervention was not delivered as intended (Moore et al., 2015). In addition to ‘what’ was delivered, process evaluations can help to investigate ‘how’ the intervention was delivered (Carrol et al., 2007; Montgomery et al., 2013.) This can provide policy makers and practitioners with vital information about how the intervention might be replicated, as well as how it is delivered in practice. When used alongside close reference to the theory of the intervention, process
evaluation can enable researchers to distinguish between adaptations to make the intervention fit different contexts and changes that undermine intervention fidelity (Hawe et al., 2004; Bumbarger et al., 2008).

2.2.2 (b) Causal mechanisms of impact
Causal mechanisms of impact may simply be described as the intervention’s theories of change (Moore et al., 2015). Complex interventions usually have multiple related intervention components, which may each contribute individually or collectively to different aspects of the overall trial outcomes. Exploring the mechanisms through which interventions bring about change is crucial to understanding both how the effects of each specific intervention component occurred and how these effects might be replicated by similar future interventions (Grant et al., 2013). The 2008 MRC guidance for developing and evaluating complex interventions argues that only through close scrutiny of causal mechanisms is it possible to develop more effective interventions, and to understand how findings might be transferred across settings and populations (Craig et al., 2008). Rather than passively receiving interventions, participants interact with them, and outcomes are produced by these interactions in context (Pawson et al., 1997). Therefore, understanding how participants interact with complex interventions is crucial to understanding the mechanisms through which the intervention works (Moore et al., 2015).

Process evaluations may test hypothesised causal pathways using quantitative data as well as using qualitative methods to better understand complex pathways or to identify unexpected mechanisms (Bonnell et al., 2012). Should discrepancies occur between an expected and observed outcome, the researcher may then look back upon the causal pathway and intervention component(s) directly linked with this outcome to attempt to identify a reason for the failed causal hypothesis.

2.2.2 (c) Context
Context can include anything external to the intervention itself that may inhibit or promote its implementation or its effects (Moore et al., 2015). Understanding the role of context in process evaluation is crucial as implementation may vary in different contexts in order to adjust to barriers or facilitators posed by different external environments. An intervention may also have different effects in different contexts even if its implementation does not vary (Shiel et al., 2008). This may be due to the differing causes of problems targeted by
interventions, for example, the cause of childhood obesity may vary from one context to another due to the relationship between socio-cultural structures, practices and health (Pallan et al., 2012). Complex interventions work by introducing mechanisms that are adequately suited to their context to produce change (Pawson et al., 1997).

A systematic review of studies that adopted the “health promoting schools” approach has recommended that process evaluation must move beyond simple measures of acceptability and fidelity to include detailed contextual information (Langford et al., 2015). Good contextual fit occurs when implementers, recipients, and other stakeholders (e.g. parents, teachers) identify an intervention as acceptable, doable, effective, and sustainable in their local setting (Hayes et al., 2019).

2.2.3 Evaluating adaptations to complex interventions

Close links have been identified between the interplay between implementation and context on complex interventions, as often intervention implementation may need to be tailored in order to suit a new context. However, adaptations made to the implementation of intervention components in new contexts must be examined to ensure that they align with the theory of the intervention and do not conflict with intervention fidelity (Hawe et al., 2004). Bauman et al., (1991) suggested that there is a range of ‘feasible fidelity’ within which varying levels of modifications are made without affecting an intervention’s core component, as well as a point of ‘dramatic mutation’, at which point the intervention is no longer recognisable or effective. Similarly, Durlak and DuPre (2008) argue for a compromise between adaptation and fidelity, emphasising that assessments of fidelity should focus on core intervention activities, while less central components could be altered to achieve a better contextual fit. This position is also reflected within guidance from the US Centre for Disease Control (CDC) (Firpo-Triplett, 2012) on the delivery of sexual health interventions. The CDC uses a traffic light system to categorise adaptations as ‘red light’ (adaptations that compromise the functioning of the intervention), ‘yellow light’ (changes that should be made with caution, in consultation with senior researchers on the theory of the intervention) and ‘green light’ (safe adaptations to allow better contextual fit).

Bumbarger and Perkins (2008) argue that rather than seeing fidelity and adaptation as opposites, evaluators need to distinguish between ‘innovation’ (skilled implementers actively attempting to make an intervention better fit their population or setting) and ‘drift’
(unintentional shortcomings, arising from barriers to full implementation). Consistent with this position, Mars et al. (2013) observed that within a self-management intervention for musculoskeletal disorders, fixed adherence to intervention manuals often reflected a robotic, inflexible or unresponsive delivery style that didn't necessarily fit participants needs. In contrast, skilful implementers were noted to have deviated from instructions in response to feedback from participants, while remaining consistent with the theoretical basis of the intervention (Mars et al., 2013). However, other adaptations that deviated from protocols which undermined the intervention theory were ruled to represent poor implementation. Moore et al. (2015) proposed that one could add a third category of ‘subversion’ to Bumbarger and Perkins’ (2008) innovation/drift theory, where individual implementers actively could choose not to adopt aspects of the intervention which conflict with their values or theories of change.

The MRC framework (Craig et al., 2008) recognises some of the challenges associated with adapting interventions to new contexts, identifying that one aspect of intervention complexity is the degree of flexibility or tailoring allowed. Some researchers have questioned the implied suggestion that programme evaluators have control over whether implementers are ‘permitted’ to adapt a programme (Pawson, 2013). In reality, evaluators must accept that interventions will inevitably be adapted as they move into new contexts (Moore et al., 2015). Instead of resisting adaptation, the challenge for researchers is to monitor any changes and attempt to understand what the nature of the change was, who was involved in the decision to make the changes, when they occurred, why they occurred, and how they may influence the functioning of the intervention in a specific context (Stirman et al., 2019).

In order to facilitate monitoring and aid understanding of the impact of modifications made to interventions in a particular context, Stirman et al. (2013) developed an expansive but flexible coding system to systematically categorise the adaptations made to interventions in a real-world setting. This system first distinguished between contextual and content modifications, identifying contextual adaptation as changes to the delivery format, setting, personnel/implementers or target population when the content of the intervention remains the same (Stirman et al., 2013; Castro et al., 2004). Meanwhile, content modifications were defined as changes made to the intervention procedures, materials or delivery (Stirman et al., 2013). Acknowledging that content modifications occur in many different ways and at
multiple levels, from an individual implementer to entire system-wide changes, the coding system developed identifies twelve different types of content modifications (for example, adding elements, removing elements, substituting elements, extending, shortening, integrating another approach, drift, etc.) as well as seven levels (for example individual, cohort, population, facilitator) at which content modifications occur (Stirman et al., 2013).

In subsequent years, Stirman and colleagues expanded their coding system to create a broader framework, intended to facilitate the comprehensive documentation of modifications (Stirman et al., 2019). The Framework for Reporting Adaptations and Modifications-Enhanced (FRAME) (Figure 2.1) developed in 2019 by Stirman and colleagues invites researchers to consider the following eight aspects when documenting and reporting adaptations: (1) when and how in the implementation process the modification was made, (2) whether the modification was planned/proactive or unplanned/reactive, (3) who determined that the modification should be made, (4) what is modified, (5) at what level of delivery the modification is made, (6) type or nature of context or content-level modifications, (7) the extent to which the modification is fidelity-consistent, and (8) the reasons for the modification, including (a) the intent or goal of the modification (e.g., improve fit, adapt to a different culture, reduce costs, etc.) and (b) contextual factors that influenced the decision (Stirman et al., 2019).

The compromise between adaptation and fidelity remains a key issue debated in implementation science (Moore et al., 2015; Stirman et al., 2012; Bishop et al., 2013), as researchers struggle to find a balance between delivering effective levels of implementation and achieving contextual fit. Despite the recognition that adaptations will occur throughout the course of an intervention, the type and extent of modifications that can occur without compromising effectiveness or degrading fidelity to an unacceptable degree has not been sufficiently explored. In theory, it is possible to make some types of changes without compromising effectiveness or removing the key elements of an intervention (Stirman et al., 2012) and indeed some adaptations can even enhance the intervention or help it to achieve better contextual fit. Ultimately, acknowledging that adaptations will occur and recording the changes made is key to understanding their impact on intervention outcomes and translating intervention delivery to real-world contexts.
Figure 2.1: The Framework for Reporting Adaptations and Modifications-Expanded (FRAME)

Source: Stirman et al., (2019)
2.2.4 Evaluating the sustainability of an intervention

As noted above, process evaluations and fidelity frameworks are increasingly concerned with not only whether an intervention is implemented as intended during the evaluation period, but the mechanisms or processes through which implementation is achieved, and how this affects efforts to incorporate the intervention into routine practice after the evaluation. Terms such as ‘sustainability’ (Linnan & Steckler, 2002; Baranowski & Stables, 2000) and ‘maintenance’ (Glasgow et al., 2001; Glasgow et al., 1999) have been used within frameworks to describe the potential for an intervention to become part of routine practice. Arguing from a systems perspective, Hawe and colleagues (2009) describe interventions as events within systems, which can either leave a lasting impression or fade away, depending on how well the intervention embraces the system dynamics.

Theories from sociology and social psychology, such as the Diffusion of Innovations Theory (Greenhalgh et al., 2004; Rogers, 2003) and Normalisation Process Theory (NPT) (May & Finch, 2009) also emphasise the processes through which interventions become a fully integrated part of their setting, using the terms ‘routinisation’ or ‘normalisation’ respectively to describe these processes. May et al. (2013) propose an integrated general theory of implementation which builds upon NPT, and links with the key constructs from sociological and psychological theories including the Theory of Planned Behaviour (Ajzen, 1991), Social Cognitive Theory (Bandura, 1991) and Diffusion of Innovations Theory (Rogers, 2003). Successful implementation is seen as a result of the actions of ‘agents’ (individuals or groups). May et al. (2013) argue that complex interventions are likely to become part of routine practice if (i) elements of the intervention can be made workable and integrated into everyday life; (ii) the social system provides the normative and interpersonal capacity for implementers to cooperate and coordinate their actions; (iii) agents individually and collectively commit to the intervention; and (iv) agents’ contributions to the intervention carry forward in time and space.

2.2.5 Tools used to evaluate the intervention process

Although the literature on process evaluation design largely focus on qualitative research methods (Oakley et al., 2006; Lewin et al., 2009; Murtagh et al., 2007), many of the objectives of process evaluation which have previously been discussed can be assessed both quantitatively and qualitatively (Schneider et al., 2009). Indeed, process evaluation of public
health interventions often explicitly use mixed methods (Linnan & Steckler, 2002). Tools that are commonly used for process evaluation fall broadly into four groups:

- Checklists or logbooks completed by intervention providers.
- Surveys, interviews or focus groups with participants and intervention providers.
- Behavioural observations by researchers.
- Use of administrative data, such as attendance or case records.

(Griffin et al., 2014)

Griffin et al. (2014) recommend that multiple tools from across these four groups be used to measure the same process evaluation dimension in order to allow for triangulation of findings from several data sources or stakeholders. Triangulation of findings using several data collection tools (method triangulation) from multiple data sources (data source triangulation) validates data by enabling confirmation of findings from different perspectives. This improves the trustworthiness of qualitative data in particular and enables the researcher to explore potential bias in reporting if findings are refuted by other data sources (Shenton et al., 2004; Carter et al., 2014) (further explained in section 3.5.3).

Quantitative methods have the advantage of quick analysis and relatively straightforward interpretation and can be useful in documenting the dose and reach of intervention activities (Schneider et al., 2009). However, these methods are incapable of answering why or how, for example, an intervention component is, or is not, delivered as intended. Qualitative methods have the advantage of being able to detail how activities are delivered in context, elicit unanticipated information, suggest innovations that may improve intervention delivery, as well as capture the diverse perspectives of intervention stakeholders. Additionally, the use of multiple stakeholders, can be used to further triangulate results (Carter et al., 2014; Shenton et al., 2004).

2.2.5 (a) Self-report logs

Logs, journals and diaries are monitoring tools for recording data over a long period of time (Laidlaw and Berson, 2014). Because these methods rely on timely and accurate documentation of an on-going process such as delivery of specific intervention components, they must be completed close to the time of the event and are not suitable as evaluation tools.
Logs are a self-assessment tool and can be completed by many stakeholders, particularly implementers including research staff, programme partners, and any group involved in delivering or monitoring an intervention. The value added by any checklist or log depends on the degree of their integration into a project’s ongoing management and reporting processes (Earl et al., 2001). Additionally, the commitment of programme members or implementers to record or collect data regularly and reflect on work honestly can also influence the value added by this method to the overall evaluation of a research project (Earl et al., 2001).

Logs have been used in health promotion literature to collect self-reported data about intervention delivery including the types of activities and dose delivered by implementers (Griffin et al., 2014). In practice, researchers must make careful considerations about what format and fields are most appropriate for the log to collect the information that is most valuable to the overall evaluation. Due to the fact that monitoring requires commitment of human and financial resources, it is recommended to plan and prioritise the monitoring needs of the project and map resources such as cost and available time against them, selecting only those tools that are within the limits of what can realistically be committed by stakeholders (Laidlaw and Berson, 2014). Griffin et al., (2014) suggests that data collection tools such as logs should maximise response while minimising the burden for stakeholders and recommends that the length of each log entry be limited to a single A4 page where possible.

2.2.5 (b) Interviews and focus groups
Interviewing is widely regarded as the most popular data collection method employed in qualitative research (Gill et al., 2008). Participants typically include informants such as implementers, intervention participants or key ‘gatekeepers’ (e.g. teachers or employers), allowing evaluators to explore experiences of the intervention from multiple perspectives (Moore et al., 2015). Intervention participants may be well positioned to provide insights into perceived strengths and weaknesses of an intervention, and how it facilitated or failed to help them achieve change (O’Reilly and Dogra, 2017). Those implementing the intervention may be able to provide insights into the emergence of socio-cultural patterns in their responses, how and why their implementation practices changed over time, and the barriers and facilitators posed by their specific context that affected the ease with which the intervention
can be implemented (Moore et al., 2015). Those at higher levels of the implementation process (e.g. regional and national coordinators) may be in a position to identify a broader range of contextual barriers and facilitators (Moore et al., 2015). Through the medium of an interview, the researcher can attempt to appreciate the world from the point of view of both the implementer and the participant (Kvale, 2008). The style of interview employed by the researcher is often dictated by a combination of the demographic of the interviewee and the objectives of the evaluation. Typically, interviews fall broadly into three different categories, (i) structured, (ii) semi-structured and (iii) unstructured (O’Reilly and Dogra, 2017).

Structured interviews are quantitative in nature and they are often used as an alternative to written questionnaires (O’Reilly and Dogra, 2017). This means that quantitative criteria, such as reliability and validity, are pertinent to the interview design and the questions must be asked in the same way and in the same order to every participant. However, the structured interview is considered to have an advantage over questionnaire design as it seeks to engage participants in the research which means that the researcher can explain more challenging questions directly (O’Reilly and Dogra, 2017). The use of structured interviews is also favoured over the questionnaire as a way of improving response rates (Roszkowski and Bean, 1990).

Semi-structured interviews which were used during the data collection for this study (section 3.5.3) are perhaps the most common type of interviewing technique and are generally favoured by qualitative researchers (O’Reilly and Dogra, 2017). The semi-structured interview allows the researcher some flexibility in how they ask their questions and in what order they present them to the participant (O’Reilly and Dogra, 2017). This means that the researcher can actively listen to what the interviewee says during the interview and use these responses to modify or change questions, or even ask new ones that are relevant to the individual experience of the participant (Gill et al., 2008).

Semi-structured interviews are a useful technique to use with children and young people as they allow researchers to explore issues and ideas that they might not have previously considered when designing the interview protocol (Flewitt, 2014). In addition, researchers may find that children introduce new ideas or issues that are relevant to the overall research question, which provides the researcher with the opportunity to add new questions for subsequent interviews (O’Reilly and Dogra, 2017).
The unstructured interview resembles the semi-structured interview in many ways (O’Reilly and Dogra, 2017). The questions used in an unstructured interview are normally open questions and are designed to encourage the participant to speak freely regarding a particular topic or issue. Although the researcher plays an active role in guiding it, in the unstructured interview the participant is allowed significant control over the direction and content of the interview (Corbin and Morse, 2003). However, while unstructured interviews potentially empower children to take control over the direction of the interview, it must also be noted that younger children may struggle to lead this type of task and so it is suggested that researchers consider the age and competencies of participants prior to selecting this open and unstructured interview style (O’Reilly and Dogra, 2017).

Traditionally researchers have conducted interviews with participants face-to-face (O’Reilly and Parker, 2014). In this format, the researcher will make provision to find a quiet private space to speak with the child about a topic or issue and stay with them with a second adult present (for ethical reasons) for the duration of the interview (O’Reilly and Parker, 2014). In this format the interviewer is able to observe the reaction of the participant to each question and monitor non-verbal behaviour such as head nodding (and possibly capture it in the recording). The venue chosen should support the participant, but also needs to be fit for purpose, i.e. private and quiet to avoid background noise in the recording (Davies and Dodd, 2000).

The growth in popularity and access to the internet provides new ways for researchers to interview research participants (O’Reilly and Dogra, 2017). The rise of digital technology and the continuing familiarity of younger age groups with these technologies have provided unique potential for researchers to engage children in new and novel ways. Notably, since the COVID-19 national lockdown, a significant increase in the use of technology has been reported by Irish households (National Anti-Bullying Research and Resource Centre, 2020). A recent survey reported that 71% of children say that it is true or very true of them that they know how to join a video conference call via Skype, Zoom and/or Microsoft Teams (National Anti-Bullying Research and Resource Centre, 2020).

Computer based interviews with children or young people can be text-based through email and instant messengers, or verbal through Skype or other video communication software. The benefits of this form of interview is that it has the potential to increase participation and
inclusion of participants who find it difficult to communicate through traditional face-to-face interviews and thus are underrepresented in research (Hinchcliffe and Gavin, 2009; Mann and Stewart, 2000). For example, children, or even adults, with disabilities, social anxieties or living in remote locations may find the internet a useful modality for social interaction (Ison, 2009). Computer-mediated interviewing may also be a more efficient use of limited resources such as travel expenses and researchers time as it is an inexpensive and convenient way to allow participants to give their views and opinions (Gunter et al., 2002). In addition to these benefits, there are also a number of challenges presented by computer-based interviews. The main practical challenge posed by all technology is the potential for computers, laptops or other digital devices to ‘crash’, with power cuts or a loss of internet connection terminating an interview prematurely (Jowett et al., 2011). Additionally, many of the computer-mediated interviewing platforms lack the visual cues of communication, which can interfere with the interpretation of responses and meanings conveyed (Hinchcliffe and Gavin, 2009).

It is now widely acknowledged that children are social actors and can play several roles in the research process (McEvilly, 2013). Therefore, research that portrays the lives and experiences of children should engage and involve children in the process. However, the idea that interviewing children is easy is a common misconception (Westcott & Littleton, 2005) and in reality, data quality can often be an issue (Scott, 2004). High-quality data is considered to be rich talk that allows researchers to evaluate the workings or process of the research topic through the perspective and experiences of the child (McEvilly, 2013). In contrast, poor-quality data results when children are silent and do not want to talk or answer questions (McEvilly, 2013). Additionally, children may also speak on tangents about topics completely unrelated to the evaluation making it difficult to keep them on task, and some may struggle to verbally express their thoughts and ideas (McEvilly, 2013; O’Reilly and Dogra, 2017). In order to overcome some of these challenges, interviews should begin with a building rapport phase, designed to put the child at ease and explain the nature of the process (Davies and Dodd, 2000). This should be followed by a free narrative phase to give the child an opportunity to provide their own account of the events or topic being evaluated. This free narrative phase should then lead into open-ended questions which could in turn be supplemented by specific yet un-leading questions and closed questions (Davies and Dodd, 2000). The use of leading questions is strongly discouraged in the literature and should be seen only as a last resort if all other prompts fail (O’Reilly and Dogra, 2017). Interviews should end with a closure phase.
which offers children reassurance and answers any questions that they might have. In order to facilitate these protocols, less structured interviews have been identified as the most appropriate format for young children (Scott, 2004). In addition, using resources and stimuli can enhance children’s interest, stimulate thought and reflection and reduce the effects of the high-control, adult dominant, question and answer format (Brooker, 2001). Thus, as well as stimulating and encouraging children, using resources can help address the adult-child power imbalance in the interview situation (Wesson & Salmon, 2001). It has also been reported that visual aids such as pictures or drawings can be helpful if children have vocabulary problems or limited attention spans (Scott, 2004).

Group interviews or focus groups may produce interactions which provide deep insights into consensus and conflict in the views and experiences of research participants (Moore et al., 2015). The group setting also offers an opportunity to elicit a wider range of perspectives more quickly than individual interviews. However, group dynamics may lead participants to respond in a different manner than in a one-to-one interview, particularly if there is an existing hierarchy amongst participants (Moore et al., 2015).

Participants included in focus groups are typically selected using either purposive or convenience sampling (Stewart & Shamdasani, 2014). In purposive sampling, the researcher chooses individuals who fulfil inclusion criteria corresponding to the objectives of the study. The participants need to have some experience with the study topic, be within the appropriate age range, or have similar psychosocial characteristics (Barbour, 2018; Krueger & Casey, 2009). In convenience sampling, persons who are conveniently accessible and have experience with the study topic are invited to participate in the study (Suen et al., 2014). Typically, these include school classes, religious communities, youth groups, or groups of parents who meet regularly (Dupper et al., 2015).

Focus groups can be used to create a safe peer environment for children (Adler et al., 2019). The support of participating in a discussion within a group can also avoid some of the power imbalances between researchers and participants, for example, those between an adult and a child in a one-on-one interview (Shaw et al., 2011). When organising focus groups with children, the significant differences in communication styles and knowledge levels that exist at various ages should be considered (Clark, 2011; Doherty & Hughes, 2013; Feldman, 2011). Grouping children according to age rather than familiarity with other members of the focus group can also help.
group can be important to creating group dynamics and generating discussion. However, some children may feel safer and more willing to express their opinion if group members are familiar to them (McGarry, 2016). Children typically want to make their peers understand their thoughts and feelings, while they also attempt to understand other children’s perspectives. Because of children’s efforts to achieve mutual understanding, adults who are moderating or “listening in” have a unique opportunity to discover the meaning of research topics from the children’s perspective and to study their behaviour in action (Kennedy et al., 2001).

As with interviews, for children, relevant questions phrased in simple language should be used throughout the focus group (Lund et al., 2016; Sandberg et al., 2017). Using prompts such as “What does everyone else think?” or “Do others have different thoughts? can improve the flow of a discussion, especially with shy individuals (Lund et al., 2016). However, statements of affirmation, for example “Great!”, “Excellent!” or “Cool!” should be avoided because they may discourage the child from talking about the parts of the research topic that they found less enjoyable or criticisms that they believe the moderator might find less favourable (Fargas-Malet et al., 2010). Additionally, questions should not be repeated, as it has been reported that this may lead children to think their first answer was somehow wrong and then change their response as a result (Adler et al., 2019). Furthermore, long pauses before responding should also not be interrupted (Lund et al., 2016) and if young children become excited and begin talking simultaneously, it may be useful to address each participant by name or employ the use of a ‘talking stick’, a token item which can be passed from one child to another, allowing only the holder of the token to speak (Gibson, 2007; Kennedy et al., 2001).

2.2.5 (c) Behavioural observations
Non-participant observation involves the researcher making detailed field notes about the implementation of an intervention and the responses of participants (Moore et al., 2015). This may be useful for capturing finer details of implementation, examining interactions between participants and intervention staff, and capturing aspects of the ‘spirit’ of implementation, rather than just the mechanics of its delivery (Moore et al., 2015). As with structured observation, the use of this method may be limited to situations where observation can be made relatively unobtrusively in order to avoid the presence of the evaluator influencing the normal behaviour of the population being observed. This bias,
categorised by the consequent awareness of being studied, and possible impact on behaviour is commonly known as the ‘Hawthorne Effect’ (McCambridge et al., 2014).

The ‘System for Observing Fitness Instruction Time’ (SOFIT) observation tool is commonly used in school-based research that assesses physical education classes by enabling the researcher to simultaneously collect data on student activity levels, the lesson context, and teacher behaviour (McKenzie et al., 2015). The system enables researchers, teachers, and supervisors to make judgements about physical education lessons, particularly as they relate to programme goals. The main outcome variable is student physical activity levels, and these can be reported in number of minutes and percentage lesson time spent in MVPA (moderate-to-vigorous physical activity); VPA (vigorous physical activity); lying down, sitting, standing, and walking; and estimated energy expenditure per lesson (kcal/kg) (McKenzie, 2015). In addition, the modification of SOFIT in 2016 (referred to as SOFIT+) can be used to identify and measure teacher practices that either promote or limit students’ MVPA during PE lessons (Weaver et al., 2016).

2.2.5 (d) Draw, write and tell

The draw-and-write technique is an arts-informed, visual research method (Pridmore et al., 1995). Since its development in the 1980s, the draw-and-write methodology has become a central technique for provoking children’s perceptions and understandings to aid in the evaluation and development of school curricula (McEvilly, 2013) health interventions (Gabhainn and Kelleher, 2002) and studies of children’s cognitive development (Mouratidi et al., 2016). Although the draw-and-write technique, which involves drawing a picture and writing a line or short paragraph in response to a specific prompt, was originally developed as a task that reflected traditional classroom activities, advocates of the technique argue that it provides a unique platform for even the youngest children to express their ideas, perspectives and experiences of a wide range of topics (McWhirter, 2014; McHugh et al., 2013; Pridmore and Lansdown, 1997).

Rather than treating children as unaware participants with flawed or limited information about research topics, the draw-and-write technique frames children as active participants in research who hold unique and complex understandings of concepts in their environment (McHugh et al., 2013; Pridmore and Bendelow, 1995). In contrast to standardised close-ended surveys which naturally restrict children’s responses, the draw-and write methodology
empowers children by inviting them to express their ideas in a relatively unguided and unrestricted manner. This format may assist children who are less verbal, provide richer more diverse insights on their beliefs and experiences, and allows children to address sensitive topics in a way that is familiar to them (McWhirter, 2014; Driessnack, 2005).

While the draw-and-write technique may break down existing power imbalances or barriers between the researcher and student, the classroom setting may create issues regarding the validity of children’s consent (Backett-Milburn and McKie, 1999; Gabhainn and Kelleher, 2002). Ironically, while most social science researchers are criticised for low participation rates, classroom researchers are most criticised for their high participation rates, implying that children may be coerced into participation in a classroom setting (McWhirter, 2014; Backett-Milburn and McKie, 1999). However, if given enough reassurance that ‘it is OK to say no’, that the task ‘is not a test as there are no wrong answers’ and especially if provided with an alternative activity, that will neither be seen as an award nor a punishment, children are more likely to feel free to withdraw their consent to participate (McWhirter, 2014). Children’s confidence to opt out has also been found to increase with age (McWhirter, 2014). Early researchers using draw and write assumed that teachers alone could give consent on behalf of the children, but this is no longer an acceptable standard in academic research (Alderson, 2004). School principals and senior teachers are now the foremost gatekeepers, often followed by parents and children themselves (McWhirter, 2014). In fact, seeking children’s consent is important for addressing the inherent adult-child power imbalance and gives children a sense of ownership and control over their participation (McEvilly, 2013).

Potential limitations of collecting data in classrooms is that it not only increases the risk of students influencing each other’s responses, it may also pressure students to produce desirable responses they perceive are pleasing to the teacher or researcher, particularly if students are familiar with the researcher or think the assignment will affect their academic grades (Backett-Milburn and McKie, 1999; McWhirter, 2014; Mauthner, 1997). Some of the practical limitations of delivering the draw and write activity in a classroom setting that were identified by McWhirter et al. (2014) and should be considered before implementing the task include:
(i) can children write for themselves or do they need adult support?

(ii) If non-native speakers, do children need scribes familiar with their home language?

(iii) How is the seating in the classroom arranged? Can children easily see what others are drawing and writing?

Despite these practical concerns, in practice, children can be encouraged to work independently, shield their work from others for this task and to whisper to adult scribes if required (McWhirter, 2014). Reassurance about the process and how the drawings will be used by the researcher generally discourages sharing ideas. In addition, if children lack confidence in their ability to draw accurately or spell correctly, reassurance can be offered that the drawings will not be put on display, alongside a ‘spelling holiday’ for the duration of the task (McWhirter, 2014). Above all, children should be treated with the same respect as adults, there is no reason to assume that children will be any less trustworthy research participants than adults (McEvilly, 2013).

During the data extraction and data evaluation phase, a possible limitation when analysing drawings as a source of feedback is that they only represent experiences and views that can be represented graphically and are limited by the individual’s skills (MacPhail et al., 2004). Furthermore, due to the abstract nature of the drawings, MacGregor et al. (1998) argue that analysis should be limited to the written statements or basic frequencies of items and themes pictured. For this reason, it is uncommon for researchers to attempt to interpret children’s responses based on a drawing alone (McWhirter, 2014). Instead, drawings are often used to encourage conversation and generate interview data (McEvilly, 2013).

The ‘Draw and Tell Technique’ was coined by Driessnack (2005) following a meta-analysis of literature and studies that introduce drawing to young children prior to the children participating in interviews. In an interview scenario, young children can struggle to spontaneously retrieve information from their memory and therefore may need assistance. The most effective retrieval cues for younger children in particular are likely to be sensory rather than verbal (Wesson and Salmon, 2001). Cues and props such as toys, photographs and drawings may add to children’s responses by acting as aids to retrieve and report information (Wesson and Salmon, 2001). For these reasons the ‘Draw and Tell Technique’ can be
employed to elicit children’s views. The technique is child-centred and constitutes a directed approach to data collection as it allows children to direct the interview with the researcher, while the drawings can be used as a facilitative method to allow the children to organise their narrative. Indeed, Hannify and Millar (2015) reported that using the ‘Draw and Tell’ technique had many benefits including placing less social pressure on the children, giving the children a platform to voice their views and removing the need for researchers to interpret what the children had drawn.

Overall, a mix of both quantitative and qualitative data collection tools appropriate to both the needs of the intervention and profile of the stakeholder are required. Furthermore, using a variety of the data collection tools described to measure the same process evaluation dimension allows for triangulation of findings, thus improving the reliability and trustworthiness of findings (Moore et al., 2015, Shenton et al., 2004).

2.3 The School Environment

The World Health Organisation (WHO) suggests that to target obesity effectively, action in multiple settings, with a range of stakeholders and a wide variety of approaches targeting both physical activity (PA) and nutritional knowledge and behaviours is required (WHO, 2012). Schools hold the potential to act as critical settings for influencing healthy eating and PA behaviours, because children have long-term contact throughout their childhood and spend much of their waking hours at school (Stewart-Brown, 2006; Kropski et al., 2008; Cavanagh et al., 2012). Effective school environments also present opportunities to embody a culture of care, and to be fully inclusive of all children regardless of any existing racial or socio-economic background differences (Cavanagh et al., 2012). For these reasons, researchers and policymakers have identified schools as logical settings for intervention (Grasten et al., 2017; Jennings et al., 2018).

2.3.1 Complexity of the school system

Schools are systems formed from multiple, diverse, interconnected components (Keshavarz et., 2010). These can be further categorised into sub-systems of different groups of people such as principal and management staff, teaching staff, administrative and support staff, students and their parents. There are also formally structured components such as school policies, guidelines, curricula, school plans, and the school physical environment and facilities, as well as more intangible components such as the school ethos and social “environment”
(Keshavarz et al., 2010). On a broader scale, schools are positioned in a network structure which includes bigger systems such as their country’s/State education system, local council and community setting (Daly et al., 2010). Due to this intertwined type of nested structure which schools typically exhibit, Keshavarz et al., (2010) characterised schools as complex adaptive systems.

The degree of diversity in and between schools has been reported by Keshavarz et al., (2010) as a further contributor to the complexity of school systems. Their study revealed that diversity was not limited to components within schools but was also found to be prevalent between schools, even when schools were located within close administrative or geographical areas. Despite many commonalities, significant differences have been reported by Woods et al. (2010) between Irish schools in terms of their size, financial and human resources, physical and social environment, the stability of the community, financial and socio-cultural status of the community, school-home interaction and school-healthcare interaction. These differences create different working environments for schools, which are often reflected in each school’s strategic management plans, targets and priorities, school performance and achievements in the health and education of their students (Woods et al., 2010). Keshavarz et al., (2010) emphasise that the diversity among people within schools and between schools is an important observation in understanding why some evidence-based policies and practices do not yield similar outcomes across different schools. By not acknowledging this level of diversity among schools, Keshavarz et al., (2010) warn that external agencies, including interventionists, health workers and health agencies may have unrealistic expectations of what schools might achieve and sustain in relation to pre-defined health/intervention goals.

2.3.2 Complex interventions
Interventions can be interpreted as an attempt to positively disrupt the prior functioning of the school system. However, the challenges associated with creating change within the school system often differ between schools. As previously discussed in section 2.3.1, this is because every school has its own unique working dynamic which is shaped by many interacting elements and ever-changing personnel (both students and staff) within the school system (Darlington et al., 2018).
Complex interventions attempt to change the dynamics of social systems (e.g. schools), through influencing the behaviours of personnel (e.g. teachers, children) within those systems (Hawe et al., 2009). Intervention outcomes may not always occur in a predictable linear manner but may build or lessen over time (Keshavarz et al., 2010). There is an increasing body of literature on complex interventions in health services research, where the intervention is a programme of multiple interconnected components, which may be delivered or implemented in a variety of ways (Griffin et al., 2014). The degree of intervention complexity can also include the number of organisational levels that the intervention targets and the difficulty of its implementation (Craig et al., 2008). Griffin et al., (2014) cite interventions relating to childhood obesity as examples of complex interventions in health services research. Such interventions usually include multiple related components, targeting children as well as other stakeholders, and have a wide range of interconnected outcomes (e.g. increased PA, reduced sedentary time) (Griffin et al., 2014). One frequent criticism of such studies is the difficulty in explaining the process by which the intervention has had the observed effects and distinguishing the relative contribution of individual intervention components to overall outcomes (Grant et al., 2013).

2.3.3 Introducing and sustaining interventions in school contexts

Many schools have limited and relatively fixed resources to undertake core tasks in addition to regular, and sometimes competing, demands for the introduction of new concepts, policies, programmes and activities (Keshavarz et al., 2010). Correspondingly, key agents within the school such as the principal and teaching staff inevitably must set priorities depending on time and the school system's rules and goals. Approaches for coping with competing requests to introduce new concepts, policies, programmes and activities into the taught curriculum and sustain them beyond the course of the intervention have been identified in the literature (Keshavarz et al., 2010; Langford et al., 2015).

Research by Keshavarz and colleagues (2010) reported on a qualitative study examining the implementation of the ‘Health Promoting Schools’ program in primary schools in Sydney, Australia. It drew upon insights from systems science to examine the relevance and usefulness of the concept of ‘complex adaptive systems’ as a framework to better understand ways in which health promoting school interventions could be introduced and sustained (Keshavarz et al., 2010, p 1). The primary data which informed the outcomes of the study was collected
using semi-structured interviews with 26 school principals and teachers (Keshavarz et al., 2010). Findings included the following:

1. *Dividing up the available time in the school day into shorter periods.* However, participants identified that these approaches have led to either less effective or less sustainable programmes as everything was “rushed” (Keshavarz et al., 2010).

2. *Focus on one issue at a time as a whole school focus.* This means that by highlighting an issue or implementing a programme across the whole school, other programmes or issues are pushed to the side. Keshavarz et al., (2010) found that some schools gave short term priority to health promoting school projects, but as new demands and influences emerged, these projects were relegated in importance and in the attention that they received.

3. *Reject any new projects particularly anything not considered compulsory by the Department of Education and Skills.* The Department of Education and Skills (Australia) has been found to exert the most influence on school values, therefore extra-curricular activities or programmes not associated with the Department of Education and Skills are often not valued by schools (Keshavarz et al., 2010).

4. *Tailoring programmes to individual schools’ needs.* This involves working with teachers to align interventions with a school’s core aims (Langford et al., 2015).

5. *Providing on-going training and support* (Langford et al., 2015). This can be effective in the short term, however barriers include insufficient workforce to implement health promotion or policies (including providing training and support) (Harrington et al., 2016), as well as difficulty in securing ongoing funding partnerships to provide support networks and resources.

Although each approach has its merits and pitfalls, every school involved in an intervention must be dealt with on a case-by-case basis. This is because the differences between schools in terms of their size, financial and human resources and physical and social environment create different operational contexts, which are reflected in each school’s strategic management plans, targets and priorities, school performance and achievements in the health and education of their students (Keshavarz et al., 2010).
2.3.4 Barriers to physical activity in schools

There is a gap between the development of effective school-based interventions and the wide-scale adoption of these interventions in real world contexts (Durlak and DuPre, 2008; Glasgow and Emmons, 2007). Generally, those implementing behaviour change interventions are confronted with the complexity of transferring interventions that were successful in optimum (controlled and monitored) research conditions to real-life contexts (Glasgow and Emmons, 2007). To bridge the gap between development and adoption of effective health promotion interventions on a scale broad enough to promote population level health changes, Durlak and DuPre (2008) believe there is a critical need to identify and understand the contextual factors that act as barriers or facilitators to implementation.

As a result of a review of over 81 reports on health promotion and prevention programmes, Durlak and DuPre (2008) identified five categories for successful implementation: (i) community level factors (for example policy and funding), (ii) characteristics of providers (for example skill level and self-efficacy), (iii) characteristics of interventions/innovations (for example adaptability), (iv) aspects of the prevention/promotion delivery system (for example, organisational functioning) and (v) the prevention/promotion support system (for example, provision of training and technical assistance) (Durlak and DuPre, 2008). Similarly, Domitrovich and colleagues (2008) presented a multi-level framework of factors that impact on implementation quality in schools at three levels (i) individual-level (for example, professional characteristics, teacher self-efficacy, perceptions and attitudes towards the programme, etc.) (ii) school-level (for example, resources, school culture and climate, school characteristics, etc.) and (iii) macro-level (for example, policies, leadership and human capital and university-community partnerships, etc.). There is much cross-over in the contextual factors identified by both Durlak and Dupre (2008) and Domitrovich et al. (2008), and both publications emphasise the importance of identification and management of these factors by researchers throughout to ensure better quality implementation.

Indeed, implementation science is an emerging area with an increasing number of studies in the last decade examining the contextual barriers and facilitators posed by the school context (Naylor et al., 2015). The six most frequently cited contextual factors affecting implemented identified in a systematic review of school-based interventions by Naylor et al., (2015), with the exception of time constraints, could fit within the Durlak and DuPre (2008) model and be
classified as either: (i) provider characteristics (self-efficacy, skill proficiency), (ii) characteristics of the innovation (compatibility/contextual appropriateness, availability and quality of resources), (iii) delivery system characteristics (supportive school climate), and (iv) the support system (training and support). This reinforces that these are critical factors to consider when designing and evaluating school-based PA interventions. Although time was not highlighted as important to implementation in the Durlak and DuPre (2008) model, it emerged as the most prominent factor affecting implementation in Naylor and colleagues (2015) systematic review of school-based interventions.

Most of the other factors that fell within the categories Naylor et al., (2015) identified aligned with the Durlak and DuPre (2008) model. However, specific contextual factors affecting implementation in schools, like lesson scheduling, weather and classroom disruption were deemed to be specific to the school context. In Ireland, weather was the most frequently identified barrier to meeting the minimum recommendation for PA in schools, with 3 in 5 schools citing this as a barrier (Mitchell et al., 2020). Lack of facilities (45.2%), time (37.4%), and staff training (7.8%) were also notable barriers in Irish schools (Mitchell et al., 2020). Furthermore, barriers to providing indoor classroom-based PA in Australian primary schools included insufficient time, limited training opportunities, limited resources, educator attitudes to PA and teacher confidence (Macdonald et al., 2020). Some of the key barriers to implementation presented in the literature to date are presented below.

2.3.4 (a) Lack of time
In school-based health promotion research, several teachers identify a lack of time as one of the main barriers to implementation fidelity (Dyrstad et al., 2018). This could be attributable to the fact that mastering new routines takes time; therefore, it could be important to prepare teachers for a challenging start to integrate new interventions into their daily routine (Fullan, 2007). Furthermore, since a lack of time is found to be the factor most consistently identified as a barrier to the implementation of school-based PA initiatives (Naylor et al., 2015), careful consideration of actions that lower teacher overload and competing demands in the start-up phase seem important. Availability of resources to support implementation is found to have a positive association with implementation of structured classroom PA and could be an effective way to lower the ‘lack-of-time’ barrier (Carlson et al., 2017).
2.3.4 (b) Overcrowded curriculum
The second challenge presented when trying to increase the amount of PA children receive in schools is that teacher’s increased concern over fulfilling the requirements of a crowded school curriculum has reduced PA during the school day (Riley et al., 2015). Historic reports suggest that increased focus on academic achievement decreases PA opportunities in schools (Howie et al., 2012). Furthermore, demands and expectations of families and the wider community were also identified as controlling factors shaping school priorities and school function. Although parents might expect schools to care for student health, Keshavarz et al., (2010) reported that in Australia it was still the case that parents and the Department of Education both placed much higher value on educational outcomes on schools, particularly literacy and numeracy.

2.3.4 (c) Weather
Several studies have found relationships between different weather variables and children’s PA. Rainfall has been associated with decreased activity (Bélanger et al., 2009; Harrison et al., 2011; Harrison et al., 2015; Duncan et al., 2008; Goodman et al., 2012). For example, Harrison and colleagues analysed a sample of English children aged 9-10 years old (n=1,794) and found they undertook almost 15 min less MVPA on the wettest days compared to days with no rain (Harrison et al., 2015). Conversely, increased temperature has shown a positive linear association with PA, with small to moderate increases in step counts associated with a 10 °C increase in temperature in studies in New Zealand (n = 1115) (Duncan et al., 2008) and Canada (n = 1293) (Bélanger et al., 2009). Harrison et al., (2017) expanded on this concept, identifying that although a significant linear correlation has been identified between temperature and PA levels in temperate climates between 0°C and 20°C, those climates which experience temperatures higher than 20 °C were associated with a decline in physical activity. The latter association has been reported among a child cohort in southeast Australia and is likely to be a contributory factor to the reduced PA levels observed during high summer (Ridgers et al., 2015).

Different seasons can also influence children’s PA levels. Aadland and colleagues, (2018), investigated the reproducibility of accelerometer determined estimates of PA among children in Norway (n=676) across two different seasons (January-February and April-May). The study found that the reproducibility of PA over two seasons during leisure time and weekend days were lower than for school hours and weekdays, indicating that children were more active in...
summer during leisure time and weekend days but no significant differences were noted between children’s PA levels during school hours and weekdays in winter versus summer (Aadland et al., 2018).

2.3.4 (d) Lack of support
Previous research has found that unsupportive school environments are related to poor implementation of school-based PA interventions (Masse et al., 2012; Naylor et al., 2006). For example, in a cross-sectional survey of 720 principals and teachers in Canada - whose schools were taking part in a comprehensive school-based health promotion programme, which included implementing 15 minutes of PA each day - schools that reported greater levels of support from administrative staff as well as teachers and parents were two times more likely to implement the programme compared to those who reported lower levels of support (Masse et al., 2012).

2.3.4 (e) Other barriers
In addition to those previously described, in Irish settings, other common reasons reported by Woods et al., (2010) for the allocation of ‘too little’ physical education/activity and sport during school hours were a lack of facilities, large class sizes and a lack of teacher confidence. Poor road and transport infrastructure, in addition to concerns around road safety, bicycle safety, security and insurance around Irish schools has also been identified as a barrier to initiatives which promote active travel (Hayes et al., 2019).

2.3.5 Suitability of schools as a setting for intervention
There is much evidence in this section (2.3) to support schools as an appropriate setting for intervention, primarily given the access they provide for researchers to a large and diverse population of children who, outside of the school context, may not have opted or had the opportunity to participate (Jacob et al., 2021). Indeed, few settings outside of schools allow researchers the same opportunity to be fully inclusive and simultaneously target children from all demographic backgrounds. Interventions, such as PS, are delivered to all classes across the whole school environment. In addition to access, schools also provide researchers with ample time in the day and prolonged contact throughout the year to positively influence children’s knowledge and reinforce healthy behaviours gradually day by day (Pulimeno et al., 2020). Indeed, the justification for PENZ and PS’s goal to deliver 20minutes MVPA within the school day was because the research team believed that if children spend one third of
their waking hours in school, then it would make sense that they also complete one third of their recommended 60 minutes of daily activity in the school setting (Coppinger et al., 2016).

However, schools are not without their challenges. In particular, schools are busy places, with teachers already struggling to fulfil the demands of an overcrowded curriculum (Naylor et al., 2015), which presents a significant challenge for researchers. Even those teachers who fully support interventions, and do their best to deliver them, often struggle to find the time due to competing demands (Riley et al., 2015). In fact, given the time constraints of the school day, it is unsurprising that intervention fidelity of PA interventions in schools is generally reported to be low (Naylor et al., 2006). Furthermore, from a research perspective, the complexity of the school environment (described in section 2.3.1), with its diverse range of actors and many interacting components competing for time, make it a difficult research setting to control. In addition, the varying contributions of the different tangible (for example access to facilities and resources) and intangible elements (for example school ethos and priorities and teacher motivation) of the school context to the impact of PA interventions on pre-specified outcomes can be challenging to capture and measure, making later interpretation of results difficult. However, this further highlights not only the value of, but the need for, an extensive process evaluation when implementing an intervention in a school context, as it allows for researchers to understand how the intervention was delivered in reality and what effects, if any contextual factors may have had on outcomes.

2.4 Overweight and Obesity

Overweight and obesity are acknowledged as a serious public health issue both worldwide and in Ireland (Department of Health, 2016). In accordance with the WHO (2003), an Irish report (Oireachtas Library and Research Services, 2011) identified obesity as a precursor of chronic illness and stated that it poses a major risk factor for cancer, type II diabetes, cardiovascular and musculoskeletal disorders, alongside premature death. Furthermore, there are now concerns that the health problems associated with being overweight or obese previously only seen in adults are now presenting in childhood (Jennings et al., 2018; Cali et al., 2008; Verhulst et al., 2008; Pinhas-Hamiel et al., 2005). The long-term health and social consequences of childhood obesity are now well-established in the literature (Jennings, 2018), with the adverse health impacts of childhood obesity known to likely continue into adulthood (Reilly et al., 2011). This position is supported by the HSE who have reported a
significant correlation between childhood and adolescent body mass index (BMI) and adult overweight and obesity (HSE, 2008). The prevalence of overweight and obesity in children is at a critical juncture. If changes are not made, the WHO predicts that by the year 2030, Ireland will have the highest prevalence of obesity in Europe (Webber et al., 2014; Jennings et al., 2018).

2.4.1 Defining overweight and obesity

In this section, the author describes how overweight and obesity is defined and measured in the literature. This is relevant to the impact evaluation of PS on pre-defined markers of health including body composition described in section 3.5.1.

The most accurate direct measures of the amount and distribution of adipose tissue include dual energy x ray absorptiometry (DEXA) and imaging techniques such as magnetic resonance imaging (Adab and Pallan, 2018). However, despite their accuracy, these measures are cumbersome and often expensive to undertake (Adab and Pallan, 2018). Although less accurate than imaging techniques, researchers most commonly use Body Mass Index (BMI) to measure overweight and obesity, due to its practicality and cost effectiveness during field studies with large samples (Himes, 2009).

There is a globally accepted definition for adult overweight and obesity using BMI guidelines (WHO, 2020a). 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/m²) (Cole et al., 1995). Adult overweight and obesity is defined as having a BMI ≥ 25kg/m² and ≥ 30kg/m² respectively (WHO, 2020a; CDC, 2012; Cole et al., 2000).

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; Kuczmasrki and Flegal, 2000), a diverse range of 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, 2019, 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, 2019). Once a child’s BMI percentile or Z-score has been calculated, this value can be checked against
various thresholds (WHO, 2019). 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).

2.4.1 (a) UK’s 1990 Growth Reference
The UK’s 1990 BMI Growth Reference 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 used in various studies (Heinen et al., 2014; Woods et al., 2018; 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).

2.4.1 (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).

2.4.1 (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 (De Onis et al., 2007; WHO, 2020f). 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).

2.4.1 (d) IOTF Growth Reference
The International Obesity Task Force (IOTF) is now known as World Obesity/Policy and Prevention, however, the growth reference chart is still referred to as the IOTF Growth Reference (Cole et al., 2012). 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/m²) and obesity (≥ 30kg/m²) (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).

2.4.2 Prevalence of overweight and obesity

Despite encouraging evidence to suggest a stabilising of childhood obesity rates (O’Donnell et al., 2020, Mitchell et al., 2020; Keane et al., 2014), current rates of overweight and obesity in Ireland remain high among the childhood population (20%) (Jennings, 2018). Data from the most recent Childhood Obesity Surveillance Initiative (COSI) report in Ireland, indicated that 15.8% of children in first class of primary school (aged 7 years) were already overweight or obese (Mitchell et al., 2020). This increased to over a fifth of children (21.8%) by fourth class (aged 10 years) (Mitchell et al., 2020). The most recent Growing up in Ireland (GUI) study reported similar findings, with 17% of 9-year old children reported to be overweight and 5% were obese (ESRI, 2018).

2.4.3 Determinants of overweight and obesity

Overweight and obesity can be attributed to several determinants that are complex and multifactorial (Heinen et al., 2016; Raychaudhuri and Sanyal, 2012). One determinant can be influenced by the interplay of a variety of others, thereby making it difficult to determine the varying contribution each has on influencing overweight and obesity (Heinen et al., 2016; Stewart, 2011). Additionally, these determinants can alter or create new interactions in specific environments and can affect all age categories, genders and socioeconomic levels (Heinen et al., 2003).

Children are now growing up in an obesogenic environment (Birch and Anzman, 2010). The term obesogenic 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).

The ecological model of childhood obesity proposed by Davison and Birch (2001) visualises the established determinants of a child’s weight status at three levels, the individual, the
family at household level, and the external environment at community level. These are summarised in Figure 2.2.

The ‘Individual’ level includes the interacting roles of internal determining factors such as gender, age, PA levels, sedentary behaviours and dietary intake which are unique to each person. The ‘Household level’ includes parenting styles and family characteristics including child feeding practices, parents’ weight status, parents PA patterns and dietary behaviour, nutritional knowledge, food available at home and screen time. Meanwhile ‘Community’ level encompasses the role of demographic and society level factors such as ethnicity, SES, accessibility of recreational facilities and accessibility of convenience foods and restaurants.

![Diagram](image)

Figure 2.2: Contextual influences on the development of childhood obesity
Source: Davison and Birch (2001)

The relative importance of the determinants of overweight and obesity may change depending on the theoretical perspective from which one views the overweight and obesity problem. For example, a person who favours the socio-cultural model will place more emphasis on a child’s family and community, the medical model is likely to place more emphasis on calorie consumption and energy expenditure (Hill et al., 2013), while a more ecological gaze will consider the environment to be more important. While it is unlikely that
any theoretical model is entirely correct, it is important to acknowledge each of the determinants of overweight and obesity outlined below.

2.4.3 (a) 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 (Mitchell et al., 2020; O’Donnell et al., 2020; Garrido-Miguel et al., 2017; Irish University Nutrition Alliance, 2011) and age groups (Mitchell et al., 2020; Jennings, 2018; Reilly, 2005b). In Ireland, the prevalence of overweight and obesity is greater among girls than boys (Mitchell et al., 2020). In addition, whilst obesity has spread across all age groups (Garrido-Miguel et al., 2017), weight gain in children tends to increase with increasing age (Mitchell et al., 2020) which may indicate that as children get older, they become more exposed to the obesogenic environment (Reilly, 2005a).

Davison and Birch (2001) state that age and gender 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. In Ireland, girls, older children and children in lower socio-economic status (SES) categories have been reported as more likely to be overweight or obese (Mitchell et al., 2020). Furthermore, girls and older children less likely to meet the daily PA guidelines or participate in sport, which may create an additional risk of weight gain in these groups (Woods et al., 2018).

2.4.3 (b) Physical Activity and Sedentary Behaviour
PA is a complex, multi-dimensional behaviour and is inversely related to overweight and obesity (Wanner et al., 2016; Lee et al., 2012; Livingstone et al., 2003). Regular PA is associated with various health benefits and the prevention of associated chronic diseases (Van der Ploeg et al., 2020; WHO, 2020e). There is a general acceptance among academics that low levels of PA and high levels of sedentary behaviour have contributed to the development of overweight and obesity among populations (Wanner et al., 2016; Saunders et al., 2014; Lane et al., 2014).

Demographic, economic, environmental factors, gender, and age can influence children’s level of PA (Woods et al., 2018; Davison and Birch, 2001; Sallis et al., 2000). Children are becoming less physically active as opportunities for safe active play, recreational activities, and active transport decrease (Whiting et al., 2020). Simultaneously, the amount of time that
children spend engaging in sedentary screen-based activities both during school and leisure time are increasing (Whiting et al., 2020). In terms of gender and age, boys are generally more physically active than girls, and PA levels appear to decline with increasing age and this decline is greater for girls (Woods et al., 2018). Furthermore, PA habits developed during childhood have been reported to likely track into adulthood, increasing the long-term risks of chronic diseases associated with sedentary lifestyles (Reilly et al., 2011; Janssen et al., 2010).

Early reports of the effects of the COVID-19 global pandemic on children’s wellbeing in the UK suggest that the national lockdowns between March and June 2020 may have resulted in children being less active (UK Department for Education, 2020). Surveyed parents reported that over half of children were fairly active (they had half an hour or more of daily physical activity on average) throughout April to July and between 12% and 22% were active (they had an hour or more of daily physical activity on average) during the same period (UK Department for Education, 2020). However, despite parents views that overall levels of activity were not on the whole much different during the pandemic, it should be noted that a separate survey (Active Lives Children and Young people survey) conducted in 2018/19 (Sport England, 2019) reported a higher level of activity prior to the pandemic than reported by parents in the 2020 coronavirus (COVID-19) survey (UK Department for Education, 2020). The 2018/19 benchmark survey suggested that 71% of children and young people were fairly active and 47% were active (Sport England, 2019).

Physical inactivity is one of the leading risk factors for poor health and is identified by the World Health Organisation (WHO) as the fourth leading risk factor for global mortality and is estimated to be associated with one million deaths per year in the WHO European Region (WHO, 2015). Globally, physical inactivity is thought to be responsible for 6% of the burden of disease from coronary heart disease (Europe 5.5%; Ireland 8.8%); 7% of type 2 diabetes (Europe 6.8%; Ireland 10.9%); 10% of breast cancer (Europe 9.3%; Ireland 15.2%); and 10% of colon cancer (Europe 9.8%; Ireland 15.7%) (Lee et al., 2012). Of concern is that in the case of all these major diseases, the Irish statistics are worse than both the European and global averages (WHO, 2015).

Sedentary behaviour is a contributor to excess weight gain (Parsons et al., 2003) and can be defined as any waking behaviour in a sitting or reclining posture, with an energy expenditure of no more than 1.5 METs (Tremblay et al., 2017). The term sedentary can also be used to
describe the absence of reaching the recommended threshold of MVPA (Tremblay et al., 2012). For instance, individuals who have low sedentary levels may still not obtain sufficient levels of MVPA (Tremblay et al., 2011). Conversely, children who meet the recommended levels of PA may also engage in a large amount of sedentary behaviours and accumulate large amounts of screen time (Pearson et al., 2014). Furthermore, screen time has been associated with higher consumption of energy dense foods and sugar sweetened beverages (Jusiene et al., 2019). Indeed, studies have indicated a relationship between advertising of unhealthy foods on television and children’s increased intake and enhanced preference for high carbohydrate and high fat foods (Boyland and Halford, 2013).

2.4.3 (c) Nutritional Behaviour
Nutritional intake is a key determinant of obesity as weight gain occurs when energy intake exceeds energy expenditure (WHO, 2020b). Poor food choices and overconsumption are associated with a higher risk of developing obesity at all ages (Fleming et al., 2013). Furthermore, unhealthy eating habits and patterns formed during childhood have been associated with increased risk of nutrition-related noncommunicable diseases such as Type II diabetes and liver disease (Branca et al., 2019; Popkin et al., 2004).

Dietary and health-related behaviours and food preferences are often established in early childhood and continue into adulthood (Fleming et al., 2013). It has been acknowledged in the literature that children learn dietary behaviours by modelling parents’ and peers’ preferences, intake and willingness to try new foods (Sahoo et al., 2015; Patrick et al., 2005). Therefore, availability of, and repeated exposure to, healthy foods is key to developing preferences and can overcome dislike of certain foods in children (Food Dudes, 2020). Mealtime structure is also important with evidence suggesting that families who eat together consume more healthy foods (Patrick et al., 2005). Furthermore, eating out or watching TV while eating is associated with a higher intake of fat (Sahoo et al., 2015).

Higher intake of snacks, consumption of sugar-sweetened beverages (SSBs), fast food consumption, eating while watching television, skipping breakfast, reduced numbers of family mealtimes spent eating together, and lower daily intake of milk, fruits, and vegetables have all been associated with increased rates of childhood obesity, leading to adverse health and dietary outcomes (Han et al., 2010). In contrast, an adequate nutritional intake of vitamins and minerals, whole grains, milk and dairy products, fruits, and vegetables as part of a
balanced diet has been reported to not only protect growth but also manage childhood obesity (WHO, 2003b; Papanikolaou et al., 2017).

According to the Health Behaviour in School-aged Children (HBSC) study (www.hbsc.org), 23% of children surveyed reported that they consume fruit and 21% report consuming vegetables more than once a day (Kolto et al., 2020). Overall, girls, younger children and children from higher social class groups are more likely to report that they consume fruit and vegetables more than once a day (Kolto et al., 2020). The survey also found that 21% of children report eating sweets more than once a day or more (27% in 2014) and 7% of children report drinking soft drinks daily or more (13% in 2014). Girls, older children and those from lower social class groups are more likely to report eating sweets once a day while boys, older children and those from lower social class groups are more likely to report drinking soft drinks daily or more. More information on the HBSC study is available in section 2.5.2.

The GUI study reported that more than half (57%) of 9-year-olds surveyed in 2017 consumed fruit at least twice in the last 24 hours (ESRI, 2018). Similar to the HBSC findings, the number of children consuming fruit was lower for families in the lowest income group (49%), or where mother’s education was at Junior Certificate level or less (40%) (ESRI, 2018). Some progress appears to have been made in the last decade, in terms of fruit consumption among children. Compared to the earlier cohort of 9-year-olds sampled in 2007, mothers of the most recent cohort surveyed in 2017 were much more likely to report that their children had eaten fresh fruit more than once in the last 24 hours (57% in 2017 vs. 38% in 2007) (ESRI, 2018).

Lower income and lower maternal education were also associated with an increased likelihood of children consuming crisps or savoury snacks (ESRI, 2018). Unlike the HBSC study, the consumption of biscuits/cakes did not vary by socio-economic background in the GUI survey, on average 27% of 9-year-olds consumed these at least twice in the last 24 hours (ESRI, 2018). According to the GUI survey, almost all children had something to eat before going to school (98%), but this was somewhat lower in the lowest income families (95% compared to 99% in the highest-income families) (ESRI, 2018). This differs from the HBSC study which found that just over one in ten children (12%) surveyed reported never having breakfast during weekdays (Kolto et al., 2020). Based on the HBSC findings, girls, older children and children from lower social class groups are more likely to report never having breakfast during weekdays (Kolto et al., 2020).
2.4.3 (d) Genetic Factors

Although genetics undoubtedly plays a role in childhood obesity, the dramatic rise in the prevalence of obesity within the last half a century in developed and developing countries alike point to risk factors beyond genetics (Hruby and Hu, 2015). However, while lifestyle and environmental changes may have driven the rise of overweight and obesity (Must and Tybor, 2005), studies indicate that anthropometric indexes such as height, weight, and waist circumference are between 40% and 70% inheritable (Farooqi and O’Rahilly, 2005; Stunkard et al., 1990).

A systematic review of twin and adoption studies identified evidence that both genetic and common environmental factors affect BMI variation in childhood, but that the effect of common environment reduces or disappears in adolescence (Silventoinen et al., 2010). On the other hand, genetic factors maintained a strong effect on BMI from early childhood through adulthood (Silventoinen et al., 2010). 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 were more substantial as a predictor of BMI (Stunkard et al., 1990). However, it is noteworthy that there do not seem to be any family studies in which the BMI of parents, measured when they were children, is related to the BMI of their offspring in childhood, in order to make age-related comparisons. Indeed, genetics, the environment and their complex interaction need to be further investigated in order to have a better understanding regarding obesity.

2.4.3 (e) Parental and Maternal Obesity

Parental obesity has been established as a significant predictor of child obesity (Keane et al., 2012). Having an overweight parent or primary caregiver doubles the risk of child obesity while obesity amongst both parents increases the risk of the child further (Magarey et al., 2003; Ochoa et al., 2009). An Irish study observed that 14.4% of children with normal weight parents were overweight or obese, whereas 46.2% of comparable children with obese parents were overweight or obese (Keane et al., 2012).

Although a large portion of this association is likely attributable to a shared unhealthy environment, researchers have also reported strong links between parental and offspring BMI (Kelly et al., 2014; Murrin et al., 2012). Furthermore, other researchers suggest that maternal
BMI alone can influence offspring BMI (Murrin et al., 2012) while height is more closely related to the paternal family line (Kelly et al., 2014).

2.4.3 (f) Maternal Employment
Studies have indicated that maternal employment can contribute to offspring overweight and obesity, with maternal employment during childhood increases children’s BMI (Fitzsimons and Pongiglione, 2019; Liu et al., 2009; Anderson et al., 2003). However, the importance of distinguishing between different family types is key, as the adverse effects on BMI are considerably larger for single mothers in employment, whether part- or full-time (Fitzsimons and Pongiglione, 2019). 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. In Ireland, nearly two-thirds of mothers surveyed as part of the GUI study were in employment (65%) and almost half of these worked over 30 hours per week (ESRI, 2018c).

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.

2.4.3 (g) Race and Ethnicity
Although childhood obesity is increasing in all ethnic and racial groups worldwide, its prevalence is higher in non-Caucasian populations (Caprio et al., 2008). Indeed, it is recognised that obesity has disproportionately affected some racial and ethnic groups (Freedman et al., 2012). The reasons for the differences in prevalence of childhood obesity among groups are complex, likely involving genetics, physiology, culture, socioeconomic status (SES), environment, and interactions among these variables as well as others not fully recognised (Caprio et al., 2008). A study in the United States found that the prevalence of overweight increased approximately three and five times among white and black children respectively who were aged between six to eleven years (Freedman et al., 2012). Similarly, the prevalence of overweight and obesity as defined by IOTF cut points for BMI is significantly higher in Māori (40 %) and Pacific island (60%) children than in their European counterparts (24 %) (New Zealand Ministry of Health, 2008).
2.4.3 (h) Social and Economic Factors

Another positive predictor of childhood overweight and obesity widely acknowledged in the literature is socio-economic status (SES) (Heinen et al., 2016). An Australian cohort study of children aged 7-12 years showed that low SES status predicted obesity risk and this trend became stronger as children entered adolescence (O’Dea et al., 2012). Similarly, the UK Millennium Cohort Study which evaluated over 16,000 children born between the year 2000 and 2002 showed that 5-year-old children from families with low income or low educational attainment were more likely to be obese regardless of ethnicity (Brophy et al., 2009). Two cross-sectional studies showed that low SES was associated with obesity in French children aged 5-11 years (Thibault et al., 2013) and in German children aged 5-7 years (Danielzik et al., 2004).

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 and Specter, 2004). Additionally, 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).

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). Furthermore, an umbrella review of 19 systematic literature reviews found no association between PA and SES or parental SES was for pre-school, school-aged children and adolescents (O’Donoghue, 2018). However, a limitation when reviewing the literature is that whilst many studies have examined the links between SES and obesity, and/or SES and PA, not all have examined the same indicators of SES making comparisons between studies difficult (Pouliou and Elliott, 2010; O’Donoghue et al., 2018).

In Ireland, the Growing Up in Ireland (ESRI, 2018) study reported that there was a clear inequality in the prevalence of overweight and obesity according to family income: 32% of children in the lowest income fifth were overweight/obese, compared with 22% in the middle
fifth and 14% in the highest fifth. Overall, 9-year-olds in the highest-income families were less than half as likely as those in the lowest-income families to be overweight/obese (ESRI, 2018). Similarly, an ongoing trend in differences between disadvantaged and other schools in Ireland is apparent, with the prevalence of overweight and obesity significantly greater ($p \leq 0.016$) in children attending schools classified as disadvantaged (DEIS) than other schools (Mitchell et al., 2020). However, the Childrens Sport Participation & Physical Activity (CSPPA) study noted that SES did not influence the proportion of children in primary school meeting the PA guidelines (Woods et al., 2018).

As mentioned previously in secton 2.4.3 (c) above which discussed children’s nutritional behaviour, lower income and lower maternal education households are associated with an increased likelihood of children consuming high energy dense foods like crisps or savoury snacks and were less likely to consume fruit (ESRI, 2018). Fourteen percent of 9-year olds in lower income families consumed crisps and savoury snacks daily, in comparison to 9% of children from higher income families. Conversely, less than half of 9-year olds from the lowest income families (49%) consumed fruit daily in comparison to 64% of children from the highest income families (ESRI, 2018).

2.4.3 (i) Transport
The development of motorisation has greatly influenced populations, decreasing levels of PA and leading to decreased energy expenditure and inevitable weight gain (Lob-Corzilius, 2007). Therefore, activities that can be incorporated into everyday life, such as active school transport (AST) provide opportunities for children to increase their daily PA levels and reduce their risk of becoming overweight or obese (Larouche et al., 2018; Larouche et al., 2014). An international study including both high income and middle to low income countries found that children who used AST were less likely to be obese, had lower BMIz, lower percentage body fat and a smaller waist circumference, compared with those who used a non-active mode of transport. Likewise, children who reported biking as their main mode of transport had a lower BMIz and waist circumference (Sarmiento et al., 2015).

The distance between home and school is the most consistent predictor of active transport in youth; the closer a child lives to school, the more likely they are to use active transport (Duncan et al., 2016). While this suggests that it is preferable to live as close to school as possible, the limited PA accumulated during short trips may not offer substantial benefits to
active transporters (Duncan et al., 2016). An evaluation of the predicted PA benefits associated with a range of home-school distances, observed that a distance from school of approximately 2 km was associated with the best PA outcomes related to active transport (9% to 15% increase on weekdays) (Duncan et al., 2016). In addition, the decrease in children actively travelling to school may also be attributed to parental concerns regarding their child’s safety (Salmon et al., 2007).

Globally, 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 (Larouche et al., 2018; Schoeppe et al., 2013; Woods et al., 2010; Metcalf et al., 2004). Whilst international figures relating to active travel to school are of concern, recent data indicates that over the last decade the number of Irish children actively commuting to school is beginning to increase (Woods et al., 2018). Forty-two percent of primary and 40% of post-primary school children actively travelled to school in 2018 compared to 31% (primary) and 40% (post-primary) in 2010 and 26% (primary) and 30% (post-primary) in 2004 (Woods et al., 2018; Woods et al., 2010).

2.4.3 (j) Screen Time and Technological Advancements

With the rising popularity of electronic media, children and adolescents now spend more than 60% of their 16-hour waking time in front of a screen and far less time engaged in physical activity (PA), resulting in increased sedentary time and associated weight gain (Barnett et al., 2018). Children are recommended to have no more than 120 minutes of sedentary screen time per day (American Academy for Paediatric, 2001, cited in Woods et al., 2018). However, recent findings report that only two thirds (63%) of primary and less than half of post-primary children are meeting these guidelines (Woods et al., 2018). Screens are now readily available to children with over 93% of children surveyed (n=3,764) by Cyber Safe Ireland in 2019 reporting that they own a smart device (Cyber Safe Ireland, 2020). This survey, which includes data from 3,764 Irish children aged 8 – 12 years old, shows that the most popular devices among children are tablets (55%) and games consoles (52%) with smartphones being the third most popular choice (44%) (Cyber Safe Ireland, 2020). Similarly, preliminary findings from the most recent Growing up in Ireland (GUI) pilot study identified that 79% of 9-year-olds had access to a tablet such as an iPad at home, 66% a games console, 45% a laptop, 40% a smartphone and 44% some other kind of handheld device (Murray et al., 2020). Furthermore, since the COVID-19 national lockdown, Irish households have accumulated an average of two
additional electronic devices (National Anti-Bullying Research and Resource Centre, 2020). Parents who were out of work and looking for a job or self-employed acquired significantly fewer devices, while employed parents acquired significantly more devices during lockdown than others (National Anti-Bullying Research and Resource Centre, 2020).

Despite the largely reported negative consequences of technology, advancements in technology and the increased availability of digital activity trackers has been related to some researchers finding an increased likelihood of children meeting the daily PA guidelines (Ng et al., 2017). The CSPPA study reported that in 2018 more than half of primary (53%) and post primary (54%) school pupils reported owning a PA tracking device (Woods et al., 2018). Furthermore, the likelihood of meeting the PA guidelines was associated with owning a PA monitoring device, using a PA monitoring device and the frequency of use (Woods et al., 2018).

Overall, there are conflicting findings regarding the determinants of paediatric obesity. While many determinants of overweight and obesity have been examined, the associations between them, including combined or confounding effects are difficult to interpret (Santiago et al., 2013). Furthermore, it is extremely difficult to successfully investigate the effect of one determinant on overweight and obesity in isolation, as one determining factor can be influenced by other defining factors (Stewart, 2011).

2.4.4 Cost of overweight and obesity

Chronic diseases associated with overweight and obesity, and associated economic losses, are major drivers of healthcare costs worldwide (Tremmel et al., 2017, Chu et al., 2019). Overweight and obesity can contribute to direct costs such as the increase in the utilisation of health care services, and indirect costs due to the loss in productivity as a result of sick days associated with being overweight or obese (Chu et al., 2019). The total lifetime costs of childhood obesity in the Republic of Ireland are estimated to be €4.6 billion, with the direct healthcare associated costs estimated at €1.7 million (Perry et al., 2017). It is projected that if early interventions were made and BMI was reduced by 1%, the lifetime cost of childhood overweight and obesity could be reduced by up to €270 million (Perry et al., 2017). Additionally, projections suggest a BMI reduction of 5% could reduce the lifetime costs by €1.1 billion (Perry et al., 2017). This demonstrates that in addition to improving lifelong health
status, early intervention to establish healthy behaviours with children also has the potential to have large economic benefits for society.

Overweight and obesity have been shown to contribute to various health and financial consequences and have placed a significant financial burden on individuals and on society (Perry et al., 2017; Wang et al., 2011). Collaborative initiatives are urgently needed to effect environmental, social, community, familial and individual change to minimise the health and financial burden of the obesity epidemic.

2.5 Tackling Overweight and Obesity

2.5.1 Policy

In 1997 the WHO and the International Obesity Task Force (IOTF) examined the need to develop public health policies and programmes to tackle the global problem of obesity (WHO, 2020g). The consultation resulted in the publication of an interim report: “Obesity – Preventing and Managing the Global Epidemic” (WHO, 2000). This document contained a review of (at the time) current epidemiological information on obesity, its determinants and the 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).

2.5.2 Surveillance
Since 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 across the WHO/Europe Region to allow for inter-country comparisons (WHO, 2020c). This initiative measures weight trends in primary school children aged six to nine years of age (WHO, 2020c). Whilst countries were advised to adhere to certain protocols regarding core items, each country was able to develop its own surveillance strategy (WHO, 2020c). Nationally representative samples of primary schools are recruited, and these schools remain as part of the sample for repeated measurements so that longitudinal trends may be observed (WHO, 2020c). 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, 2020c). Data are analysed at both the country level by the national coordinating centre and at European level (WHO, 2020c).

The HBSC study mentioned earlier in this chapter (section 2.4.3 (c)) is an example of a cross-sectional surveillance study conducted in collaboration with the WHO Regional Office for Europe. The HBSC international survey runs on an academic four-year cycle and in 2017/2018 there were 47 participating countries and regions (Kolto et al., 2020). The overall study aims to gain new insight into and increase our understanding of young people’s health and wellbeing, health behaviours and their social context. As well as serving a monitoring and a knowledge-generating function, one of the key objectives of the HBSC study has been to inform policy and practice (Kolto et al., 2020).

Cross-nationally, HBSC collects information on the key indicators of health behaviour and health outcomes as well as the diverse context of health for young people aged between 11 and 15 years (Kolto, 2020). HBSC is a school-based survey with data collected through self-completion questionnaires administered by teachers in the classroom. The international HBSC survey instrument is a standard questionnaire developed by the international HBSC research alliance (Kolto et al., 2020).
2.5.3 Physical Activity

PA is generally described as having three levels of intensity; light, moderate and vigorous, and these intensity levels vary between individuals (WHO, 2020e). 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 moderate 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 (three or four on the RPE scale) and examples include brisk walking, dancing and active games (WHO, 2020e; CDC, 2011b). Vigorous PA can be described as an activity that results in sweating, rapid breathing and a substantial increase in heart rate (between five and ten on the RPE scale) (WHO, 2020e; Biddle et al., 2004) and examples include running, aerobics and competitive sports.

The WHO recommend that children should be physically active at a moderate to vigorous level for an average of sixty minutes every day and should include vigorous intensity activities at least three times a week (WHO, 2020e; Van der Ploeg et al., 2020). This recommendation is also supported in Ireland. According to the National Physical Activity Guidelines for Ireland children and adolescents (aged two to eighteen years) should be active at a moderate-vigorous level for sixty minutes daily and should include other components of fitness such as muscle-strengthening, flexibility and bone-strengthening three times a week (Department of Health and Children, 2009). It should be noted that while an average of sixty minutes daily MVPA is recommended, some activity, at any intensity is better than none as even small increases in PA can elicit positive changes to children’s health (WHO, 2020e; Van der Ploeg et al., 2020).

2.5.4 (a) Physical activity and health

Low levels of PA and high levels of sedentary time are both associated with a higher risk of overweight and obesity. A positive association exists between regular participation in PA and a range of physiological and psychological health outcomes in children and youth. This
includes benefits to cardiometabolic health, muscular strength, bone health, cardiorespiratory fitness and psychosocial outcomes (Janssen et al, 2010). To produce the most substantial health benefits, PA should be of at least moderate intensity, although a dose response relation for PA exists (i.e. some is better than none, more is better than some) (Janssen et al, 2010).

BMI has emerged as an influencing factor among 9-year olds in the Growing up in Ireland study, as children who were classified as overweight or obese were less likely to meet the recommended PA guidelines every day, in comparison to children of a normal weight (20% vs. 27% of non-overweight children) (ESRI, 2018). Higher cardiorespiratory fitness has also been positively associated with the number of days where children achieved the PA guidelines (Woods et al., 2018). Of all correlations, this may be the most important physical health association, as higher levels of cardiorespiratory fitness are also associated with decreased cardiovascular risk factors (Hurtig-Wennlof et al., 2007, cited in Woods et al., 2018), as well as overall life satisfaction (Padilla et al., 2012) in children and adolescents.

Estimates suggest that globally, physical inactivity costs $53.8 billion annually (Ding et al, 2016). In the Republic of Ireland, low levels of PA levels account for approximately 0.74% of total health-care costs (Ding et al., 2016). These costs are likely to rise significantly if today’s inactive children reach late adulthood without changing their behaviour. According to the ‘Designed to Move’ (Lee et al., 2012) agenda, this generation of physically inactive children could die 5 years younger than their parents. This highlights a social, as well as a health related, cost of inactivity. In Ireland, the average expected gain in life expectancy based on the elimination of physical inactivity is 0.87 years (Lee et al., 2012).

2.5.4 (b) Trends in Ireland
Overall, the number of children in Ireland meeting the recommended PA guidelines is low. According to the CSPPA study, only 13% of children surveyed (n = 4,697, aged 10 to 18 years) are reported to have met the 60-minutes of moderate-to-vigorous daily PA criterion (17% primary school pupils and 10% post primary school pupils) (Woods et al., 2018). In addition, girls were significantly less likely to meet the guidelines than boys, with only 13% of girls undertaking 60 minutes of daily MVPA in comparison to 23% of boys (Woods et al., 2018). Although boys were more likely to meet the guidelines than girls at all ages, the most significant change observed by the CSPPA study since 2010 was the decline in the proportion
of primary school boys reporting meeting the guidelines from 27% to 23% (Woods et al., 2018). However, this is still significantly more than the 13% of primary school girls who met the guidelines. At post primary school level, even fewer boys (14%) and girls (7%) met the PA guidelines (Woods et al., 2018). The CSPPA study also highlighted that the likelihood of meeting the PA recommendations decreased as children got older (Woods et al., 2018).

Similarly, the HBSC 2018 evaluation found that overall, only 23% of children surveyed (n=15,557; aged 8 – 18 years) reported being physically active on 7 days in the last week (23% in 2014) (Nic Gabhainn et al., 2018). Gender and age differences were also observed in the sample surveyed with boys and younger children identified as more likely to report being physically active on 7 days in the last week, however, no significant differences across social class groups were reported (Nic Gabhainn et al., 2018). Additionally, 52% of children surveyed reported exercising four or more times a week at a vigorous level (52% in 2014) (Nic Gabhainn et al., 2018). Again, boys, younger children and children from a higher social class groups are more likely to report exercising four or more times a week. These trends are also reflected in the CSPPA study which discovered that 87% of are not receiving sufficient amounts of PA to meet the Department of Health and Children’s physical activity guidelines (Woods et al., 2018).

In terms of physical inactivity, statistically significant differences by gender, age group and social class have also been identified in Irish children (Nic Gabhainn et al., 2018). According to the HBSC study, girls (13%) are more likely than boys (8%) to report participating in vigorous exercise less than once a week (Nic Gabhainn et al., 2018). Additionally, older children are more likely to report participating in vigorous exercise less than weekly than younger children, and children from lower social class groups are more likely to report participating in vigorous exercise less than weekly than those from higher social class groups (Nic Gabhainn et al., 2018).

Worryingly, the number of children reported to be meeting the PA guidelines in the 2018 CSPPA was significantly lower than the number children recorded meeting the guidelines in primary and post primary schools respectively in 2010 (Woods et al., 2018). Overall, it is concerning that these findings seem to directly contradict the goal of the National Physical Activity Plan for Ireland, ‘Get Ireland Active’, which aims to increase the proportion of children meeting the physical activity guidelines by 1% each year (Healthy Ireland, 2014).
Information from academic articles, open use datasets, reports and policy documents between 2011 and 2015 extracted and collated for the 2016 PA Report Card for Ireland identified that between 25% (self-report data) and 30% (objectively measured data) of Irish children were meeting the WHO PA guidelines (Harrington et al., 2016). These figures suggested a D grade for PA among Irish children in the 2016 Report Card, a slight improvement on the D minus grade awarded for PA in 2014 (Harrington et al., 2016). However, there have been a limited number of studies in Ireland that have objectively measured the PA levels of children and further investigation that includes a large representative sample of this demographic is needed (Harrington et al., 2016).

2.5.4 Sedentary Time

As sedentary behaviour can be viewed as an independent risk factor for health (Saunders et al., 2014), it is possible for individuals to meet the PA guidelines, but still accrue large amounts of sedentary time. High levels of sedentary time (defined as more than three hours of sitting per day) increased the risk of overweight and obesity in high and low active children (Lane et al., 2014). Similarly, in an Irish context, overweight and obese adolescents accumulate more minutes of overall sedentary screen time daily compared to their normal-weight counterparts (O’Brien et al., 2018).

Many countries including Ireland do not currently have established guidelines for sedentary time for adults or children. The difficulty in developing national guidelines for sedentary behaviour is reflected by the current lack of such guidelines worldwide. 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 that children (aged five to eighteen years) participate in less than two hours of daily screen time and generally limit sedentary behaviour throughout the day (Department of Health, 2014; Canadian Society for Exercise Physiology, 2012; Ministry of Education, 2007).

2.5.5 (a) Trends in Ireland

Reports from the CSPPA study, indicate that the average sedentary leisure time of Irish children in 2018 was 5.1 hours/day for primary school children and 6.6 hours/day for post primary children (Woods et al., 2018). On average, 37% percent of primary and 58% of post primary pupils did not meet the sedentary screen time guideline of no more than 120 minutes/day (Woods et al., 2018).
The GUI study observed that over 90% of 9-year-olds surveyed (n=7,563) in 2017 spent at least some time watching TV on both weekend and weekdays (ESRI, 2018b). Half of children spent two or more hours watching TV/DVDs on a weekend day and 15% did so on a weekday, an increase of 5% on the previous GUI report (ESRI, 2018b). Apart from watching TV/DVDs, most 9-year-olds also spent time every day on other types of screen-based activities (such as on a computer or tablet). One-third spent over two hours on such activities per weekend day while just 9% did so on a weekday (ESRI, 2018b). The report also identified differences by gender and socio-economic status in time spent on screen-based activities. Boys and those from families with lower income or lower maternal education were reported to be more likely to spend 2 hours or more on screen-based activities of either kind (TV or computer/tablet) (ESRI, 2018b).

During the Covid-19 national lockdown, a survey by the National Anti-Bullying Research and Resource Centre (2020) reported that 71% of participants (n=504) who reported using smartphones prior to lockdown (56% of the entire sample) said they used smartphones more often than before. Similarly, 66% of children who reported using gaming consoles (49% of the entire sample) said they used gaming consoles more often after lockdown than before and 72% of children who used social media (53% of the entire sample) said they used social media more often than before the lockdown (National Anti-Bullying Research and Resource Centre, 2020). During lockdown, no significant differences in increased usage of electronic devices for gender or age were identified (National Anti-Bullying Research and Resource Centre, 2020). However, previous research among overweight and obese Irish children and adolescents found these young people to accumulate more minutes of overall sedentary screen time daily compared to normal-weight children and adolescents (O’Brien et al., 2018).

2.6 School-based Interventions & Evaluations

As noted in section 2.3, and in terms of improving the health status of children, the school environment has the potential to make important differences and presents several opportunities for intervention given the access it provides to the majority of children (Lavelle et al., 2012; Van Sluijs et al., 2008; Vasques et al., 2014; Ward et al., 2007). Effective school environments provide opportunities for interventions to embody a culture of care, and to be fully inclusive of all children; regardless of any existing racial or socio-economic background differences (Cavanagh et al., 2012; Grasten et al., 2017).
Primary schools are particularly favourable settings for intervention, as due to their prolonged contact with intervention activities throughout the course of the school year, children of primary school age are increasingly likely to be influenced by health promotion initiatives, which can promote positive behavioural changes that can continue into adulthood (WHO, 2017). Children also spend considerable amounts of time at school and this setting enables large numbers of children to be targeted at one time (Sobol-Goldberg et al., 2013). Although they provide suitable settings to target multiple children from varied background, ironically, schools internationally are reported to be one of the dominating locations of sedentary behaviour in children with class time representing a significant sedentary period of the day (Holt et al. 2013). Children are mostly required to remain seated to receive curricular lessons (Gibson et al. 2008). For these reasons, researchers and policymakers have identified schools as logical settings for intervention, and as such, there has been a dramatic increase in the number of school-based PA initiatives on offer to schools worldwide (Grasten et al., 2017; Jennings et al., 2018). School-based PA interventions fall broadly into five categories: physical education (PE) curriculum, classroom activity breaks, active commuting to school, modified playgrounds, and multi-component approaches that combine all, or some, of the above to adapt the whole school environment (Grasten et al., 2017). Globally, and in Ireland, it is recommended that all schools develop policies to address PA as part of the school day and not just in PE or active travel, to combat the inherent sedentary nature of traditional classrooms (Martin & Murtagh, 2015).

The literature is saturated with systematic reviews demonstrating the effectiveness of school-based approaches (e.g., Naylor et al., 2015; Dobbins et al., 2013; Van Sluijs et al., 2007; Dudley et al., 2011; Kriemler et al., 2011; Lai et al., 2014), and highlighting the importance of multi-component models (e.g., Van Sluijs et al., 2007; Kriemler et al., 2011). School-based interventions with combined diet and physical activity components have been reported to have the greatest effect at tackling childhood overweight and obesity (Bleich et al., 2018). However, systematic reviews investigating the effectiveness of single or multi-component school-based interventions on children’s PA levels, sedentary time, and healthy eating behaviours have, to date, produced mixed findings (Evans et al., 2012; Naylor et al., 2015; Love et al., 2019).
A systematic review to determine if sub-populations of students benefit equally from school-based interventions in terms of CRF and PA found that while PA interventions modestly improve students’ CRF, these effects were not distributed equally across subpopulations (Hartwig et al., 2021). It found that girls and older students benefited less from school-based interventions than boys and younger students, respectively (Hartwig et al., 2021). In addition, students with lower levels of initial fitness, and those with higher levels of baseline physical activity benefitted more from the intervention than those who were initially fitter and less active (Hartwig et al., 2021). This could be cause for concern, given that girls and older children tend to be less active and have a higher prevalence of overweight and obesity, and are perhaps the ones in greatest need of intervention (Mitchell et al., 2020; Woods et al., 2018.)

The variability between studies reported in the literature shows both the complexity of implementing school-based interventions and their evaluations, and the challenges in identifying key successful components (Langford et al., 2015). It also highlights the importance of understanding the contextual variables that dictate why only some school-based interventions are effective in achieving their outcomes (Naylor et al., 2015; Schapp et al., 2018).

2.6.1 Project Energize

In 2004 the Waikato District Health Board (WDHB) in New Zealand invested in a school-based health promotion initiative called 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 aimed 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). Over time, 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.

2.6.2 Project Spraoi

In response to the success of Project Energize (PENZ), and the need for intervention among Irish children, a school-based health promotion programme, based on Project Energize was developed. ‘Project Spraoi’ (www.cit.ie/projectspraoi) aims to promote increased daily PA, improve nutritional knowledge and attitudes and, through the adoption of these behaviours, improve the health of Irish primary school children. Based on PENZ, which utilised the Social Ecological Model of Health Behaviour (Sallis et al., 2008), PS aims to target multiple layers of influence by engaging with the child, their school friends and family, the school and the community, in order to support and promote increased PA and improved nutritional knowledge and attitudes (O’Leary et al., 2019).

The larger PS RCT (ISRCTN92611015) described by Coppinger et al., (2016) was initiated in primary schools in Cork, Ireland, in September 2013 and, to date, has involved 11 schools. Within the larger RCT, a team of researchers have conducted distinct research projects in the areas of PA levels, nutritional knowledge and attitudes, dietary intake, sedentary behaviour, fundamental movement skills and process evaluation (O’Leary et al., 2019; Merrotsy et al., 2019; Bolger et al., 2018).
Following two years of the PS intervention, an analysis of 4 schools (2 intervention and 2 control schools) with similar characteristics revealed that PS had significant favourable changes associated with smaller waist circumference relative to gender and age \( (p < 0.0005) \), slower resting heart rate \( (p = 0.003) \) and favourable nutritional attitudes among 10-year-olds (O’Leary et al., 2019). No significant changes were identified among the 6-year-old cohort. Further studies have also reported significant favourable improvements in WCHt ratio and blood pressure among 10-year olds (Merrotsy et al., 2019).

A further study of the effectiveness of PS on nutritional knowledge (NK) and dietary intake (DI) of a cohort of 6- and 10-year-olds reported statistically significant improvements in the nutritional knowledge of 10-year-olds following a two-year PS intervention. However, despite the significant improvement in NK, no significant changes were identified in the same group of 10-year-olds DI (Merrotsy et al., 2019). This may be due to the fact that despite their NK, primary-school children have little control over what they eat. Research conducted with children in Northern Ireland indicated that parents were major influencers in their children’s diets (Walsh & Nelson, 2010). Parents are responsible for what children eat at this age and therefore despite the efforts of the PS intervention, DI is largely dependent on food provided by parents. The author noted that although PS involved parents in some aspects of the programme (healthy lunchbox demonstrations, sugary drinks and takeaway information sessions, recipes), this involvement was limited and therefore increasing the amount of parental participation in PS in future may help to further improve DI (Merrotsy et al., 2019).

Among 6-year-olds, although no significant improvements in fruit and vegetable intake were identified following the two-year intervention, a significant increase in the fibre intake of 6-year-old males was identified (Merrotsy et al., 2019). Children with diets high in fibre see many health benefits, including normal gastrointestinal function, prevention and treatment of childhood obesity, lower BP and lower risk for CVD in adulthood (Anderson et al., 2004).

In addition to health markers, PA levels, NK and DI, the effectiveness of PS on improving children’s fundamental movement skill (FMS) proficiency has also been investigated. Over the course of 2 years, Bolger et al. (2018) investigated the effect of the standard PA based PS intervention (year 1) and a specialised FMS PS intervention (year 2) on the FMS proficiency of a junior and senior child cohort using the Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000). Findings from this study suggest that although locomotor proficiency improved
and object-control proficiency was maintained among the intervention group, the ordinary PA based PS intervention as delivered in year 1 was not significantly more effective than the standard Irish Physical Education (PE) curriculum carried out in the control school (in which no improvements in FMS proficiency were observed) (Bolger et al., 2018). Even though FMS instruction and feedback were not provided as part of the ordinary PS intervention, improvements in locomotor proficiency among the intervention group may have resulted from the increased PA opportunities provided through lessons delivered by the qualified specialist (Energizer), daily PA and weekly PE provided by teachers (Bolger et al., 2018).

In year two, the specialised FMS PS intervention resulted in significant group-time interactions for locomotor, object-control, and overall FMS proficiency, in favour of the intervention group (Bolger et al., 2018). Significant increases were found in locomotor standard score, object-control standard score, and overall Gross Motor Quotient (GMQ) score among the 6-year-old and 10-year-old intervention groups, while significant decreases were observed among the respective control groups (Bolger et al., 2018). These findings further support the effectiveness of targeted FMS interventions in improving FMS proficiency among primary school children.

In conclusion, PS is a tried and tested multi-component intervention, which has positive associations with a range of health markers including WCHtR, resting heart rate, blood pressure, NK and FMS proficiency.

2.6.3 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 ’80s (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) with their normal classroom teacher (Sallis et al., 1997). While this study did provide early evidence of the benefits of specialist teachers in implementing greater amounts of school-based PA, overall, the programme was not found to have any statistically significant impact on children’s body composition (Sallis et al., 1997).

2.6.4 Health Promoting Primary Schools of the Future

The Health Promoting Primary Schools of the Future (HSPF) is an initiative that focuses on healthy eating and physical activity (PA), to improve Dutch children’s health and well-being by enhancing health promotion throughout the whole school system, with the aim of contributing to fostering a healthier future generation (Young et al., 2013; Willeboordse et al., 2016). Central to this HPSF-concept is the top-down initiation of two changes, a free healthy lunch provided to children each day and daily structured PA sessions. While in some other national school systems these may be normal practice, these two changes were hypothesised as being positively disruptive to the Dutch school system.

The time for having lunch in intervention schools was increased by 20–30 minutes in order to incorporate additional daily PA (Bartelink et al., 2019). For this reason, the school day was also extended: children in the full HPSF intervention schools attend school until approximately 15:30/15:45 instead of 15:00. To avoid increasing the workload of teachers further, the structured activity sessions were delivered by external educational employees provided by local childcare organisations. The integration of the childcare organisation during school hours was not to provide a temporary solution, but to change the school’s organisation in a sustainable way. The aim for the future being to bring local school and childcare closer together and thereby create an integrated day for children, whereby children are supervised by the same people before, during and after school hours. Employees of sports and leisure organisations supported the childcare employees during implementation when needed, and after a year they provided a training course (8 sessions of 2hrs) to supply the childcare
employees with additional tools for how to motivate children for active participation during the PA sessions (Bartelink et al., 2019).

In addition to increasing daily PA, a dietician was hired to develop a lunch menu cycle for participating schools that changed every 10 weeks, in which at least 80% of the products met the advice of the Dutch Health Council (Gezondheidsraad, 2015). In addition to lunch, a mid-morning snack, consisting of fruits and/or nuts, was also provided to schools participating in the full HSPF.

The study \( n = 1676 \) children employed a quasi-experimental design with four intervention schools, two full HPSF (focus: nutrition and PA) and two partial HPSF (focus: PA), and four control schools. Following two years of intervention, analyses showed significant positive changes in the schools who adopted the full HPSF versus control schools for, among others, school water consumption, lunch intake of vegetables and dairy products, sedentary time and light PA. However, almost no significant differences were found in the schools who adopted the partial HPSF compared to control schools.

As a result, the authors concluded that the full HPSF is effective in promoting children’s health behaviours compared with control schools. Furthermore, this study highlighted that interventions focusing on both nutrition and PA components are more effective in promoting healthy behaviours than those that focus exclusively on PA.

2.6.5 The Daily Mile

The Daily Mile was developed by a school in central Scotland in 2012 to address a perceived lack of fitness in primary school children (children aged five to twelve) (Ryde et al., 2018). The intervention involves teachers leading their class in an outdoor walk, jog or run for approximately 15 minutes every day during class time in addition to national curriculum physical education (PE) and timetabled break times (The Daily Mile Foundation, 2018). As the approximate distance covered within this time was around a mile, the initiative was named ‘The Daily Mile’ (Ryde et al., 2018).

Based mainly on anecdotal reports of benefit in terms of reducing obesity and improving academic attainment, as well as seemingly low cost, over 6000 schools and nurseries (preschool centres) worldwide have adopted the intervention (The Daily Mile Foundation, 2018). Furthermore, the UK Government called for all primary schools to adopt initiatives such as
The Daily Mile within their updated Childhood Obesity Plan (UK Department of Health and Social Care, 2018). While the Daily Mile has been found to improve children’s cardiorespiratory fitness level (Marchant et al., 2020), a recent randomised control trial on the clinical and cost effectiveness of ‘The Daily Mile’ across 40 schools observed a small but not significant effect on children’s body composition (BMIz) (Breheny et al., 2020).

Due to a lack of relevant process evaluation data included in Breheny et al. (2020) study to aid the interpretation of outcomes, the authors hypothesised anecdotally that the minimal effect on BMIz observed in the whole sample during the RCT may be a result of a lack of compliance (Breheny et al., 2020). They commented that “it is perhaps unrealistic for schools to complete The Daily Mile every day, given the competing activities and focus on academic attainment” (Breheny et al., 2020, p.817). Indeed, a previous qualitative study conducted by Ryde et al. (2018) to assess the implementation of the Daily Mile across four separate schools in the UK found that the intervention was delivered on average three days a week, with teachers less likely to implement the intervention on days when there was organised PE. Furthermore, The Daily Mile only addresses one aspect of the energy imbalance that contributes to excess weight. Multi-component childhood obesity interventions that address both physical activity and dietary behaviours are likely to be more effective (Khambalia et al., 2011), with those also infiltrating the home environment being the most successful (Bleich et al., 2018).

2.6.6 Application, conclusions and impact of process evaluation methods used in childhood obesity interventions
A variety of process evaluations are reported in the school-based health promotion literature (Gibson et al., 2008; Schneider et al, 2009; Griffin et al, 2014; Bartelink et al., 2018). An extensive process evaluation was reported for the Physical Activity Across the Curriculum (PAAC) study in which six evaluation dimensions were considered: Context, Reach, Fidelity, Dose (delivered and received) and Implementation, and evaluated through a variety of data collection methods (attendance records, surveys, observations, questionnaires and focus groups) (Gibson et al., 2008). However, although the intervention assessed was school-based, it involved only the single component of incorporating PA into classroom-based curricular activities (Gibson et al., 2008).
Two large-scale multicomponent school-based interventions targeting both diet and physical activity; the HEALTHY study (Schneider et al., 2009) and the WAVES study (Griffin et al., 2015) adopted a range of different assessment methods in their process evaluations. The HEALTHY study used a combination of observations of intervention sessions, interviews and focus groups (with school staff and children) alongside teacher feedback forms on class behaviour in their data collection. Such a diversity of methods allows for triangulation of data from different sources; however, their evaluation was restricted, assessing only Fidelity, Reach and Dose (Schneider et al., 2009), with little data on context captured.

The WAVES study (Griffin et al., 2015) aimed to provide structure to the planning of process evaluation methods in complex interventions by posing specific research questions and mapping these onto pre-defined process evaluation dimensions. Guided by the evaluation dimensions outlined by Linnan and Steckler (2002) and Dane and Schneider (1998) (Fidelity, Reach, Dose, Recruitment, Context, Responsiveness, Programme differentiation), seven specific research questions such as “Are there intervention components which are more essential than others?” were developed and mapped onto the different evaluation dimensions (Griffin et al., 2015). Multiple methods including logs, interviews, focus groups, and behavioural observations were then selected to measure evaluation dimensions and to triangulate findings in order to provide reliable answers to each of the research questions posed. A major strength of the study was the authors also included a diverse range of stakeholders in their data collection, including, teachers, programme administrators, parents and children to gain a multi-perspective understanding of the mechanisms by which the WAVES intervention resulted in behaviour change. Although this process evaluation was one of the most comprehensive to date, the authors cautioned that the additional workload that the process evaluation inflicted on teachers was, at times, burdensome. Consequently, they recommend that any data collection tools selected by future researchers should be condensed to maximise impact, while minimising workload for school staff (Griffin et al., 2015).

The focus groups conducted with parents and children as part of the process evaluation of the WAVES study identified three over-arching themes; (1) ‘Impact’, (2) ‘Sustainability’ and (iii) ‘Responsibilities’, under which a number of subthemes were also determined (Clarke et al., 2015). Children and parents were supportive of the school-based intervention, and
parents expressed that school-based healthy lifestyle programmes should not be ‘one-offs’ (p.5), as there is a need for healthy lifestyles to remain an important part of the school curriculum in every year group (Clarke et al., 2015). Other conclusions from the WAVES evaluation were that parental involvement and the influential role of the teacher were seen as key ingredients for success in promoting consistent messages to children and empowering some parents to make positive behavioural changes at home. Parents also recognised that whilst they held the primary responsibility for obesity prevention in their children, they faced a number of barriers to healthier lifestyles at home (such as a perceived high cost of healthy food, lack of time due to work and the attractiveness of sedentary activities), and agreed that schools have an important role to play in their child’s health and wellbeing (Clarke et al., 2015). During interviews, teachers expressed that the main motivator for them to implement the WAVES study was a moral responsibility to support children’s holistic development, rather than solely to prevent overweight and obesity (Clarke et al., 2017). In terms of the role that the school had to play in obesity prevention, opinions varied among teachers involved in the WAVES intervention, with some viewing it more as the role of the child’s family, while others, (mostly teachers working in more deprived areas) recognised that in their context, schools adopt certain additional responsibilities (such as breakfast club) that elsewhere may be fulfilled by parents (Clarke et al., 2017). This was an interesting observation as it suggests that the SES of children influences how teachers view their role in the school context. 

In line with other studies, teachers who participated in the WAVES evaluation identified a number of common contextual barriers across many schools; including a lack of classroom space, curricular time pressure and a lack of access to expert support and resources (Clarke et al., 2017). However, despite these barriers, head teachers involved in the WAVES intervention largely agreed with the views of parents that school-based obesity prevention should be an integral part of the curriculum, and not just a ‘one-off’ or ‘add-on’ initiative (Clarke et al., 2017; Clarke et al., 2015).

The aim of the research into the Healthy Primary Schools of the Future (HPSF) initiative, previously described (see section 2.6.4), was not only to evaluate, but also to support the process of health promoting change in the schools, with a specific focus on contextual differences (Bartelink et al., 2018). To be able to achieve this, the authors developed and implemented the CARA framework, which built upon their previous experiences in school
health promotion research and on the international literature regarding new insights into complex systems thinking (Patton, 2011; Moore et al., 2015). CARA, as described earlier in this chapter (see section 2.2.1), is an adaptation of action research principles, whereby the traditional steps of intervention evaluation are removed and, instead, where, how and if, intervention adaptations are interacting with contextual aspects of the school are identified (Moore et al., 2015; Rutter et al., 2017).

The methodology centred around four key questions: (1) What is the pre-existing context of each school? (2) How does the process of change in each school evolve and which factors affect this process? (3) How can research contribute to the process of change? and (4) Do children’s health and health behaviours improve as a result of the HP changes? (Bartelink et al., 2018). Data collection methods included interviews, observations, questionnaires, and health and behavioural measurements. The development of feedback loops between the researchers and school staff was of key importance to the evaluation, with the building of trustworthy relationships identified as crucial to creating effective and sustained change in the schools evaluated (Bartelink et al., 2018). As a result, the researchers were no longer neutral and fully objective, but joined in the discussions about barriers and potential adaptations that could be made. They also offered support to the implementers whenever possible, on the basis of their professional knowledge, skills, and expertise; as well as the results of the data collected (Patton, 2011; Bartelink et al., 2018). The authors proposed that providing regular feedback, such as summaries of the most important results of interviews, provided valuable guidance to the process of change in the schools (Bartelink et al., 2018).

Similar to Griffin et al., (2015), the HPSF researchers acknowledged that the thorough insight needed to evaluate the intervention process can be time consuming for schools (Bartelink et al., 2018). As a result, the authors conclude that the selection of appropriate mixed quantitative and qualitative methods were the most feasible way to support and evaluate a health promoting initiative in schools, as quantitative methods can be used to elicit feedback quickly and qualitative methods can be used to explore more in-depth challenges and contextual issues (Bartelink et al., 2018).

The Daily Mile, described in section 2.6.5, is considered by many in the UK as an implementation success due to its widespread roll out and adoption by schools. The intervention has also been reported to positively affect children’s CRF (Marchant et al., 2020).
Despite little empirical evidence to suggest that it positively effects children’s body composition (Breheny et al., 2020), the popularity of the Daily Mile initiative as a chosen obesity prevention strategy by over 6,000 schools (both in the UK and worldwide), is impressive (Breheny et al., 2020). In order to explore the factors associated with the implementation success of the Daily Mile in UK schools, Ryde et al., (2018) conducted a process evaluation, which focused on assessing two themes: context and implementation.

Ryde et al., (2018) chose to adopt an exclusively qualitative methodology, conducting semi-structured interviews with head teachers involved in leading the Daily Mile in their respective schools. Interview questions included: what is a typical day at their school; why they started The Daily Mile; how it was implemented at the school; what barriers they faced; and its perceived benefits (Ryde et al., 2018). In order for comparisons to be made, four schools were included in the evaluation: two of which were successfully implementing the Daily Mile and two who found implementation of the Daily Mile more challenging.

The Ryde et al. (2018) study concluded that having simple, core intervention components; flexible delivery that supported teacher autonomy, space, and adaptability to suit the specific school context were important factors that contributed to the Daily Mile’s success. Interestingly, the evaluation also uncovered a lack of understanding in some schools as to what the intervention actually entailed, with one school interpreting the intervention title literally and expecting that the children were to run one mile everyday, which they found was not sustainable. This reinforces the importance of having a strong working relationship between schools and intervention deliverers while also ensuring a clear mutual understanding of the roles and responsibilities required of school staff when delivering interventions. While there was much to be gained from the insights of teachers produced by Ryde et al. (2018), a key limitation of their study acknowledged by the authors, was the lack of input from the children in the schools to provide a more well-rounded insight into the intervention and to further triangulate findings. Furthermore, whilst the process evaluation carried out by Ryde et al. (2018) identified factors that might be related to the successful implementation of The Daily Mile, without specifically testing each individual intervention factor, the extent to which these truly influence implementation and outcome success is unknown.
Marchant et al., (2020) followed on from the Ryde et al. (2018) study by assessing which implementation factors were associated with successful outcomes (CRF) of the Daily Mile and recommended suitability steps to ensure the intervention’s long-term sustainability. A key strength of the Marchant et al. (2020) study was the inclusion of both implementer’s and children’s perspectives. However, the process evaluation methods chosen used solely qualitative methods (interviews and focus groups), with a key limitation to the interpretation of outcomes being the lack of quantitative data to support the assessment of fidelity and dose delivered. Similar to Ryde et al. (2018), Marchant et al. (2020) found a lot of variation in how different schools and even individual classes within the same school were implementing the Daily Mile. The key factors associated with successful implementation were allowing schools flexible adaptable implementation and promoting student feedback; delivering the intervention during curricular time (excluding PE) and not during student’s existing leisure/break time; encouraging individual competition through individual goal setting; active involvement of teachers and school staff; and whole community/family involvement. Empowering the voice of children, also allowed Marchant et al. (2020) to uncover a key barrier to the Daily Mile, which was reported as the repetitiveness of the intervention, which the children found boring at times, and, as a result, negatively affected their motivation. For this reason, Marchant et al. (2020) emphasised the importance of schools eliciting their student’s feedback to adapt the Daily Mile to maintain their interest and enable the intervention to be more sustainable long term. Although the authors set out to identify links between implementation and outcomes, the authors conceded that a limiting factor was that they did not directly measure implementation (fidelity and dose) and so similar to Ryde et al., (2018), the authors cannot truly understand the extent to which the factors they identified influenced implementation and outcomes.

Among the existing literature evaluating school-based PA interventions, only a few studies have addressed the link between implementation and outcomes (Naylor et al., 2015), thus limiting our understanding of their relationship. The way in which these interventions are implemented may partly determine their effectiveness (Durlak and Dupre, 2008). However, monitoring and evaluating implementation has not often been prioritised in school-based PA intervention research to date (Naylor et al., 2015; Watson et al., 2017; Daly-Smith et al., 2019). This inability to properly interpret outcomes increases researchers’ risk of making a type 3 error (Salkind N.J., 2010). A type 3 error can occur when researchers dismiss a
potentially effective intervention based on unsatisfactory outcomes, when, in fact, the outcomes were as a result of poor implementation and not the intervention itself.

When assessing implementation of school-based PA interventions, Tarp et al. (2016) highlighted that quantitative measures of dose delivered alone is not enough to truly understand how an intervention was delivered and interpret how implementation may affect outcomes. Although dose delivered is relatively straight-forward to measure and can be an accurate portrayal of the amount of PA provided, if used alone as the only measure of implementation, researchers may incorrectly assume successful implementation solely on the grounds of high delivery rates, while low levels of fidelity to intervention activities, quality of PA and responsiveness of student’s remain unobserved and unreported (Avitsland et al., 2020). This aligns with the findings of Tarp et al. (2016), who conducted a school-based PA RCT called ‘LCoMotion’ (Learning, Cognition and Motion) and found no effect. According to objective measurements, the authors of the study concluded that implementers could not deliver their targeted PA dose, but they could not explain why (Tarp et al., 2016). As a result, the authors recommended that qualitative data on implementation be included in future studies to improve researcher’s ability to interpret and explain results (Tarp et al., 2016).

A recent process evaluation of a school-based PA intervention called ‘Don’t Worry, Be Happy’ DWBH by Avitsland et al. (2020) used a mixed methods approach to understand how intervention implementation affected outcomes. Acknowledging the complexity of the school setting, the authors of the study reported large differences between schools regarding how the intervention was implemented and received, and how various factors, including the individual school setting, influenced implementation. Intervention characteristics (including freedom of choice in activities and extra time added to the school day), spacious school facilities, scheduling and participant and provider characteristics, positively influenced all aspects of implementation. Limited facilities and unfavourable scheduling that interfered with student’s leisure time, negatively impacted fidelity. Indeed, the variability between schools included in the Avitsland et al. (2020) study further highlighted the complexity of the school environment, and how schools can differ when carrying out a complex and demanding intervention. This coincides with the Moore et al. (2019) argument that introducing a complex intervention, in a complex system, poses an almost infinite number of uncertainties, which no evaluation is able to address completely. Despite this, Avitsland et al. (2020) suggests that
preconditions such as suitable facilities may predetermine the ability of schools to successfully deliver certain PA interventions. From a research perspective, in assessing the effectiveness of a complex PA intervention in a school setting, Avitsland et al. (2020) suggest a matched pairs design be used in lieu of RCTs, using inclusion criteria to limit participation in the intervention to schools with similar characteristics in terms of key implementation factors, such as available facilities and resources, as well as participant and provider characteristics. In their opinion, researchers should ask themselves “what will the intervention require from the school, if it is to be implemented with high quality?” and recruit schools accordingly (Avitsland et al., 2020, p135). Although this tactic would undoubtedly reduce the representativeness of the schools included in a study, less variation in implementation would make the outcomes more comparable.

To summarise, schools are challenging and complex settings for intervention, given the fact that instead of being delivered under ideal and controlled conditions, school-based interventions are subject to real-life factors, many of which are out of the control of the researcher, but can influence the implementation and overall study’s outcomes. The introduction of complex interventions such as multi-component interventions into the already complex school setting, is likely to highlight an almost infinite number of uncertainties, which no evaluation will be able to explain completely (Moore et al., 2019). Although it may not provide all the answers, conducting a robust process evaluation that uses mixed methods to link implementation with outcomes reduces the risk of researchers making a Type III error, and improves their ability to interpret findings and make recommendations to support the expansion or large-scale adoption of school-based interventions in future.

2.7 Conclusion
The overweight and obesity crisis, both globally and in Ireland, are well established and extensively reported in the literature (Department of Health, 2016; Webber et al., 2014), with over one fifth of Irish children reported to be overweight or obese (GUI, 2018; Jennings et al., 2018). The long-term health and social consequences of childhood obesity are also widely acknowledged in the literature (Jennings, 2018), with the adverse health impacts of childhood obesity known to likely continue into adulthood (Reilly et al., 2011). In order to tackle the problem, the WHO recommend that action in multiple settings, with a range of stakeholders and a wide variety of approaches that target both PA and nutritional knowledge and
behaviours, is required (WHO, 2012). Researchers and policymakers have identified schools as logical settings for interventions promoting healthy eating and PA behaviours, because children have long-term contact throughout their childhood and spend much of their waking hours at school (Jennings et al., 2018; Grasten et al., 2017; Cavanagh et al., 2012; Kropski et al, 2008).

Schools have been identified in the literature as complex adaptive systems because every school has its own unique context and working dynamic which is shaped by many interacting elements and ever-changing personnel within the school system (Darlington et al., 2018; Keshavarz et al., 2010). Complex interventions targeting childhood obesity usually include multiple related components targeting a variety of stakeholders, which interact to positively disrupt the prior functioning of the school system (Griffin et al., 2014). However, the challenges associated with creating change within the school system, such as curriculum constraints, weather and provision of resources and facilities, often differ between schools (Darlington et al., 2018). Similarly, the difficulty in explaining the process by which the intervention has had the observed effects and distinguishing the relative contribution of individual intervention components to overall health outcomes, has frequently been criticised (Grant et al., 2013).

Process evaluations aid the investigation of complex interventions by providing supplementary information on the implementation process and context, which allows researchers to gain useful insights that aid their interpretation of outcomes. Normally, process evaluations describe how different components and resources were used and/or adapted, and explain the role, level of participation and reasoning of different stakeholders’ involvements. They also help explain how all these factors might have interacted to impact the effectiveness of the intervention on pre-defined outcomes (Oakley et al., 2006; Moore et al., 2015). Many different frameworks are reported throughout the literature, but the recurring focus has mainly revolved around the evaluation of implementation and context. Although the importance of process evaluation is widely recognised, previous studies have highlighted that delivery of the intervention must be prioritised and any evaluations that compromise intervention delivery, by causing excessive workload for school staff or implementers, should be avoided (Griffin et al., 2014). Despite process evaluations being closely linked with qualitative data collection methods, such as interviews or focus groups,
mixed methods are more widely used, with triangulation of data using multiple data collection tools to measure the same evaluation dimension recommended to improve the translation and trustworthiness of findings (Moore et al., 2015, Griffin et al., 2015, Bartelink et al., 2018).

In line with the literature, when interpreting the results from a complex RCT intervention such as PS, the results from a process evaluation represent an invaluable tool, and the evaluation should always be conducted whenever there may be variability in the implementation process, which inevitably is the case in multi-site school-based interventions (Avitsland et al., 2020; Craig et al., 2008; Oakley et al., 2006). The literature recommends that researchers should view the traditional RCT as allowing us to attempt to answer the question “what works?”, but by combining a RCT with a robust process evaluation, we are enabled to answer the question, “why things work?” (Deaton and Cartwright, 2018) and “under what circumstances?” (Bonell et al., 2012). Answering these questions is essential to understand the school context, to interpret outcomes and to design school-based PA interventions that are feasible for large-scale implementation.
Chapter 3: Methodology
3.1 Overview
The methodological approach for PS (Coppinger et al., 2016) is founded on a New Zealand based study, Project Energize (Graham et al. 2008; Rush et al., 2011b) and derived from further evidence-based research (Bergh et al., 2012; Treuth et al., 2012; Flodmark et al., 2006; Trost et al., 2002). PS is a multi-component school-based health promotion intervention, led by a PA specialist known as an ‘Energizer’ (See section 2.6.1). While the intervention design of PS was multi-pronged, the main focus of the intervention was to improve the PA levels of children, and indirectly reduce their sedentary time at school by delivering 20 minutes additional MVPA daily. The secondary focus was to improve the nutritional knowledge and behaviours of children to help them make healthier food and drink choices.

PS was targeted at children attending primary school. In Ireland, this includes children between the ages of five and twelve. The primary school calendar in Ireland runs from the beginning of September to the end of June. During this time, each of the 8 year-groups in a primary school has a designated class teacher who remains with the class for the entire year, with additional support provided where required by special needs assistants. Each Energizer was assigned to work with a specific school(s), who had signed up to participate in the intervention. A breakdown of the demographics of participating schools is provided in Table 3.3. Using a whole-school approach, the Energizer visited all classes in their designated school(s) 1-2 days per week throughout the school year, delivering twenty-minute PA breaks and healthy eating lessons to each class. On the days when the Energizer was not there the class teacher was expected to deliver 20 minutes of MVPA, based on the lessons modelled by the Energizer. In summary, the main goal of the PS intervention was to implement 20 minutes of MVPA daily in addition to curricular physical education (PE). The PA breaks, known as ‘Huff & Puff’, focused on delivering high quality PA lessons that were fully inclusive of all children and kept them moving at a moderate to vigorous level for twenty minutes. The healthy eating lessons were based on the resources, accompanying lesson plans and worksheets developed for Project Energize by Sport Waikato, New Zealand.

3.2 Study Design and Overview
The impact evaluation of this study built on the work of Delaney et al., (2015), who delivered and reported the findings of the PS intervention in a rural mixed gender school (n=297; school A) in its first year of inception. Year one (academic year 2013/14) involved both impact
evaluation and an initial attempt at process evaluation in school A (Figure 3.1). The intervention delivered by Delaney et al., (2015) in year one amounted to approximately two days or 10 hours per week in the school, when all classes (n=12) were allocated two 20-minute time slots with the Energizer. On the other three days each week, the class teacher was responsible for delivering intervention activities to all students in their class, on their own.

Year two (academic year 2014/15) was the beginning of this study for the current researcher as an Energizer. The intervention was delivered by the current researcher who employed a ‘step-back’ approach to intervention delivery at school A (Figure 3.1). This involved 50% less Energizer contact time, which amounted to approximately 5 hours or 1 day per week, when all classes (n=11) were allocated one 20-minute time slot with the Energizer. This approach was adopted in order to evaluate the sustainability of PS in a real-world setting, gradually giving the teacher increased autonomy for intervention delivery. This amounted to approximately one day or five hours of Energizer contact time per week, when the Energizer would model a 20-minute PA or healthy eating lesson for all classes (n=11). The intervention ran throughout the entire school year (September – June). Outcomes were measured among the same junior (total n=40; boys n=20; girls n=20) and senior (total n=46; boys n=25; girls n=20) cohort of children at the beginning and end of the school year. During year two, the researcher also piloted a robust methodology for process evaluation, which focused on trialling and refining the process evaluation data collection tools and using the information gathered to optimise intervention delivery at school A. Process evaluation ran concurrently to intervention delivery, with data collected at multiple timepoints throughout the school year.

Year three (academic year 2015/16) focused on expanding the methodology for process evaluation to all active PS intervention schools (n=5) (Figure 3.1). The focus was on capturing the moderating role of context on PS. It was intended that interpreting how different contexts and implementers influenced the intervention would aid the translation of PS, and other school-based health promotion interventions, to new contexts in the future. In year three, the impact evaluation of PS in school A was also continued, as a one-year post intervention sustainability evaluation was conducted with the same intervention cohorts (n=86) analysed during year one and two. Although not a main focus to this current thesis, this three-year data set of physical measures with the same cohort of Irish primary school students is a rarity in
the literature, (outside of long-term population obesity surveillance data such as the COSI and GUI data sets) and allows for longitudinal comparisons to be made. It also allows the sustainability of PS to be evaluated, in order to identify whether a two-year health promotion intervention has a lasting effect on school ethos and health markers in children.

Figure 3.1: Summary of study progression

<table>
<thead>
<tr>
<th>Year 1 (Delaney et al., 2015)</th>
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<tbody>
<tr>
<td><strong>Intervention Delivery:</strong></td>
</tr>
<tr>
<td>All classes (n=12)</td>
</tr>
<tr>
<td>2 days/week</td>
</tr>
<tr>
<td>School A : Rural Mixed gender</td>
</tr>
<tr>
<td><strong>Impact Evaluation:</strong></td>
</tr>
<tr>
<td>Senior Infant &amp; Fourth Class</td>
</tr>
<tr>
<td>Age: 6.03 ± 0.33 &amp; 10.15 ± 0.35</td>
</tr>
<tr>
<td>School A: n=40 n=45</td>
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<tr>
<td><strong>Process Evaluation:</strong></td>
</tr>
<tr>
<td>Initial attempt</td>
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<tr>
<td>School A</td>
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<th>Year 2 ('Step-back' approach &amp; Pilot process evaluation)</th>
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<tr>
<td><strong>Intervention Delivery:</strong></td>
</tr>
<tr>
<td>All classes (n=11)</td>
</tr>
<tr>
<td>1 day/week</td>
</tr>
<tr>
<td>School A: Rural Mixed gender</td>
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<tr>
<td><strong>Impact evaluation:</strong></td>
</tr>
<tr>
<td>First Class &amp; Fifth Class</td>
</tr>
<tr>
<td>Age: 7.14 ± 0.33 &amp; 11.26 ± 0.38</td>
</tr>
<tr>
<td>School A: n=40 n=46</td>
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<tr>
<td><strong>Process Evaluation:</strong></td>
</tr>
<tr>
<td>Refine methods and data collection tools</td>
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<tr>
<td>School A - all classes</td>
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<tr>
<th>Year 3 (1 year follow up &amp; Multi-site process evaluation)</th>
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<tr>
<td><strong>Intervention Delivery:</strong></td>
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<tr>
<td>No Energizer contact</td>
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<tr>
<td>School A: Rural Mixed gender</td>
</tr>
<tr>
<td><strong>Impact Evaluation:</strong></td>
</tr>
<tr>
<td>Second Class &amp; Sixth Class</td>
</tr>
<tr>
<td>Age: 8.12 ± 0.23 &amp; 12.23 ± 0.27</td>
</tr>
<tr>
<td>School A: n=40 n=46</td>
</tr>
<tr>
<td><strong>Process Evaluation:</strong></td>
</tr>
<tr>
<td>Methods applied to all intervention schools</td>
</tr>
<tr>
<td>School 1-5 - all classes</td>
</tr>
</tbody>
</table>
3.2.1 Ethical considerations

Ethical approval for the larger PS RCT was obtained from the Research Ethics Committee at Cork Institute of Technology (CIT) in October 2013 and extended to include this study in 2014. Consent was obtained on three levels: at school/principal, parent and child level prior to the school’s enrolment in PS. Initially, an invitation letter and a Memorandum of Understanding (MOU) were sent to the principal in which the objectives of the intervention and expectations of the school during intervention delivery were explained (Appendix A). Consent for the school to participate in the intervention was then requested. Subsequently, all parents from the selected junior and senior classes in the school were given a letter explaining PS, study procedures and the proposed measurements. Signed consent forms were then obtained from both parent and child, prior to the child’s enrolment to the study (Appendix B). At the beginning of subsequent testing phases (year 2 & year 3), parents were sent a renewed consent letter (Appendix B), which allowed them, or their child, the opportunity to withdraw from participation in the measurements. If no communication was received from the parents, renewed consent was assumed. On the day of the measurement, verbal consent was also obtained from participating children.

3.2.2 Data protection

To ensure confidentiality for all collected and archived data, unique identification (ID) numbers were assigned to each stakeholder (teacher, child) and each data sheet referred only to these numbers. Only the researcher and their supervisor/s had access to the full list of ID numbers and corresponding names of the stakeholders sampled, this data is stored separately from the examination data (questionnaires, anthropometric and PA data). Pseudonymised data sheets are stored on the researcher’s password protected laptop and the original hardcopy records are stored in locked cabinets in a restricted access office in MTU and used only for reference if required. These records will be destroyed 5 years after the project has ceased.

3.3 Intervention Planning

As described by Coppinger et al., (2016), prior to the commencement of the intervention, 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 the researcher with planning the intervention (Table 3.1).

<table>
<thead>
<tr>
<th>Document title</th>
<th>Completed by</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. School Stocktake</td>
<td>Principal</td>
<td>To profile the school’s environment, policy, practice and resources with regards to PA and nutrition.</td>
</tr>
<tr>
<td>2. Needs Analysis</td>
<td>All teachers</td>
<td>Teachers’ assessment of current practice with regards to PA and nutrition practices and policies.</td>
</tr>
</tbody>
</table>

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 conducted by the Energizer with the school principal. An analysis of these completed documents informed the development of an individualised ‘Action Plan’ that was drawn up by the researcher and signed off by the lead teacher and the principal (Appendix A). The Action Plan was used to design and plan a tailored intervention strategy based on the school’s needs, resources, support and capabilities. A ‘Spraoi delivery’ timetable was then prepared in collaboration between the lead teacher and researcher. This outlined the days and times that the researcher would attend the school and deliver the PA sessions to each class.

3.4 Intervention Delivery

Central to the delivery of the PS intervention was the researcher’s ability to act as an ‘Energizer’ and to be an ‘agent of change’ within their intervention school(s). This included leading healthy lifestyle initiatives, modelling PA and healthy eating classes, and providing resources on PA and healthy eating to help teachers achieve the intervention goals of delivering 20 minutes extra daily MVPA to students during the school day and improving students’ nutritional knowledge and behaviours (Coppinger et al., 2016). As noted, Energizers were required to be teachers/graduates in the fields of exercise, nutrition and/or Physical Education (Graham et al., 2008). At induction, and then at regular intervals, the Energizers undertook combined training with members of the PS team and maintained regular contact with the PENZ team through Skype in order to share experiences, resources and skills. This
protocol ensured the quality of delivery of the PS intervention to schools by their appointed Energizer (Coppinger et al., 2016).

As advocated for in the literature (Naylor et al., 2015; Egan et al., 2018), a whole school approach to intervention delivery was adopted by PS, with all classes in the school receiving equal contact time with the Energizer each week. In year one (prior to the commencement of the current study), the Energizer had 2 contact days per week in the school where all classes (n=11) received two 20-minute, Energizer lead PA or healthy eating lessons (Delaney et al., 2015). In year two (the beginning of the current study), the researcher adopted a ‘step-back’ progression with 50% less Energizer contact time in year two and no Energizer contact in year three to gradually give class teachers increased autonomy over intervention delivery and to assess the sustainability of PS in a real-world context (Figure 3.1). On the days when the Energizer was not present, each teacher was responsible for delivering 20 minutes MVPA to all students in their class to meet the requirements of PS.

The step-back approach to implementation of PS was based upon the ‘gradual release of responsibility’ framework, first put forward by Pearson and Gallagher (1983). The mechanism behind this framework is based on purposefully shifting the learning and lesson responsibility from the teacher as ‘model,’ to joint responsibility of ‘teacher’ and ‘learner’, and then to independent practice and application by the learner themselves (Maynes et al., 2010). While the original model limited these interactions to three phases of (i) ‘Modelling’ (‘I do it’); (ii) ‘Co-construction’ (‘We do it together’); and (iii) ‘Independent Practice’ (‘You do it’), Fisher and Frey (2021) added an additional phase to recognise a vital component of learning, (iv) ‘Student collaboration’ with their peers (‘You do it together’) (Figure 3.2).

In the case of PS, the Energizer acted as the ‘teacher’ of the intervention by first modelling best practice and then gradually, but purposefully, supporting the classroom teacher (learner) as they took more responsibility for delivering ‘Huff & Puff’ lessons. This transition included the Energizer involving class teachers as they delivered intervention activities to their class, and progressively giving class teachers opportunities to lead ‘Huff & Puff’ lessons (under their supervision) and providing them with support and feedback, when needed.
3.4.1 Intervention components

The PS intervention included both PA and nutrition components, 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 alone (Dabravolskaj et al., 2020; Brown et al. 2016).

3.4.1(a) Physical Activity

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 in the intervention schools as ‘Huff & Puff’. 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 intended to be delivered to all classes for twenty minutes every day in addition to physical education. On the days when the Energizer was not present, teachers were expected to deliver twenty-minutes of PA activities, based on those modelled by the Energizer to their class. The twenty minutes would ideally be delivered in one session, however teachers could deliver this in multiple segments spread throughout the day, if necessary. 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).
Physical activity lesson plans were prepared and tailored to suit the junior (aged five to eight years) and senior (aged nine to thirteen years) age groups. The lesson plans provided teachers with a menu of activities they could teach on the days when the researcher was not present in the school. These included a range of cross-curricular games which were developed in response to teacher feedback throughout the course of the intervention (Appendix E). Ideally, ‘Huff & Puff’ took place outdoors, however alternative indoor games were also prepared in the event of poor weather conditions.

3.4.2 (b) Nutrition
Improving nutritional behaviour was targeted by planning and delivering presentations and nutritional resources to school stakeholders (namely students, teachers and parents). The presentations and resources were developed by Sport Waikato for Project Energize and were adapted by the PS team, in consultation with Project Energize researchers, to suit the Irish setting. The nutrition lessons comprised of four main presentations and related resources to support the learning outcomes. The curriculum delivered included topics such as ‘Healthy Breakfast’, ‘Sugary Drinks’, ‘Food Groups’, and ‘Takeaways’ (Appendix F). The presentations were delivered to each class group in their classroom with their teacher present, as part of the standard school day. Presentations were also organised for parents/guardians after school hours upon request.

Teachers, pupils and parents/guardians also received nutritional resources to support the learning outcomes and help promote and encourage healthy nutritional behaviour in both their school and home lives. Nutrition posters, fridge magnets known as ‘tip sheets’, and health promotion electronic files referred to as ‘nuggets’ were provided by the researcher that could be brought home (Appendix F). In addition, teachers were given a nutritional resource with class worksheets 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 but instead embed these into their teaching at appropriate times during the school day. Examples of some of the resources used during the course of the intervention are available in Appendix F.
3.5 Evaluation
The evaluation of PS was multi-pronged, assessing both the impact of PS on pre-specified determinants of health and the process by which PS was implemented to achieve its intended effects in context. As previously outlined in section 3.3, impact evaluation was conducted at the beginning and end of each academic year with a targeted junior and senior child cohort who at induction were aged approximately 6 and 10 years old. In contrast, process evaluation was implemented on an ongoing basis throughout the academic year with all relevant stakeholders including Energizers, teachers, and students. Although a longitudinal impact evaluation was conducted as part of the larger PS intervention, the primary focus of this current study was to report the pilot, implementation and assessment of a process evaluation of PS across multiple settings. Consequently, only a brief description of the impact evaluation will be outlined below.

3.5.1 Impact evaluation
The methods used in the impact evaluation of PS have previously been described (Coppinger et al., 2016). Impact evaluation health markers included height, weight, body mass index (BMI), waist circumference, waist to height ratio, blood pressure, resting heart rate, cardiorespiratory fitness and PA intensity.

BMI was calculated by dividing participants mean mass (kg) by their mean height (m²). Children were classified as ‘thinness’, ‘normal weight’, ‘overweight’ or ‘obese’ using International Obesity Task Force (IOTF) cut off points (Cole et al, 2000; Cole et al, 2007). Waist circumference to height (WCHt) ratio was calculated by dividing the participant’s mean waist circumference (cm) by their mean height (cm).

PA was objectively measured using triaxial ActiGraph GT3X+ accelerometers (Fort Walton Beach, FL, USA) worn on the right hip during all waking hours, except for when swimming or bathing for 7 consecutive days. Parents were reminded, via daily text messages, to ensure that children wore their accelerometer each morning. ActiLife software (version 6.13.3) was used in the data analysis. Inclusion criteria required wear time of ≥3 days of the week, with ≥600 minutes recorded per day, which has been shown to give adequate reliability and power among children (Riddoch et al., 2007). Of 85 children who received accelerometers at baseline, 68 (80%) met these requirements. Periods of 20 minutes of consecutive zero counts were indicated as non-wear time (Esliger et al., 2005). The first day of wear time was removed.
from the dataset to allow for subject reactivity (Esliger et al., 2005). The last day of wear time (i.e. Day 7) was also excluded from analysis. Cut points developed by Evenson et al. (2008), were used to compute average time spent in MVPA daily. In accordance with the validation protocol used by Evenson et al., (2008), a 15-second epoch length was used to measure activity as using epoch lengths that differ from those originally used to validate the selected activity cut-points introduces significant error into resulting estimates of sedentary behaviour and PA intensity levels (Banda et al., 2016).

3.5.2 Process evaluation

Following the first year of implementation of PS, impact evaluation results revealed discrepancies between expected and observed results (Delaney et al., 2015). The inability to explain these findings with empirical evidence highlighted a need to include a comprehensive methodology for process evaluation and, ultimately, led to the inception of the current study. The study was designed to investigate the process by which PS achieved its effects in context and aid the translation of findings.

The methods for process evaluation of PS used in this study were guided by the three themes outlined by Moore et al., (2015); (i) implementation, (ii) context and (iii) mechanisms of impact. These themes were further subcategorised into six evaluation dimensions; (i) barriers and facilitators, (ii) adaptations, (iii) fidelity, (iv) dose delivered, (v) activities, and (vi) interactions. Suitable data collection tools were identified from the literature, piloted and refined before use. Triangulation of findings was achieved by using multiple tools including surveys, PA logs, reflective journals, write and draw, and semi-structured interviews, to measure the same evaluation dimension (Griffin et al., 2014). An overview of the process evaluation methodology for PS is illustrated in Figure 3.3.

Before beginning the process evaluation of PS, the research team needed to first define the intervention, its activities and theory of change and distinguish both how the effects of each specific intervention activity were expected to occur and how these effects might be replicated by similar future interventions (Grant et al., 2013). As already stated, PS was based on a proven methodology, PENZ, and as such, the theories of change upon which PS is based were set out by its New Zealand counterpart.

The intervention’s mechanisms of impact were analysed both through the activities conducted to achieve its effects and through its interactions with participants and the larger
context or environment (Moore et al., 2015). The activities undertaken to achieve the causal assumptions of the intervention theory were evaluated primarily using questionnaires with the intervention implementers (Energizers and teachers). A combination of open and closed style questions was used to identify what activities were actually implemented at each school and feedback as to which activities implementers thought worked most effectively.

As previously mentioned, understanding how participants interact with complex interventions is a key element in understanding the mechanisms through which the intervention works (Moore et al., 2015). Therefore, qualitative analyses were used to scrutinise the interactions of participating schools, teachers and students with the PS intervention. To include all who interacted with the intervention, open-ended reflections of teachers, school staff and Energizers were evaluated using questionnaires, focus groups, and a reflective journal. Evaluating the interactions of the student cohort with PS was primarily achieved through analysis of the write and draw task and child interviews. The ‘student enjoyment’ section of the Energizer’s reflective journal was also used to give implementers valuable insight into which activities students enjoyed most. This information can then be used to identify successful intervention activities, that will positively engage students with PS in the future.

Evaluating the influence of context on the delivery of PS encompassed two evaluation dimensions, (i) barriers and facilitators and (ii) adaptations. Adaptations were categorised under three headings, ‘innovation’, ‘drift’ and ‘subversion’ (Bumbarger et al., 2008; Moore et al., 2015) and further explained in line with the FRAME structure (Stirman et al., 2019) which was previously discussed in Chapter 2. Questionnaires and focus groups with implementers of PS, Energizers and teachers, were conducted and analysed throughout the course of the intervention year to document and track adaptations made to implementation of the intervention across schools. This information enabled Energizers to make mid-course adaptations to intervention delivery in response to individual teacher’s perceived barriers and facilitators. These adaptations were then documented using Energizer’s reflective journals and questionnaires.

Similar to the HEALTHY study described in chapter 2, the process evaluation of PS opted to omit the analysis of ‘reach’ (Schneider et al., 2009). The ‘reach’ dimension was deemed to be fixed throughout the course of the study, as the intervention was delivered under controlled
conditions to all classes in intervention schools each year; that is, students did not have the opportunity to ‘opt out’ of the intervention, which was delivered using a whole of school approach. Therefore, implementation of PS was analysed using two of the three dimensions described by Linnan and Steckler (2002), fidelity and dose.

Fidelity was evaluated using questionnaires and interviews with intervention implementers (Energizers and teachers) and participants (students). Dose was evaluated using PA logs and an Energizer reflective journal, to quantify the total minutes of extra daily PA and number of healthy eating lessons delivered by implementers of the PS intervention.

Unlike the impact evaluation, where outcomes were measured among the same junior and senior cohort of children at the beginning and end of each school year, the process evaluation ran concurrently to intervention delivery, with data collected at multiple timepoints throughout the school year (September – June). A summary of the data collection timeline is provided in Table 3.2.

Table 3.2: Process Evaluation Data Collection Timeline

<table>
<thead>
<tr>
<th>Data Collection Tool</th>
<th>Month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sept</td>
</tr>
<tr>
<td>PA logbook</td>
<td></td>
</tr>
<tr>
<td>Reflective Journal</td>
<td></td>
</tr>
<tr>
<td>Write &amp; Draw</td>
<td></td>
</tr>
<tr>
<td>Student Interview</td>
<td></td>
</tr>
<tr>
<td>Teacher Questionnaire</td>
<td></td>
</tr>
<tr>
<td>Teacher Focus Group</td>
<td></td>
</tr>
<tr>
<td>Parent Questionnaire</td>
<td></td>
</tr>
<tr>
<td>End of Year Review</td>
<td></td>
</tr>
<tr>
<td>PA &amp; nutrition profile</td>
<td></td>
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</tbody>
</table>
Figure 3.3: Process evaluation methodology of Project Spraoi

**Process Evaluation Methodology:** *Triangulation of Key Themes, Dimensions, Tools and Stakeholders.*
Tools for process evaluation

An explanatory sequential mixed-methods research design (Thomas et al., 2015) was used for this study. This design enabled the evaluation of PS using both quantitative and qualitative methods, specifically by first analysing the quantitative data to describe the extent to which PS was delivered as intended and then analysing qualitative data to aid interpretation of the quantitative results. Tools for data collection are described below and summarised in Table 3.3.

3.5.3. (a) Write and draw

Write and draw was identified from the literature review (Section 2.2.5 d) as a suitable tool to enable children to contribute their views and unique perspectives on PS. The write and draw task was delivered to all students in testing classes (junior & senior evaluation cohorts) in intervention schools by the researcher. In addition to their original consent to participate in PS, further consent was sought on three levels; school, teacher and child. Teachers were asked to sign a consent form for their class to participate. Children were given the opportunity to assent to participate on their own behalf by simply raising their hand. To avoid children feeling coerced into participation, a separate task of colouring or drawing on a blank sheet was offered as a substitute activity. This task was chosen as it would neither be a reward nor a punishment for opting out of participation in the write and draw evaluation (McWhirter, 2014).

As explained in Chapter 2, possible limitations of using drawings as a source of feedback are that they only represent experiences and views that can be represented graphically and are limited by the individual's skills (MacPhail et al., 2004). To avoid this, drawings were used in conjunction with interviews. Thus, children were not limited to expressing experiences that could only be represented graphically, and they had the opportunity to explain their pictures, avoiding issues of clarity. Indeed, it did not matter if drawings were unclear, as similar to McEvilly (2013), drawings were used to encourage conversation and generate interview data, rather than as a source of data in themselves. The writing which accompanied the drawing was included in qualitative analysis to assess students’ interactions with the PS intervention. This data was evaluated using computer assisted qualitative analysis software, Quirkos (version 2).
3.5.3 (b) Interviews
Despite much qualitative research involving the use of purposive sampling, random sampling was selected for this component to negate charges of researcher bias in the selection of participants (Preece, 1994; Shenton, 2004). Two children from each class, one girl and one boy if the school was mixed, were selected to participate. The interviews were led by a member of the PS research team, accompanied by a research assistant. In addition to their original consent, further consent was sought by both parent/guardian and child to participate in the interview and have audio recorded.

Interviews were conducted in a private quiet space, often a teacher resource room, separate to the main classroom. For ethical reasons, two children were present in the interview room at all times with two members of the PS research team (the interviewer and a research assistant). One child was questioned at a time by the interviewer, while the other participated in a colouring activity with the research assistant. The participant was presented with their completed write and draw work sheet and asked to talk about their drawing. This protocol was adopted to break the perceived power imbalance between interviewer and interviewee and generate open conversation about PS (McEvilly, 2013). Questions were trialled during the preliminary study (May 2015) and refined/rephrased for clarity as needed. Each interview lasted on average 10 minutes 15 seconds (±2.38mins).

3.5.3 (c) Questionnaires
Similar to Griffin et al., (2014), multiple questionnaires were developed for completion by school staff, and Energizers throughout the course of the academic year. Following recommendations from the literature (Griffin et al., 2014), questionnaires were condensed to a single A4 size page, using ‘tick the box’ style questions to maximise response, while minimising burden and additional workload for school staff. As questionnaires were specific to the implementation of PS, questions were piloted in the preliminary study (2014/15) with teachers in school A (n=11), before being used across all intervention schools (schools 1-5) in the following year (2015/16). A one-week test-retest evaluation was conducted during the pilot phase with a sub-sample of teachers from school A (n=7) to assess the repeatability and reliability of the Likert scale ‘attitude’ questions. The reliability coefficient for teacher surveys ranged between .78 and .91. An overview of the process evaluation dimensions analysed, and questionnaire methods are presented in Table 3.3 and Table 3.4, respectively.
<table>
<thead>
<tr>
<th>Measure</th>
<th>Evaluation Dimension</th>
<th>Stakeholder</th>
<th>Methods</th>
<th>Source</th>
</tr>
</thead>
</table>
| Physical Activity Log   | Dose delivered       | Class teachers (intervention schools)                                      | • Teachers indicated by ticking a box the time spent (5, 10, 15 or 20mins) and type of activity (Huff and Puff, learning games, activity breaks or other) delivered to their class each day during a given week.  
• Teachers indicated which day and for how long physical education (PE) lessons were delivered each week by ticking the appropriate box and writing in the minutes of PE delivered.  
• If teachers did not deliver any activity on any given day, they indicated the reason why in a comments box. |
|                         | Barriers             |                                                                             | Griffin et al., (2014)                                                                                                                                                                                   |
| Write & Draw            | Interactions         | Students (phase 2: all classes; phase 3: testing classes only)             | • Children completed a worksheet resembling a class activity that was titled ‘What Project Spraoi means to me’.  
• Children drew a picture in the outlined drawing area.  
• Children then wrote on the lines below about what Project Spraoi means to them.  
• A ‘spelling holiday’ was granted for the duration of the task.  
• Reassurance was offered that this was not a test and drawings would not appear on display. |
| Semi-structured         | Fidelity             | Students (a sub sample of 2 students from each class that completed W&D)  | • Interviews were conducted 1 week after completion of the Write and Draw.  
• Questions were grouped under three headings; (i) write and draw, (ii) intervention activities and interactions with Project Spraoi, and (iii) the school environment.  
• Questions and interview protocol employed were influenced by the considerations outlined by Westcott et al (2002; 2005). Open ended questions were favoured to encourage longer responses.  
• Interviews audio was recorded using a Dictaphone, transcribed verbatim and analysed using NVivo version 11 qualitative analysis software. |
| Reflective Journal      | Dose                 | Energizer (n=5)                                                            | • Section A included structured questions to quantify dose delivered and received by participants. Section A also documented what activities were delivered that week and how participants interacted with them using an enjoyment scale.  
• Section B used open ended questions that allowed Energizers the opportunity to openly and honestly reflect on their daily experiences as the interventionist (“What went well?/could be improved?”). |
<p>|                         | Activities           |                                                                             | Griffin et al., (2014)                                                                                                                                                                                   |
|                         | Barriers             |                                                                             | Griffin et al., (2014)                                                                                                                                                                                   |
|                         | Facilitators         |                                                                             | Griffin et al., (2014)                                                                                                                                                                                   |</p>
<table>
<thead>
<tr>
<th>Questionnaires</th>
<th>Fidelity</th>
<th>Interactions</th>
<th>Activities</th>
<th>Barriers</th>
<th>Facilitators</th>
<th>Adaptations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers (Intervention &amp; control schools)</td>
<td>School Staff</td>
<td>Energizer (n=234)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Data collection involved the use of 5 different questionnaires: teacher questionnaire; PA &amp; healthy eating profile; end of year review; energizer questionnaire and parent questionnaire.</td>
<td>• Questions were presented as a set of statements with which respondents were asked to indicate their level of agreement using a 5-point Likert scale.</td>
<td>• Open ended questions were used to gather information about stakeholders’ interactions with Project Spraoi, prompt any unanticipated information and suggest innovations to maximise intervention delivery and support at each site.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thomas et al. (2015)
The schedule for process evaluation data collection was tied to the primary school calendar which runs from September to June. Data was collected at multiple time points throughout the school year in order to capture the different intervention components from the perspective of all relevant stakeholders in the complex school environment throughout the course of the intervention. Adaptations to intervention delivery and refinement of the data collection tools throughout the course of the pilot study were enabled due to ongoing analysis and feedback of process evaluation data to intervention implementers.

Table 3.4 Summary of data collected by questionnaires relative to process evaluation dimensions

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Stakeholder</th>
<th>Purpose</th>
<th>Evaluation Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Survey</td>
<td>Class teachers (intervention) (n=63)</td>
<td>• Assess implementers self-perceived delivery of each intervention component.</td>
<td>Fidelity Dose Adaptation Barriers/ Facilitator Inter-Actions Activities</td>
</tr>
<tr>
<td>Energizer Survey</td>
<td>Active Energizers (n=5)</td>
<td>• Identify contextual barriers/facilitators.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Suggest innovations.</td>
<td></td>
</tr>
<tr>
<td>Physical activity &amp;</td>
<td>Evaluation class teachers (control &amp;</td>
<td>• Understand school context and activities undertaken by school outside of PS which may influence outcomes.</td>
<td></td>
</tr>
<tr>
<td>nutrition profile</td>
<td>intervention) (n=16)</td>
<td>• Compare control context to the intervention context</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End of year review</td>
<td>All school staff (intervention) (n=85)</td>
<td>• Note changes to the school environment incl. student behaviour &amp; staff morale.</td>
<td></td>
</tr>
</tbody>
</table>
Throughout the course of the intervention, stakeholders participated in some, or all, of the process evaluation data collection (Tables 3.2 & 3.4). All school stakeholders, including teachers, support staff, and children were included in order to gain a comprehensive, multi-perspective understanding of the delivery of the PS intervention from the primary actors involved. The use of a wide range of informants has also been identified by Carter et al., (2014) as a useful way of triangulating data sources. This way, individual viewpoints and experiences can be verified against others and, ultimately, a rich picture of the attitudes, needs and behaviour of those under scrutiny may be constructed based on the contributions of a range of stakeholders. However, if data sources refuted each others findings, the lead researcher in consultation with the researcher (Energizer) based in the school in question made a judgement call as to which data source was more reliable.

3.6 Participants
The school context in which the impact and pilot process evaluation was conducted, referred to throughout this thesis as School A, was a rural mixed gender primary school based in Cork, Ireland. Although the impact evaluation sample only included a targeted junior and senior cohort of children (n=86), the intervention was delivered to all (n=285) students in all classes (n=11) in the school. The school was equipped with modest facilities which included a small tarmac yard and grass pitch on site, with limited access to an indoor hall a short distance off-site.

3.6.1 Process evaluation - pilot study sample 2014/15 (School A)
Throughout the course of the school year, a wide range of stakeholders, including children (n=287), teachers (n=11), and other school staff including classroom assistants (n=8), participated in some, or all, of the process evaluation data collection in order to gain a comprehensive, multi-perspective understanding of the delivery of the PS intervention from the primary actors involved (Table 3.5).
Table 3.5: Pilot Study summary of methods and total participating stakeholders

<table>
<thead>
<tr>
<th>Data Collection Tool</th>
<th>Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Teachers</td>
</tr>
<tr>
<td>PA Logbook</td>
<td>n=11</td>
</tr>
<tr>
<td>Write &amp; Draw</td>
<td></td>
</tr>
<tr>
<td>Interview</td>
<td></td>
</tr>
<tr>
<td>Reflective Journal</td>
<td></td>
</tr>
<tr>
<td>Teacher Questionnaire</td>
<td>n=11</td>
</tr>
<tr>
<td>PA &amp; Nutrition Profile</td>
<td>n=3</td>
</tr>
<tr>
<td>End of Year Review</td>
<td>n=11</td>
</tr>
<tr>
<td>Focus Group</td>
<td>n=11</td>
</tr>
</tbody>
</table>

3.6.2 Process evaluation – full study sample
During year three (2015/16), the methods for process evaluation which were previously piloted in school A during 2014/15 were scaled up to include all active intervention schools (n=5). As previously stated, each Energizer also acted as a postgraduate researcher and so each Energizer had a specific research focus as part of the larger PS intervention, for example fundamental movement skill (FMS) proficiency in children (Bolger et al. 2017). Furthermore, as previously mentioned the PS intervention was designed to be adaptive to each school’s needs instead of rigidly following a pre-defined curriculum. This flexibility to accommodate individual class and school requirements, as well as each Energizer’s specific research focus, added complexity to the delivery of PS and emphasised the importance of evaluating the processes of intervention delivery at each school. A summary of each PS data collection site and the specific research focus of the assigned Energizer is displayed in Table 3.6.
Table 3.6: Summary of active PS data collection sites during full study (2015/16)

<table>
<thead>
<tr>
<th>Site</th>
<th>Gender</th>
<th>Intervention / Control</th>
<th>School Location</th>
<th>School SES</th>
<th>Energizer contact days</th>
<th>Intervention year</th>
<th>Research focus</th>
</tr>
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<tr>
<td>1</td>
<td>Boys</td>
<td>Intervention</td>
<td>Urban</td>
<td>Non-Deis</td>
<td>2</td>
<td>2</td>
<td>FMS</td>
</tr>
<tr>
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<td>Urban</td>
<td>Non-Deis</td>
<td>2</td>
<td>2</td>
<td>FMS</td>
</tr>
<tr>
<td>3</td>
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<td>Rural</td>
<td>Non-Deis</td>
<td>1</td>
<td>2</td>
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</tr>
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<td>1</td>
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<tr>
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<td>Intervention</td>
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<td>Deis</td>
<td>1</td>
<td>1</td>
<td>Sedentary</td>
</tr>
<tr>
<td>6</td>
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<td>Control</td>
<td>Rural</td>
<td>Non-Deis</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>7</td>
<td>Mixed</td>
<td>Control</td>
<td>Urban</td>
<td>Deis</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Again, all relevant stakeholders from all active intervention schools were included in the full study. These included teachers (n=63), support staff (n=22), Energizers (n=4) and students (n=295). Throughout the course of year three (academic year 2015/16), stakeholders from all active intervention (schools 1-5) and control (schools 6-7) schools participated in some or all of the process evaluation data collection (Table 3.7).

Table 3.7: Full Study summary of methods and total participating stakeholders

<table>
<thead>
<tr>
<th>Data Collection Tool</th>
<th>Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Teachers</td>
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<tr>
<td>PA Logbook</td>
<td>n=63</td>
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<td>Write &amp; Draw</td>
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<tr>
<td>Interview</td>
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<tr>
<td>Reflective Journal</td>
<td></td>
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<td>Teacher Questionnaire</td>
<td>n=63</td>
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<tr>
<td>Energizer Questionnaire</td>
<td></td>
</tr>
<tr>
<td>PA &amp; Nutrition Profile</td>
<td>n=16</td>
</tr>
<tr>
<td>End of Year Survey</td>
<td>n=63</td>
</tr>
<tr>
<td>Focus Group</td>
<td>n=63</td>
</tr>
</tbody>
</table>
3.6.3 Impact evaluation sample – School A

The impact evaluation sample was divided into a junior (n=40) and senior (n=45) cohort for the purpose of analysis. The junior cohort included males (n=20) and females (n=20) aged 6.03 ± 0.33 years at induction. The senior cohort included males (n=25) and females (n=20) aged 10.15 ± 0.35 years. Measures were taken pre and post intervention with the same junior (n=40) and senior cohort (n=45) in year one and two. In year three, a one-year post intervention impact evaluation was conducted with the same cohort, allowing for longitudinal comparisons.

3.7 Statistical Analysis

3.7.1 Impact evaluation

Quantitative data was analysed using SPSS statistical analysis for Windows, version 24 (IBM Corp, Armonk NY, 2015). The alpha level required for significance for all tests was set at p<.05. Effect size was interpreted using Cohen’s classification of effect size (small 0.2≤d<0.5, medium 0.5≥d<0.8, large ≥0.8) (Cohen, 2013). A repeated measures analysis of variance (ANOVA) was used to assess age differences in the mean markers of health between year 1 and year 3. Baseline data acted as a covariate in order to control for an individual’s start measurements prior to the PS intervention. Significant increases in height (cm) and mass (kg) in parallel with increasing age, suggested significant linear growth amongst the children in both subgroups (p<0.05). Due to the growth spurt observed over the course of the intervention, change in height between year 1 and year 3 also acted as a covariate in analysis of variables with which height was deemed to be an influencing factor, such as BMI and WCHt ratio. Pairwise comparisons were used to further examine significant interaction and main effects.

Participants were only included in comparative analysis if they were present during each of the intervention impact evaluation data collection days over the course of three years between October 2013 and May 2016. However, due to non-compliance of accelerometer wear time during follow up evaluations, the ‘intention-to-treat’ principle was applied to the PA data in order to avoid bias in the estimation of intervention effect due to reduced sample size over time (Gupta, 2011). Those included in the accelerometer analysis at baseline, were maintained in the sample throughout all evaluation time points, with any missing values replaced by the mean/median score of the group.
3.7.2 Process evaluation
Qualitative data such as interviews and focus groups were recorded and transcribed verbatim. All interview transcripts were checked by a second researcher to ensure accuracy of recording. Thematic analyses were conducted on the qualitative data from the interviews, focus groups, and open-ended survey questions. Data was coded into categories based on Programme theory using a computer assisted qualitative data analysis software (CAQDAS), Quirkos (version 2.0) (Rogers, 2008). During the coding process, CAQDAS was used to identify key words and associated synonyms across all attached data sources. Identified themes reviewed several times to see if they still worked in relation to the new data sources. After all data was coded, subcategories were identified per theme if necessary, and when possible a distinction between inhibiting and promoting was made for each of the influencing factors. Next, the coded text was retrieved to create an overview per theme (or per subcategory) with the findings split up into the five schools to study similarities and differences across schools. Furthermore, for each school, the frequency of counts per sub-category/theme was calculated to evaluate open-ended survey questions. Themes and subcategories identified and coded during analysis were reviewed by a second researcher to ensure consistency and compatibility throughout.

Quantitative survey data from Likert scale questions was analysed using SPSS (version 23). For each time of measurement, and separately for each respondent group, descriptives and frequencies were calculated. Changes in survey responses over time and/or between schools was calculated using both paired sample t-test and analysis of variance. Standardized effect sizes (Cohen’s d) per school, (defined as mean at follow-up time of measurement minus mean at baseline divided by standard deviation at baseline), were also calculated. This effect size calculation was presented in addition to the pre- and post-mean (SD) per school, to give an indication of the extent of the changes over time and in order to compare them between the schools.
3.8 Conclusion
This chapter summarised the overall structure of this study which is presented in three distinct sections;

(i) the preliminary study which was used to pilot the identified methods and data collection tools for process evaluation of PS at school A (2014/15).

(ii) the expanded implementation and evaluation of the process evaluation methods to all active PS intervention (S1-S5) and control (S6 & S7) schools (2015/16).

(iii) the longitudinal impact evaluation of a step-back approach to PS on a junior (n=40) and senior (n=45) child cohort at a rural mixed gender (2013-16).

The following chapters (4 and 5) and supplementary data reported in Appendix D detail the findings of this study.
Chapter 4: Evaluation of a step-back approach to implementation of a multicomponent school-based intervention
4.1 Abstract:

Project Spraoi (PS) is a specialist-led school-based multicomponent health promotion intervention. Under the guidance of an ‘Energizer’, PS has reported improvements in the prevalence of overweight and obesity, and a range of health markers in Irish primary school children. This study evaluates the effectiveness of a step-back approach to PS; over the course of three years, the Energizer contact time was gradually reduced, giving teachers increased autonomy to deliver intervention activities unsupervised in a real-life context.

Methods: Objectively measured physical activity (PA) as well as a variety of health markers were measured annually with the same children (n=85). Focus groups, interviews, surveys and PA logs were also conducted to evaluate intervention fidelity, dose delivered and barriers/facilitators to intervention delivery.

Results: Significant improvements in children’s BMI (junior only), BMI z scores (both cohorts), cardiorespiratory fitness (senior only) and PA levels were observed over the course of the intervention (p<0.05). Notably, after an initial significant increase in PA in year one, PA levels gradually declined in year two and three in line with reduced Energizer contact. Generally, intervention fidelity among teachers was low, they delivered significantly less extra daily MVPA than the 20minutes prescribed.

Conclusion: To optimise the effectiveness of PS, the barriers posed by the school context, including lack of time, facilities and resources, need to be addressed. The Energizer has a key role to play, as all stakeholders identify having regular access to a PA specialist as being the greatest facilitator to intervention delivery in a primary school context.
4.2 Introduction

Overweight and obesity are precursors for numerous adverse health conditions (Williams et al., 2015). A variety of medical consequences associated with obesity, previously only seen in adulthood, are now presenting in children and adolescents (Jennings et al., 2018). Low levels of physical activity (PA) and high levels of sedentary time in childhood are both associated with a higher risk of overweight and obesity and thus a higher risk of the associated health problems (Layte et al., 2011; Jennings et al., 2018). Despite encouraging evidence to suggest the stabilising of childhood obesity rates (Mitchell et al., 2020; O Donnell et al., 2020; Keane et al., 2014; Bel-Serrat et al., 2017), current rates of overweight and obesity in Ireland remain high among the childhood population (20%) (Mitchell et al., 2020; Jennings, 2018). Additionally, PA levels are low (Woods et al., 2018) and have been shown to decrease with age; a trend that has been similarly observed in other European countries and the USA (Cooper et al., 2015). Considering the lifelong consequences of physical inactivity, there is a need for the early intervention of effective, evidence-based programs and policies to increase PA levels in school-aged children.

In respect of providing opportunities to increase children’s PA, the school environment has potential to make important differences and presents numerous opportunities for intervention (Lavelle et al., 2012; Van Sluijs et al., 2008; Vasques et al., 2014; Ward et al., 2007). Most notably, schools provide opportunities for interventions to incorporate a culture of care, and to be fully inclusive of all children; regardless of their background and any existing racial or socio-economic differences (Cavanagh et al., 2012, Grasten et al., 2017). Children also spend considerable amounts of time at school and this setting enables researchers to target large numbers of children at one time (Sobol-Goldberg et al., 2013). Ironically, it should also be noted that schools internationally are reported to be one of the dominating locations of sedentary behaviour in children with class time representing a significant sedentary period of a child’s day (Holt et al. 2013). Although there is some debate about the suitability of the school setting for intervention, given the crammed curriculum and competing demands already placed on teachers (Naylor et al., 2015), many researchers and policymakers have advocated for schools as suitable and logical settings for intervention (Grasten et al., 2017; Jennings et al., 2018).
School-based PA interventions fall broadly into 5 categories: physical education (PE) curriculum, classroom activity breaks, active commuting to school, modified playgrounds, and multifaceted approaches that combine all the above to adapt the whole school environment (Grasten et al., 2017). The literature is saturated with systematic reviews demonstrating the effectiveness of school-based approaches (Naylor et al., 2015; Dobbins et al., 2013; Van Sluijs et al., 2007; Dudley et al., 2011; Kriemler et al., 2011; Lai et al., 2014), and highlighting the importance of multi-component models (Van Sluijs et al., 2007; Kriemler et al., 2011). Some effective school-based PA studies have advocated for specialist-led interventions to ensure the quality of intervention delivery (Tompsett et al., 2017; Telford et al., 2016), while others see longitudinal and cost-effective benefits to giving generalist teachers the autonomy to lead PA intervention activities (Ryde et al., 2018; Holt et al., 2013; Erwin et al., 2011; Naylor et al., 2006).

‘Project Spraoi’ (PS) is one such example of a specialist-led, multicomponent school-based intervention. PS is a randomised control trial (reg: ISRCTN92611015) that promotes PA and healthy eating in primary schools through an ‘Energizer’ led intervention and was delivered in Cork, Ireland. PS (www.projectspraoi.cit.ie) is based on the internationally recognised and fully evaluated ‘Project Energize’ (PENZ), an ongoing programme which began in the Waikato district of New Zealand (NZ) in 2004 (www.projectenergize.org.nz). PS has been found to have a positive impact on the prevalence of overweight and obesity, as well as a wide range of health markers including cardio-respiratory fitness, PA levels, fundamental movement skills and nutritional knowledge of Irish primary school children (O’Leary et al., 2018; Bolger et al., 2018; Merrotsy et al., 2018). Furthermore, PS has been found to positively impact the school context and those who interact with it, including teachers, parents and pupils (O’Leary et al., 2019).

Many interventions developed in a research setting appear to be effective in controlled conditions but often do not translate well into less controlled, real life contexts (Glasgow et al., 2007; Durlak and DuPre, 2008). Process evaluations are often not conducted and reported alongside these interventions, thus leaving a void in understanding how to translate the implementation of seemingly effective interventions in new contexts outside the confines of their modelled research conditions (Durlak and DuPre, 2008; Moore et al., 2015).
As implementation science is an emerging area in PA research (Naylor et al., 2015), this study sought to investigate the effectiveness of a step-back approach to the delivery of PS, in which over the course of three years, the Energizer gradually reduced contact time with the intervention school and gave class teachers increased autonomy over intervention delivery to simulate a less controlled, real life context. A comprehensive process evaluation was conducted alongside the impact evaluation in order to aid the transparency of implementation, the translation of findings and to identify what factors acted as key barriers and facilitators to the implementation of PS in a rural mixed gender primary school context.

4.3 Methods

4.3.1 Intervention delivery
Central to the delivery of the PS intervention was the researcher’s ability to act as an ‘Energizer’ and be an ‘agent of change’ within their intervention school(s). This included leading healthy lifestyle initiatives, modelling PA and healthy eating classes, and providing resources on PA and healthy eating to help teachers achieve the intervention goals of delivering 20 minutes extra daily moderate-vigorous physical activity (MVPA) to students during the school day and improving student’s nutritional knowledge and behaviours (Coppinger et al., 2016).

As advocated for in the literature (Naylor et al., 2015; Egan et al., 2018), a whole school approach to intervention delivery was adopted by PS, with all classes in the school receiving equal contact time with the Energizer each week. In year one, the Energizer had 2 contact days per week in the school where all classes (n=11) received two 20-minute, Energizer lead PA or healthy eating lessons (Delaney et al., 2015). A ‘step-back’ progression with 50% less Energizer contact time in year two and no Energizer contact in year three was adopted by the researcher to gradually give class teachers increased autonomy over intervention delivery. On the days when the Energizer was not present, each teacher was responsible for delivering 20 minutes MVPA to all students in their class to meet the requirements of PS.

This step-back approach was adopted with the ‘gradual release of responsibility’ framework in mind whereby the Energizer played the role of the teacher modelling lessons in the beginning, but gradually and purposefully shifting that responsibility to the classroom teacher who played the role of the learner (Fisher and Frey, 2021). This transitional process involved the Energizer exclusively leading intervention activities (modelling) to then including the
teacher in the delivery of PA lessons to their class (co-construction), and gradually giving the classroom teacher more opportunities to lead the PA lessons under their supervision, providing support and feedback when needed (facilitation). In year three, the Energizer removed all physical support allowing the teacher to take full responsibility independently.

4.3.2 Impact evaluation
The methods used in the impact evaluation of PS have previously been described (Coppinger et al., 2016). This paper evaluates the impact of PS on children’s PA levels as well as a variety of health markers including height, weight, body mass index (BMI), waist circumference, waist to height ratio, cardiorespiratory fitness and PA intensity. BMI was calculated by dividing participants mean mass (kg) by their mean height (m²).

PA was objectively measured using triaxial ActiGraph GT3X+ accelerometers (Fort Walton Beach, FL, USA) worn on the right hip during all waking hours, except for when swimming or bathing for 7 consecutive days. Parents were reminded, via daily text messages, to ensure that children wore their accelerometer each morning. ActiLife software (version 6.13.3) was used in the data analysis. Inclusion criteria required wear time of ≥3 days of the week, with ≥600 minutes recorded per day, which has been shown to give adequate reliability and power among children (Riddoch et al., 2007). Of 85 children who received accelerometers at baseline, 68 (80%) met these requirements. Periods of 20 minutes of consecutive zero counts were indicated as non-wear time (Esliger et al., 2005). The first day of wear time was removed from the dataset to allow for subject reactivity (Esliger et al., 2005). The last day of wear time (i.e. Day 7) was also excluded from analysis. Cut points developed by Evenson et al. (2008), were used to compute average time spent in MVPA daily. In accordance with the validation protocol used by Evenson et al. (2008), a 15-second epoch length was used to measure activity as using epoch lengths that differ from those originally used to validate the selected activity cut-points has been shown to introduce significant error into resulting estimates of sedentary behaviour and PA intensity levels (Banda et al., 2016).

4.3.3 Process evaluation
After the first year of implementation of PS, impact evaluation results revealed discrepancies between expected and observed results, with the control cohort making significant unexplained improvements (Delaney et al., 2015). This motivated the implementation of
comprehensive methods for process evaluation in year two, in order to investigate the process by which PS achieved its effects in context.

The methods for process evaluation of PS were guided by the three themes outlined by Moore et al. (2015); (i) implementation, (ii) context and (iii) mechanisms of impact. These three themes were then further sub-categorised into six evaluation dimensions: (i) fidelity, (ii) dose delivered, (iii) adaptations, (iv) barriers and facilitators, (v) activities and (vi) interactions. Following this, suitable data collection tools were identified from the literature, piloted and refined before use (Figure 4.1). Triangulation of findings was achieved by using multiple tools including surveys, PA logs, reflective journals, write and draw and semi-structured interviews, to measure the same evaluation dimension (Griffin et al., 2014).

Quantitative methods were used to examine pre-specified intervention hypotheses relating to implementation of key intervention activities (Grant et al., 2013). For example, PA logs were used to quantify the amount of extra daily PA delivered by teachers in order to examine whether the intervention (20mins extra daily MVPA) was being delivered as intended (Grant et al., 2013). Qualitative methods were selected as more flexible tools for examining facilitators and barriers to implementation, unexpected outcomes and participant’s interactions with intervention activities (Schneider et al., 2009).

Throughout the course of the school year, stakeholders, including children (n=287), teachers (n=11), and other school staff (n=8), participated in some, or all, of the process evaluation data collection in order to gain a comprehensive, multi-perspective understanding of the delivery of the PS intervention from the primary actors involved (Table 4.1). Furthermore, the use of a wide range of informants has been identified by Shenton (2004) as another useful way of triangulating data.
Process Evaluation Methodology: Triangulation of Key Themes, Dimensions, Tools and Stakeholders.
Table 4.1: Summary of process evaluation methods and participating stakeholders

<table>
<thead>
<tr>
<th>Data Collection Tool</th>
<th>Stakeholder</th>
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</thead>
<tbody>
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<td></td>
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<td>PA Logbook</td>
<td>n=11</td>
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<td>Write &amp; Draw</td>
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<td>Interview</td>
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<td>Reflective Journal</td>
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<td>Parent Questionnaire</td>
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</tr>
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<td>PA &amp; Nutrition Profile</td>
<td>n=3</td>
</tr>
<tr>
<td>End of Year Review</td>
<td>n=11</td>
</tr>
<tr>
<td>Focus Group</td>
<td>n=11</td>
</tr>
</tbody>
</table>

4.3.4 Statistical analysis
Quantitative data was analysed using SPSS statistical analysis for Windows, version 24 (IBM Corp, Armonk NY, 2015). The alpha level required for significance for all tests was set at $p < 0.05$. Effect size was interpreted using Cohen’s classification of effect size (small $0.2 \leq d < 0.5$, medium $0.5 \leq d < 0.8$, large $d \geq 0.8$) (Cohen, 2013). A repeat measure analysis of variance (ANOVA) was used to assess age differences in the mean markers of health between year 1 and year 3. Baseline data acted as a covariate in order to control for each individuals’ start measurements prior to the PS intervention.

Participants were only included in comparative analysis if they were present during each of the intervention data collection days over the course of three years between October 2013 and May 2016. However, due to non-compliance of accelerometer wear time during follow up evaluations, the ‘intention-to-treat’ principle was applied to the PA data in order to avoid bias in the estimation of intervention effect due to reduced sample size over time (Gupta, 2011). Those included in PA analysis at baseline, were maintained in the sample throughout all evaluation time points, with any missing values replaced by the mean/median score of the group.
Qualitative data such as interviews and focus groups were recorded and transcribed verbatim. All interview transcripts were checked by a second researcher to ensure accuracy of recording. Thematic analyses were conducted on the qualitative data from the interviews, focus groups, and open-ended survey questions. Data was coded into categories based on Programme theory using a computer assisted qualitative data analysis software (CAQDAS), Quirkos (version 2.0) (Rogers, 2008). During the coding process, CAQDAS was used to identify key words and associated synonyms across all attached data sources. Themes were identified and reviewed several times to see if they still worked in relation to the new data sources. After all data was coded, subcategories were identified per theme if necessary, and when possible a distinction between inhibiting and promoting was made for each of the influencing factors. Next, the coded text was retrieved to create an overview per theme (or per subcategory). Furthermore, for each stakeholder group, the frequency of counts per subcategory/theme was calculated to evaluate open-ended survey questions. Themes and subcategories identified and coded during analysis were reviewed by a second researcher to ensure consistency and compatibility throughout.

4.3.5 Sample
The school context in which this study was conducted was a rural mixed gender school based in Cork, Ireland. The school was equipped with modest facilities which included a small tarmac yard and grass pitch on site, with limited access to an indoor hall a short distance off-site. The impact evaluation sample was divided into a junior (n=40) and senior (n=45) cohort for the purpose of analysis. The junior cohort included males (n=20) and females (n=20) aged 6.03 ± 0.33 years at induction. The senior cohort included males (n=25) and females (n=20) aged 10.15 ± 0.35 years. Measures were taken pre and post intervention with the same junior (n=40) and senior cohort (n=45) in year one and two. In year three, a one-year post intervention impact evaluation was conducted with the same cohort, allowing for longitudinal comparisons.

4.4 Results
4.4.1 Impact evaluation
Significant increases in height (cm) and mass (kg) in parallel with increasing age, suggested significant linear growth amongst the children in both subgroups (Table 4.2). For this reason, change in height between year 1 and year 3 also acted as a covariate in analysis of variables with which height was deemed to be an influencing factor. Pairwise comparisons were used
to further examine significant interaction and main effects. Results of the ANOVA are presented in Table 4.2.

A statistically significant decrease in both BMI (p<0.05, ES=0.27) and BMI (SDS) (p<0.05, ES=0.42) with a small effect size was observed over time in the junior cohort. In contrast, a significant increase in BMI with small effect was observed in the senior cohort over the same time period (p<0.05, ES=0.42).

In order to control for the effect of increased stride length of children over the three-year evaluation period due to significantly increased height, change in height was used as a covariate during analysis of cardio-respiratory fitness (CRF). The time taken to complete the 550m walk/run test decreased in both subgroups over time (Table 4.2), indicating increased CRF. Despite both subgroups recording faster times, a significant increase in CRF was only observed in the senior cohort (p=0.03, ES=0.13). Analysis of CRF revealed statistically significant age effects on 550m run/walk time as the senior cohort recorded significantly faster times than the junior cohort with a large effect size (p<0.0005, n²=0.573).
Table 4.2: Summary of markers of health and analysis of variance, controlling for baseline

<table>
<thead>
<tr>
<th></th>
<th>Junior Cohort (n=40)</th>
<th></th>
<th>Senior Cohort (n=45)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1</td>
<td>Year 2</td>
<td>Year 3</td>
<td>Mean difference</td>
</tr>
<tr>
<td>Age (years)</td>
<td>6.57</td>
<td>7.54</td>
<td>8.54</td>
<td>1.97</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>120.68</td>
<td>126.68</td>
<td>136.54</td>
<td>-15.86</td>
</tr>
<tr>
<td>Mass (kg)</td>
<td>24.34</td>
<td>27.02</td>
<td>30.92</td>
<td>-6.58</td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>16.66</td>
<td>16.76</td>
<td>16.49</td>
<td>0.17</td>
</tr>
<tr>
<td>BMI (SDS)</td>
<td>0.59</td>
<td>0.45</td>
<td>0.09</td>
<td>0.5</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>56.1</td>
<td>57.87</td>
<td>57.24</td>
<td>-1.14</td>
</tr>
<tr>
<td>WCHt Ratio</td>
<td>0.47</td>
<td>0.46</td>
<td>0.42</td>
<td>0.05</td>
</tr>
<tr>
<td>550m run (secs)</td>
<td>195.19</td>
<td>169.52</td>
<td>164.39</td>
<td>-30.81</td>
</tr>
</tbody>
</table>

*p≤0.05
4.4.2 Physical activity

At baseline, 68 students (junior, n=32; senior, n=36) met the required accelerometer wear time to be included in analysis. The introduction of the PS intervention saw a significant increase in the mean daily MVPA of both subgroups at the end of year 1 when compared to their baseline measures (mean difference = 22.83 mins, p=0.00; senior mean difference = 31.16 mins, p=0.00) (Figure 4.1). In the junior cohort only, the mean daily minutes of MVPA accumulated by participants between year 1 and year 3 significantly decreased (p=0.034, $n^2$ =0.107). No significant changes in mean daily minutes of MVPA was noted amongst the senior cohort over the course of the intervention. Despite both subgroups PA levels decreasing as the intervention was stepped back in year two and three, the children in both subgroups were significantly more active at intervention end in year three compared to baseline, prior to the introduction of PS (p<0.05) (Figure 4.2).

![Mean Daily MVPA](image)

Figure 4.2: Change in mean daily MVPA over time

Figure 4.3 outlines the proportion of children meeting the recommended PA guidelines at each time point. The proportion of children meeting the MVPA guidelines decreased in both subgroups over the course of the three years with the greatest drop off occurring between year 2 and year 3. No significant differences were found to exist between the junior and senior cohorts in year 1 and year 2. However, in year 3, the senior cohort of sixth class children (aged 12.23 ± 0.27) were significantly less likely to meet the recommended MVPA guidelines than their junior counterparts in second class (aged 8.12 ± 0.23)(p=0.00, ES=0.64).
PA logs were completed weekly by all class teachers (n=11) during year 2. Teachers indicated by ticking the box, the type and time (either 5, 10, 15 or 20 minutes) of activity delivered by them each day. The mean amount of extra daily MVPA (mins) delivered by teachers during year two of PS was analysed using a between and within subjects’ ANOVA test. The within subjects’ factor was time and the between subjects’ factor was the class taught by the relevant teacher. Teachers who taught class groups from junior infants to second class were assigned to the junior category (n=6), while teachers who taught class groups from third class to sixth class were assigned to the senior category (n=5). Over the course of the academic year, the mean amount of extra daily PA delivered by teachers each month varied significantly (p<0.05, n²=0.68) (Figure 4.4). The interaction effect of time and class group taught indicated that over the course of the school year, junior class teachers delivered significantly more extra daily PA than teachers of senior classes (p=0.002, n²=0.355).

A Bonferroni post-hoc test was conducted to explore the monthly difference in the amount of extra daily MVPA delivered by teachers within the eight months of intervention implemented in year two. Although the increase in the amount of extra daily MVPA delivered by teachers over time did not occur in a linear manner, a statistically significant mean increase of 10.9 minutes (p=0.005) was reported between November and June. The largest increase in the amount of extra daily MVPA delivered by teachers was between April and June (mean difference = 11.5mins, p=0.021).
Further analysis of the PA logs using a one-sample t-test revealed discrepancies in the fidelity of intervention delivery by class teachers. The mean amount of extra MVPA delivered by teachers daily (12.2 minutes) was significantly lower than the PS target of 20 minutes from November to May ($p<0.05$). Both groups did not achieve the target amount of extra daily MVPA until June (Figure 4.4).

4.4.4 Contextual barriers and facilitators to intervention delivery
Barriers and facilitators to intervention delivery were primarily identified through focus groups and survey data from class teachers (n=11), children (n=20), the principal and support staff (n=8). The views of the Energizer (n=1), documented in the reflective journal, were also considered during analysis. Common themes triangulated from multiple sources (focus groups, surveys, and reflective journal) were highlighted and are presented in Table 4.3 and Table 4.4.

The biggest barrier to the implementation of PS identified by teachers was a lack of time to deliver extra daily MVPA due to an already overcrowded curriculum. This barrier was particularly prevalent among teachers with senior classes during months of particularly low fidelity in implementing 20 minutes extra daily MVPA (Figure 4.3: April & May). During these
months many teachers, particularly those teaching senior classes, expressed a “lack of time” and feeling of “pressure” as they had “too many other subjects to teach” and “very little time due to preparation for exams”. The second most frequently identified barrier by teachers and school staff to PA was a ‘lack of facilities and equipment’ (45%).

In year two, (2014/15) the Energizer was the most frequently identified facilitator by all stakeholders (teachers, school staff and students). Teachers and school staff praised the “enthusiasm”, “creativity” and “organisation” of the Energizer, with one describing the Energizer as a “live interactive resource”. However, in year three (2015/16), most teachers (80%) (n=8) identified the “lack of Energizer contact” as a barrier to intervention delivery and many (60%) (n=6) suggested the need for ongoing resources to maintain intervention activities in the school without weekly Energizer contact. Furthermore, it was noted that when the Energizer no longer had a presence in the school in year 3 (2015/16), the intervention was forgotten.

“I think I definitely tried at the start of the year to keep PS going with my class, but when the Energizer isn’t there to keep driving it on, other programmes take its place and it gets forgotten.” (Teacher – senior class group)
<table>
<thead>
<tr>
<th>Barrier to intervention delivery</th>
<th>Frequency (%)</th>
<th>Illustrative quotes</th>
<th>Facilitators to intervention delivery</th>
<th>Frequency (%)</th>
<th>Illustrative quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child n=20</td>
<td>Teacher n=11</td>
<td>Teacher – “I find it very hard to fit 20 minutes extra physical activity in everyday to accompany all the other curriculum areas.”</td>
<td>Energizer</td>
<td>90 91</td>
</tr>
<tr>
<td>Time constraints due to a crowded curriculum</td>
<td>70 91</td>
<td></td>
<td>Child - “If it’s raining, we normally don’t go outside and we can’t always do games in our classroom because it’s too small.”</td>
<td>Breaking the 20 minute block into shorter activity breaks</td>
<td>35 73</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Energizer – “Equipment and space to undertake PA is very limited. No hall, so if the weather is bad, PA is limited to the classroom.”</td>
<td>Cross-curricular games</td>
<td>45 63</td>
</tr>
<tr>
<td>Weather</td>
<td>35 32</td>
<td></td>
<td>Teacher – “I have a class of 32, it’s difficult to facilitate physical activity safely with such a large group... our classroom is very small”.</td>
<td>Physical activity challenges</td>
<td>60 45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Teacher – “I struggle to run the games by myself on the days when our Energizer is not here.”</td>
<td>Classroom activities</td>
<td>20 45</td>
</tr>
<tr>
<td>Lack of facilities &amp; equipment</td>
<td>20 45</td>
<td></td>
<td>Teacher – “Our Energizer is such a great asset to our school, her enthusiasm rubs off on others and she brings lots of new ideas that are fun and easy to do. Every school should have one.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class Management</td>
<td>0 18</td>
<td></td>
<td>Teacher – “20 minutes is really difficult to achieve. I find it works better to do 5/10 minute PA breaks throughout the day.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher confidence</td>
<td>0 27</td>
<td></td>
<td>Teacher – “The maths games that she (Energizer) does are great and the students really enjoy ....I can do these games without feeling like I am losing time in other subjects.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Teacher – “The ‘Stride for 5’ challenge was a great motivator for the whole school to be active. It challenged the students and staff to work together to achieve a goal in something many would never have done before.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Teacher - “Interactive classroom activities like the 12 days of fitness were such valuable resources for rainy days. They are easy to do and require little space so they are perfect for any classroom.”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.4: Barriers and Facilitators to intervention delivery (Year3)

<table>
<thead>
<tr>
<th>Barrier to intervention delivery</th>
<th>Frequency (%)</th>
<th>Illustrative quotes</th>
<th>Facilitators to intervention delivery</th>
<th>Frequency (%)</th>
<th>Illustrative quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Staff n=8</td>
<td>Teacher n=10</td>
<td>Weather</td>
<td>37.5</td>
<td>Teacher - “I must admit, I struggled during the winter, but definitely since Easter, the sunny weather encourages us to get outside and be active”</td>
</tr>
<tr>
<td>Time constraints due to a crowded curriculum</td>
<td></td>
<td>Teacher – “Time is and will continue to be the biggest barrier to this otherwise fantastic project due to an already hectic curriculum”</td>
<td>Breaking the 20 minute block into shorter activity breaks</td>
<td>0</td>
<td>Teacher – “I don’t do 20 minutes every day, but I do try to add in a couple of short brain breaks in the afternoons instead.”</td>
</tr>
<tr>
<td>No Energizer presence</td>
<td>70</td>
<td>90</td>
<td>Weather</td>
<td>37.5</td>
<td>Teacher - “I must admit, I struggled during the winter, but definitely since Easter, the sunny weather encourages us to get outside and be active”</td>
</tr>
<tr>
<td></td>
<td>87.5</td>
<td>80</td>
<td>Weather</td>
<td>37.5</td>
<td>Teacher - “I don’t do 20 minutes every day, but I do try to add in a couple of short brain breaks in the afternoons instead.”</td>
</tr>
<tr>
<td>Lack of resources</td>
<td>12.5</td>
<td>60</td>
<td>Cross-curricular games</td>
<td>0</td>
<td>Teacher – “This year I’ve tried to be more creative in integrating activity into the curriculum. I use the Project Spraoi game cards often for ideas”.</td>
</tr>
<tr>
<td>Weather</td>
<td>50</td>
<td>30</td>
<td>School resources and equipment</td>
<td>37.5</td>
<td>Staff – “We also got some new P.E. equipment this year which is a big help. There’s much more variety with what we can do with the classes.”</td>
</tr>
<tr>
<td>Lack of motivation</td>
<td>25</td>
<td>30</td>
<td>Classroom resources</td>
<td>25</td>
<td>Teacher - &quot;I still use the 12 days of fitness ppt and the kids love it too. We continued it in our class for months after Christmas&quot;</td>
</tr>
</tbody>
</table>
4.4.5 Mechanisms of impact: interactions

The teacher survey assessed the teachers’ attitudes towards delivering PS and their interactions with the intervention and Energizer. At the beginning of year two (December 2014), 90.9% of teachers (n=10) either disagreed or strongly disagreed that delivering 20 minutes extra daily MVPA was manageable. This feedback motivated adaptations to intervention delivery, by trying to incorporate the facilitators identified by teachers, such as breaking the 20-minute MVPA block down into shorter activity breaks throughout the day and providing additional resources to meet the teachers’ needs, for example, cross-curricular and classroom games.

As the intervention progressed during year 2, a significant change in teachers’ attitudes towards delivering the extra 20 minutes MVPA daily over time was identified using a paired sample t-test \( p=0.000, n^2=0.729 \) (Table 4.5). At the end of the year (May 2015), 63.6% (n=7) of teachers agreed that delivering 20 minutes daily MVPA was manageable while only 27.3% (n=3) disagreed. However, this improvement was not sustained as during follow up evaluation at the end of year three (May 2016), 75% of teachers either disagreed or strongly disagreed that delivering the 20 minutes MVPA was manageable.

Another notable improvement as the intervention progressed in year 2, was the significant increase in the number of teachers who noticed an improvement in their students’ fitness levels \( p=0.013, n^2=0.478 \) and eating habits as a result of PS \( p=0.014, n^2=0.468 \). At the beginning of year two (December 2014), only 36.4% (n=4) of teachers had noticed an improvement in their students’ fitness levels and 27.3% (n=3) had noticed improvements in students’ eating habits as a result of PS (Table 4.5). Encouragingly, by the end of the year (May 2015), this had increased to 81.9% (n=9) of teachers who reported noticing improvements in their students’ fitness levels and eating habits (Table 4.5).
Table 4.5: Summary of teacher questionnaire responses

<table>
<thead>
<tr>
<th>Questions</th>
<th>December 2014 (n=11)</th>
<th>May 2015 (n=11)</th>
<th>Difference p-value (effect size)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Undecided</td>
</tr>
<tr>
<td>Delivering 20mins daily PA is manageable.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I make every effort to deliver 20mins daily PA.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>After ‘Huff &amp; Puff’ my students were more attentive in class.</td>
<td>9.1</td>
<td>1</td>
<td>63.6</td>
</tr>
<tr>
<td>After ‘Huff &amp; Puff’ my students were more boisterous in class.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I actively participate while the Energizer delivers activities to my class.</td>
<td>27.3</td>
<td>3</td>
<td>27.3</td>
</tr>
<tr>
<td>I actively participate while I deliver activities to my class.</td>
<td>45.6</td>
<td>5</td>
<td>27.3</td>
</tr>
<tr>
<td>As a result of PS, I have noticed an improvement in my children’s fitness levels.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>As a result of PS, I am more aware of the importance of PA.</td>
<td>9.1</td>
<td>1</td>
<td>72.7</td>
</tr>
<tr>
<td>As a result of PS, my knowledge of healthy eating has improved.</td>
<td>9.1</td>
<td>1</td>
<td>18.2</td>
</tr>
<tr>
<td>As a result of PS, I have noticed an improvement in my student’s eating habits.</td>
<td>18.2</td>
<td>2</td>
<td>9.1</td>
</tr>
</tbody>
</table>

*p≤0.05
4.5 Discussion

The findings of this study suggest that a step-back approach to PS can positively influence children’s health with significant decreases in BMI (junior cohort) and BMI z scores (both cohorts) observed over the course of a three-year intervention. Children’s CRF also improved, with both cohorts recording faster times at each evaluation point. Further analysis of CRF, revealed statistically significant age effects, indicating that the senior cohort recorded significantly faster times than their junior counterparts. Similar findings have been reported by Roriz De Oliveira et al., (2014) among a cohort of Portuguese children. This may be explained by the increase in aerobic capacity of children as they age.

This study also indicates that PS can have lasting positive effects on PA levels with the children in both junior and senior cohorts significantly more active at intervention end in year three compared to baseline (Figure 4.1). Despite this, it is notable that after an initial increase during the first year, the MVPA levels of both the junior and senior cohorts decreased over the course of the intervention. Although this may have been partly due to novelty bias (Persaud et al., 2019), it was also likely attributable to the step-back approach to intervention as the linear decrease in MVPA appears to align with the reduced Energizer contact each year. The mean difference in minutes of accumulated daily MVPA between year one and year two is -3.75 minutes (senior cohort) and -3.38 minutes (junior cohort), while the mean difference between year two and year three is -15.51 minutes (senior cohort) and -4.79 minutes (junior cohort). Based on this it seems that Energizer contact can positively influence children’s activity levels, with two contact days per week more effective than one, but one contact day more effective than none. This supports the recommendations of Tomsett et al., (2017) who concluded that the most effective PA and fundamental movement skill interventions are those that are led by specialist teachers. Similarly, Telford et al., (2016) reported that specialist teachers can provide higher levels of PA during PE lessons than the usual practice PE conducted by generalist classroom teachers, and that this can make a small contribution to children’s whole day PA levels. However, as the study was confined only to curricular PE class, there was no evidence to suggest that it translated to an increase in daily habitual PA or an increase in the number of students meeting PA recommendations, therefore, it suggested the need for daily classes or supplementary PA strategies.
In the absence of the Energizer in year three, there was a significantly greater drop off in MVPA amongst the senior cohort, in comparison to their junior counterparts (p<0.05) (Figure 4.1). This could be attributed to the significant interaction effect between class and time identified in analysis of the PA logs which suggested that teachers of junior classes delivered significantly more MVPA to their students over the course of the school year than teachers of senior class groups (p<0.05). Given that the burden of curricular constraints tends to increase as children age, it is likely that teachers of senior classes struggled more than those of junior classes to deliver PS, particularly during the latter months of the year (April/May) when senior class teachers reported feeling “pressure” and additional time constraints due to “preparation for exams”.

Findings from the PA logs indicate low to moderate fidelity of PS. Both groups did not achieve the target amount of extra daily MVPA (20 minutes) until June but this was after impact evaluation data collection had taken place and therefore will not be reflected in the anthropometric measures of the child cohort. Similar issues with fidelity were encountered by Naylor et al., (2006) who reported that during the ‘Action Schools! BC’ intervention, teachers only delivered on average two-thirds of the prescribed 15 minutes of additional daily PA. In the current study, low levels of fidelity could be linked to a lack of facilities, particularly in times of poor weather, which was identified by 45% of teachers as a barrier to intervention delivery. This is consistent with the findings of the review by Nathan et al. (2018) which reported that factors such as inadequate facilities and adverse weather have been cited as barriers to the implementation of school-based interventions across seven studies.

Low intervention fidelity could also be linked to the burden of curricular time constraints which was the most frequently identified barrier to implementation of PS according to both teachers (91%) and pupils (70%). This finding supports that of Hall et al. (2014) and the review conducted by Naylor et al (2015) who reported that time constraints was the most frequently (23/29 studies) noted barrier that influenced implementation of PA interventions in schools. Similarly, in Ireland, Mitchell et al., (2020) reported that a lack of time was cited in the COSI survey as a barrier to meeting the minimum recommendations for PA by 37.4% of schools. However, Greenberg et al. (2005) identified time constraints (time to prepare and deliver the PA intervention, competing demands and teacher overload) as a school level resourcing issue with increasing focus on academic achievement resulting in decreased PA opportunities in
schools (Howie et al., 2012). It seems curricular time constraints in this context can only be overcome if changes occur at a government policy level considering in similar developed countries such as Australia, the Department of Education has been found to exert the most influence on school priorities (Keshavarz et al., 2010).

Data from teacher surveys in year two revealed a statistically significant improvement in teachers’ attitudes towards delivering PS, as facilitators were maximised and controllable barriers minimised. Rather than passively receiving interventions, participants interact with them, and outcomes are produced by these interactions in context (Pawson et al., 1997). Therefore, one could speculate that more successful implementation and, consequently, more pronounced anthropometric differences could potentially have been attained if school-related barriers had been minimised and facilitators maximised earlier in the study, e.g. year one (2013/14). Inversely, in year three when the Energizer no longer had contact with the school, teachers’ attitude towards delivering PS worsened and interestingly the lack of Energiser contact became one of the most frequently identified barriers to implementation of PS, second only to curricular time constraints.

The availability of data relating to dose delivered by teachers enables the researcher to interpret discrepancies between expected and observed outcomes and investigate whether the limited effects of PS were due to poor intervention design or poor fidelity (Grant et al., 2013; Moore et al., 2015). A dose-response relationship exists between PA and its associated health benefits. Specifically, improvements in health outcomes tend to increase with increasing levels of PA (Foulds et al., 2014; Williams, 2013). The mechanisms of impact of PENZ, the intervention upon which PS is based, suggest that for children to achieve the health benefits associated with the intervention, they need to undertake 20 minutes extra daily MVPA through Energizer and/or teacher led ‘Huff & Puff’ sessions. Based on the teachers’ self-report PA logs, children received significantly less extra daily MVPA than the target set and therefore given the dose-response relationship, improvements in health outcomes were not maximised. However, given that the poor intervention fidelity observed in this study was linked to contextual barriers such as curricular time constraints which can only be overcome if changes occur at a government policy level (Keshavarz et al., 2010), perhaps the invention design of PS needs to be reviewed. The PS target of 20 minutes additional daily MVPA may
have been an overly ambitious task. Perhaps it would be more attainable for teachers to deliver 10 to 15 minutes of additional daily MVPA (Naylor et al., 2006; Ryde et al., 2018).

4.5.1 Limitations
A key limiting factor of this study was the lack of comparable control data over the three-year evaluation period. A delayed treatment approach was employed when recruiting control schools to participate in PS, whereby participating control schools were introduced into the PS programme after a period of two-years (Coppinger et al., 2016). Therefore, the control subgroup for this study was only valid for the first two years of evaluation before they went on to become an intervention school.

Another limiting factor was the size of the study sample. These results are based on one rural mixed gender school and as such, have limited population generalisability. Further investigation into the implementation of PS across a variety of schools is needed in order to draw more informed conclusions about the effectiveness of the PS intervention.

4.6 Conclusion
The step-back approach to PS reported in this study, indicates that PS can have positive lasting effects on childrens’ health, fitness and PA levels. Children in both junior and senior cohorts recorded significantly more daily MVPA in year 3 than at baseline prior to the introduction of PS. Improvements were also realised in both CRF and BMI z scores over the course of the intervention. However, the gradual reduction in Energizer contact time negatively influenced the amount of daily MVPA children undertake with a significant decrease in children’s objectively measured MVPA observed between year 1 and year 3. This may also be attributable to a lack of intervention fidelity among teachers as the self-report PA logs indicated that they delivered significantly less daily MVPA than the PS target of 20minutes. In order to optimise the effectiveness of PS, the barriers posed by the school context, such as a lack of time, facilities and resources need to be addressed. The Energizer has a key role to play, as all stakeholders identify having regular access to a PA specialist as being the greatest facilitator to intervention delivery in a primary school context.
Chapter 5: ‘Translating interventions from research to reality’ - insights from Project Spraoi, an Irish multicomponent school-based health promotion intervention
5.1 Abstract
The aim of this study was to explore the extent to which Project Spraoi (PS) was delivered as intended across five intervention schools and to examine the processes through which PS and each of the school contexts adapted to one another throughout the course of an academic year.

Methods: Data collection took place throughout the 2015/16 academic year. Process evaluation was undertaken based on the three themes identified by Moore et al., (2015): implementation, context and mechanism of impact. These themes were subcategorised into six evaluation dimensions and appropriate data collection tools were identified. Qualitative methods included interviews, focus groups and write and draw to elicit information about contextual barriers and facilitators, adaptations and interactions. Quantitative tools included physical activity (PA) logs and questionnaires to quantify fidelity; the extent to which PS was delivered as intended across 5 schools. A diverse range of stakeholders, including teachers (n=63), support staff (n=22), Energizers (n=4) and children (n=295) all participated to gain a comprehensive, multi-perspective understanding of the delivery of PS from the primary actors involved.

Results: Overall, intervention fidelity was low, with significant variations between the dose delivered in each of the schools. On average, teachers managed to deliver between 50% and 80% of the prescribed 20minutes daily MVPA. Common barriers across all schools were identified as a lack of time, curricular constraints and weather, however lack of support from school staff was also identified as an inhibiting barrier in two schools. Adaptations made to achieve better contextual fit, including shorter activity breaks, cross curricular games and PA challenges facilitated the delivery of core intervention components.

Conclusion: The individuality of the Energizers’ research focus and the flexibility of implementation resulted in much variability in how PS was delivered and received but adaptations that supported better contextual fit facilitated intervention delivery. These findings offer solutions to overcome the inherent contextual barriers of delivering primary school-based health promotion interventions.
5.2 Introduction
Childhood obesity is a serious public health concern both globally (World Health Organisation, (WHO) 2013) and in Ireland (Mitchell et al., 2020). Data from the Childhood Obesity Surveillance Initiative (COSI) report in Ireland, indicated that 15.8% of children in first class of primary school (aged 7 years), were already overweight or obese (Mitchell et al., 2020). This increased to over a fifth (21.8%) of children by fourth class (aged 10 years) (Mitchell et al., 2020). The long-term health and social consequences of childhood obesity are well-established in the literature (Jennings, 2018), with the adverse health impacts associated with the condition likely to continue into adulthood (Reilly et al., 2011). Establishing healthy behaviours at an early age is therefore important, as they may help to prevent obesity and its comorbidities, whilst also improving children’s overall health and wellbeing. Such behaviours could also have a long-lasting influence on a child’s health status into adolescence and later in life (Jennings, 2018).

The WHO suggest that to target obesity effectively, action in multiple settings, with a range of stakeholders and a wide variety of approaches targeting both physical activity (PA) and nutritional knowledge and behaviours is required (WHO, 2012). Schools hold much potential to act as critical settings for influencing healthy eating and PA behaviours, because they have long-term contact with pupils throughout their childhood and children spend much of their waking hours at school (Cavanagh et al., 2012; Kropski et al., 2008; Stewart-Brown, 2006). However, systematic reviews investigating the effectiveness of single or multi-component school-based interventions on children’s PA levels, sedentary time, and healthy eating behaviours have, to date, produced mixed findings (Love et al., 2019; Naylor et al., 2015; Evans et al., 2012). The variability between studies suggests both the complexity of implementing school-based interventions and their evaluations, and the challenges in identifying key successful components (Langford et al, 2015). It also highlights the importance of understanding the contextual variables that dictate why only some interventions are effective in achieving their outcomes (Schapp et al., 2018; Naylor et al, 2015).

School-based interventions can be interpreted as an attempt to positively disrupt the prior functioning of the school system (Darlington et al., 2018). However, the challenges associated with creating change within the school environment often differ between schools. This is because every school has its own unique working dynamic, which is shaped by many interacting elements and ever-changing agents within the school system (Darlington et al.,
Schools can therefore be conceptualised as complex adaptive systems (Keshavarz et al., 2010). A complex adaptive system can be described as a system that consists of many interacting components which are dynamic, can learn and adapt (Keshavarz et al., 2010). The system’s behaviour is typically non-linear, not easily controlled or predicted, and it tends to self-organise to a state of stability (Darlington et al., 2018; Turunen et al., 2017; Moore et al., 2015). Embracing this perspective of considering schools as complex adaptive systems means that it depends on the specific school context whether a health promotion intervention succeeds in a school, and that in each school, the implementation process of specific intervention components may need to be adapted to achieve better contextual fit (Moore et al, 2015). It also means that even when identical intervention activities are delivered, these can have different effects across schools as the changes may be moderated by the unique context of the school and the agents within it (Moore et al., 2015; Keshavarz et al, 2010).

PS (www.projectspraoi.cit.ie) was an Irish multi-component school-based intervention based on the fully evaluated and internationally recognised ‘Project Energize’ intervention (www.projectenergize.org.nz). The intervention, with a focus on PA and healthy eating, aimed to improve children’s health and well-being by affecting health promoting changes throughout the whole school system. Central to the PS concept was the ‘Energizer’; a PA specialist, who was responsible for leading and supporting health promoting change. Their role included modelling structured PA sessions known as ‘Huff and Puff’ to teachers, delivering healthy eating workshops and providing PA and healthy eating resources to support teachers in achieving the intervention target of 20 minutes additional moderate to vigorous PA (MVPA), in addition to each school’s designated weekly physical education time (Coppinger et al., 2016). These changes to the whole school environment were supported by involvement of class teachers and parents.
On the days when the Energizer was not present, class teachers were expected to deliver intervention activities (20 minutes daily MVPA) and parents supported intervention activities by participating in after school healthy eating workshops and helping their children with ‘active homework’. The ‘Energizer’ also acted as a researcher for the larger PS evaluation and had a specific research objective when delivering the PS intervention in their designated school. These additional research objectives included the development of children’s fundamental movement skills (FMS), reducing daily sedentary time, and enhancing healthy eating behaviours.

To better understand the implementation processes of PS, a process evaluation was undertaken to focus not only on the fidelity of the intervention but also the adaptation of the intervention and school system to one another and to identify contextual factors crucial for sustained change. In ‘multi-site’ interventions like PS, where the ‘same’ intervention theory may be implemented and received in different ways, process evaluation is crucial in translating overall outcomes and understanding potential variances between schools (Day et al., 2019; Moore et al., 2015).

The aim of the current study was to generate knowledge and experiences on how to implement changes in the complex school system to integrate school health promotion initiatives and to share key learning points from PS. Specifically, the study explored the extent to which the prescribed intervention was delivered as intended across five intervention schools and examined the processes through which PS and the school context adapted to one another throughout the course of an academic year.

5.3 Methods
5.3.1 Study Sample
The seven primary schools included as part of this PS evaluation were from both urban (n=3) and rural (n=2) locations and middle to high (n=4) and low (n=1) social economic status (SES) schools. In Ireland, schools with high concentrations of students from socioeconomically disadvantaged backgrounds are known as Delivering Equality of Opportunity in Schools (DEIS) schools (Department of Education and Skills, 2017). A summary of each of the schools included in this evaluation can be found in Table 5.1.
### Table 5.1: Summary of evaluation schools

<table>
<thead>
<tr>
<th>School</th>
<th>Gender</th>
<th>Location</th>
<th>School SES</th>
<th>Energizer contact days</th>
<th>Intervention year</th>
<th>Research focus</th>
<th>Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Boys</td>
<td>Urban</td>
<td>Non-DEIS</td>
<td>2</td>
<td>2</td>
<td>FMS</td>
<td>Yard Sports hall</td>
</tr>
<tr>
<td>S2</td>
<td>Girls</td>
<td>Urban</td>
<td>Non-DEIS</td>
<td>2</td>
<td>2</td>
<td>FMS</td>
<td>Yard Sports hall</td>
</tr>
<tr>
<td>S3</td>
<td>Mixed</td>
<td>Urban</td>
<td>DEIS</td>
<td>1</td>
<td>1</td>
<td>Sedentary</td>
<td>Yard Sports hall</td>
</tr>
<tr>
<td>S4</td>
<td>Mixed</td>
<td>Rural</td>
<td>Non-DEIS</td>
<td>1</td>
<td>1</td>
<td>Sedentary</td>
<td>Yard Playground Sports hall All weather pitch Grass pitch</td>
</tr>
<tr>
<td>S5</td>
<td>Mixed</td>
<td>Rural</td>
<td>Non-DEIS</td>
<td>1</td>
<td>2</td>
<td>Nutrition</td>
<td>Yard Sports hall Grass pitch</td>
</tr>
<tr>
<td>S6*</td>
<td>Mixed</td>
<td>Rural</td>
<td>Non-DEIS</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
<td>Yard x 3 Sports hall All weather pitch Grass pitch</td>
</tr>
<tr>
<td>S7*</td>
<td>Mixed</td>
<td>Urban</td>
<td>DEIS</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
<td>Yard Sports Hall Grass pitch</td>
</tr>
</tbody>
</table>

*control schools

5.3.2 Data Collection

5.3.2 (a) Physical Activity Logs

PA logs were completed weekly by all class teachers (n=65) between November 2015 and May 2016. Teachers indicated by ticking the box, the type and length of time (either 5, 10, 15 or 20 minutes) of activity delivered by them each day. Teachers were also asked to indicate on which day(s) and how many minutes of Physical Education was delivered. A comments box was provided at the end of each sheet, as a space where teachers could specify, if necessary, any reasons for not delivering PA on any given day (Appendix C).

5.3.2 (b) Write and Draw

In addition to their original consent to participate in PS, further consent was sought for a write a draw activity on three levels; school, teacher and child. After verbal consent was given by the school principal, teachers were asked to sign a consent form for their class to participate (Appendix C). Children were then given the opportunity to consent to participate on their own behalf by simply raising their hand. To avoid any child feeling coerced into participation, a
separate task of colouring or drawing on a blank sheet was offered as a substitute activity. This task was chosen as it would neither be a reward nor a punishment for opting out of participation in the write and draw evaluation (McWhirter, 2014).

The write and draw activity was delivered to all consenting students in testing classes (junior & senior evaluation cohorts) by the researcher. Children were invited to complete a worksheet resembling a class activity that was titled ‘What Project Spraoi means to me’ (Appendix C). They were asked to draw a picture in the outlined drawing area and then write a few lines below about what PS meant to them. A ‘spelling holiday’ was granted for the duration of the task and reassurance was offered that this was not a test and drawings would not be displayed at school.

Possible limitations of using drawings as a source of feedback are that they only represent experiences and views that can be represented graphically and are limited by an individual’s skills (MacPhail et al, 2004). To avoid this, drawings were used in conjunction with interviews. Thus, children were not limited to expressing experiences that could only be represented graphically, and they had the opportunity to explain their pictures, avoiding issues of clarity.

5.3.2 (c) Semi-structured interviews
Semi-structured interviews were conducted one week after completion of the Write and Draw task. Two children from each junior and senior evaluation class, one girl and one boy, if the school was mixed, were selected to participate (n=20). Despite much qualitative research involving the use of purposive sampling, random sampling was selected for this component to negate charges of researcher bias in the selection of participants (Preece, 1994; Shenton, 2004). Both the interview protocol and questions were piloted in advance with a test sample (n=20) and amendments were made where necessary (Appendix C).

The interviews were conducted by the lead researcher, accompanied by a research assistant. In addition to their original consent, further consent was sought by both parent/guardian and child to participate in the interview and to have it audio recorded. Interviews were conducted in a private quiet space, often a teacher resource room, separate to the main classroom. For ethical reasons, two children were always present in the interview room with the interviewer and research assistant.

Questions were grouped under three headings; (i) write and draw, (ii) intervention activities and interactions with PS, and (iii) the school environment. The interview protocol employed
was influenced by the considerations outlined by Westcott et al (2002; 2005) with open ended questions favoured to encourage longer responses.

5.3.2 (d) Questionnaires
Questionnaires were developed for completion by school staff, and Energizers throughout the course of the academic year in order to analyse key stakeholders’ interactions with PS, record adaptations to intervention delivery and identify barriers and facilitators to PS activities across all intervention schools. Five different questionnaires: teacher questionnaire; PA & healthy eating profile; end of year review; energizer questionnaire and parent questionnaire were implemented throughout the course of the school year (Appendix C). Questions were presented as a set of statements which respondents indicated their level of agreement using a 5-point Likert scale. Open ended questions were also used to gather information about stakeholders’ interactions with PS, prompt any unanticipated information and suggest innovations to improve intervention delivery and support at each school.

As questionnaires were specific to the implementation of PS, questions were piloted in a preliminary study (2014/15) before being used across all intervention schools in 2015/16. Following recommendations from the literature and feedback from stakeholders in 2014/15, questionnaires were condensed to a single A4 size page, using ‘tick the box’ style questions to maximise response while minimising burden and additional workload for school staff (Griffin et al, 2014). A summary of the questionnaires used is provided in Table 5.2.
Table 5.2: Summary of questionnaires used and evaluation dimensions assessed

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Stakeholder</th>
<th>Purpose</th>
<th>Evaluation Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Questionnaire</td>
<td>Class teachers (intervention) (n=63)</td>
<td>• Assess implementers self-perceived delivery of each intervention component. • Identify contextual barriers/facilitators. • Suggest innovations.</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dose</td>
</tr>
<tr>
<td>Energizer Questionnaire</td>
<td>Active Energizers (n=5)</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Adaptation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Barrier/Facilitator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inter-Actions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Activities</td>
</tr>
<tr>
<td>Physical activity &amp; nutrition profile</td>
<td>Evaluation class teachers (control &amp; intervention) (n=16)</td>
<td>• Understand school context and activities undertaken by school outside of PS which may influence outcomes. • Compare control context to the intervention context</td>
<td>✓</td>
</tr>
<tr>
<td>End of year review</td>
<td>All school staff (intervention) (n=85)</td>
<td>• Note changes to the school environment incl. student behaviour &amp; staff morale.</td>
<td>✓</td>
</tr>
</tbody>
</table>

5.3.3 Analyses

Qualitative data such as interviews and focus groups were recorded and transcribed verbatim. All interview transcripts were checked by a second researcher to ensure accuracy of recording. Thematic analyses were conducted on the qualitative data from the interviews, focus groups, and open-ended survey questions. Data was coded into categories based on programme theory using a computer assisted qualitative data analysis software (CAQDAS), Quirkos (version 2.0) (Rogers, 2008). During the coding process, CAQDAS was used to identify key words and associated synonyms across all attached data sources. Themes were identified and reviewed several times to see if they still worked in relation to the new data sources. After all data was coded, subcategories were identified per theme if necessary, and when possible a distinction between inhibiting and promoting was made for each of the influencing
factors. Next, the coded text was retrieved to create an overview per theme (or per subcategory) with the findings split up into the five schools to study similarities and differences across schools. Furthermore, for each school, the frequency of counts per subcategory/theme was calculated to evaluate open-ended survey questions. Themes and subcategories identified and coded during analysis were reviewed by a second researcher to ensure consistency and compatibility throughout.

Quantitative survey data from Likert scale questions was analysed using SPSS (version 23). For each time of measurement and separately for each respondent group, descriptive statistics and frequencies were calculated. Changes in survey responses over time and/or between schools was calculated using both paired sample t-tests and analysis of variance.

The mean amount of extra daily MVPA (minutes) reported by teachers on the PA logs was calculated for each month in Microsoft Excel and was subsequently analysed in SPSS (version 23) using a repeat measure between and within subject’s ANOVA test. The within subjects’ factor was time and the between subject’s factor was the class taught by the relevant teacher. For the purpose of analysis teachers who taught class groups from junior infants to second class were assigned to the junior category (n=6), while teachers who taught class groups from third class to sixth class were assigned to the senior category (n=5).

5.4 Results:

5.4.1 Implementation – fidelity and dose delivered
Over the course of an academic year, the mean amount of extra daily MVPA delivered by teachers each month varied significantly (p=0.000, n²=0.403) (Figure 5.1). There was also a statistically significant difference between schools (p=0.024, n²=0.275), with S1 delivering the highest amount of extra daily MVPA (16.223 mins) and S3 delivering the least (10.386 mins). The interaction effect of time and class group taught indicated that over the course of the school year, junior class teachers delivered significantly more extra daily PA than teachers of senior classes (p=0.05, n²=0.07).

A Bonferroni post-hoc test was conducted to explore the monthly difference in the amount of extra daily MVPA delivered by teachers within the seven months of intervention evaluated. Although the increase in the amount of extra daily MVPA delivered by teachers over time did not occur in a linear manner, a statistically significant mean increase of 6.76 minutes (p=0.000, n²=0.57) was reported between November and May. The largest and most notable increase
in the amount of extra daily MVPA delivered by teachers was between March and April (mean difference = 7.34 mins, p=0.000).

Further analysis of the PA logs using a one-sample t-test revealed discrepancies in the fidelity of intervention delivery by class teachers. The mean amount of extra MVPA delivered by teachers daily (junior 14.18 minutes; senior 12.41 minutes) was significantly lower than the PS target of 20 minutes from November to May (p<0.05), with the exception of April (Table 5.2).
At the beginning of the intervention evaluation in November, only 5.1% (n=3) (junior=3.1% (n=1); senior=7.4%(n=2)) of teachers were meeting the PS target of 20 minutes extra daily MVPA. This increased to 16.4% (n=10) (junior =21.9% (n=7); senior =10.3% (n=3)) of teachers meeting the target at intervention end in May, with a peak of 42.9% (n=27) (junior=50% (n=16); senior=35.5% (n=11)) of teachers meeting the target in April.

Table 5.3: Implementation fidelity – PS target versus dose delivered by teachers

<table>
<thead>
<tr>
<th></th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Mean daily MVPA (min)</td>
<td>9.33</td>
<td>12.26</td>
<td>13.94</td>
<td>16.00</td>
<td>14.85</td>
<td>23.73</td>
<td>17.45</td>
</tr>
<tr>
<td>SD</td>
<td>5.82</td>
<td>9.57</td>
<td>8.02</td>
<td>11.20</td>
<td>11.25</td>
<td>11.63</td>
<td>18.38</td>
</tr>
<tr>
<td>p value</td>
<td>0.000*</td>
<td>0.005*</td>
<td>0.009*</td>
<td>0.174</td>
<td>0.098</td>
<td>0.234</td>
<td>0.600</td>
</tr>
</tbody>
</table>

| S2 |          |          |         |          |       |       |     |
| N  | 10       | 8        | 11      | 11       | 11    | 11    | 11  |
| Mean daily MVPA (min) | 5.51 | 4.51 | 10.38 | 13.14 | 11.40 | 23.17 | 14.27 |
| SD  | 2.03 | 5.72 | 7.34 | 5.94 | 7.06 | 3.44 | 5.09 |
| p value | 0.000* | 0.000* | 0.001* | 0.003* | 0.002* | 0.122 | 0.004* |

| S3 |          |          |         |          |       |       |     |
| N  | 13       | 14       | 14      | 15       | 12    | 15    | 14  |
| Mean daily MVPA (min) | 8.23 | 9.60 | 9.49 | 9.27 | 7.87 | 9.87 | 9.71 |
| SD  | 3.77 | 2.39 | 6.54 | 5.50 | 4.35 | 6.80 | 4.94 |
| p value | 0.000* | 0.000* | 0.000* | 0.000* | 0.000* | 0.000* | 0.000* |

| S4 |          |          |         |          |       |       |     |
| N  | 11       | 11       | 12      | 12       | 12    | 12    | 12  |
| Mean daily MVPA (min) | 12.73 | 12.18 | 14.58 | 15.42 | 15.07 | 19.50 | 17.46 |
| SD  | 5.97 | 3.52 | 5.42 | 3.12 | 2.60 | 2.39 | 2.76 |
| p value | 0.002* | 0.000* | 0.005* | 0.000* | 0.000* | 0.484 | 0.109 |

| S5 |          |          |         |          |       |       |     |
| N  | 10       | 11       | 10      | 11       | 8     | 11    | 10  |
| Mean daily MVPA (min) | 9.00 | 10.22 | 11.28 | 12.27 | 9.55 | 17.73 | 13.5 |
| SD  | 3.20 | 2.28 | 4.99 | 3.13 | 4.39 | 2.28 | 1.96 |
| p value | 0.000* | 0.000* | 0.000* | 0.000* | 0.000* | 0.008* | 0.000* |

*ps≤0.05 significant difference between daily MVPA dose delivered and PS target of 20mins daily MVPA
5.4.2 Mechanisms of Impact: Interactions

The teacher survey assessed each teacher’s attitude towards delivering PS and their interactions with the intervention and Energizer (Table 5.4).

Table 5.4: Teacher Questionnaire - Frequencies of responses

<table>
<thead>
<tr>
<th>Questions</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivering 20mins extra daily MVPA is manageable.</td>
<td>8.6</td>
<td>51.7</td>
<td>17.2</td>
<td>22.4</td>
<td>0</td>
</tr>
<tr>
<td>I make every effort to deliver 20mins PA every day.</td>
<td>10.3</td>
<td>67.2</td>
<td>15.5</td>
<td>6.9</td>
<td>0</td>
</tr>
<tr>
<td>After I deliver ‘Huff &amp; Puff’ my students were more attentive in class.</td>
<td>22.4</td>
<td>50</td>
<td>29</td>
<td>1.7</td>
<td>0</td>
</tr>
<tr>
<td>After I deliver ‘Huff &amp; Puff’ my students were more boisterous in class.</td>
<td>1.7</td>
<td>12.1</td>
<td>19</td>
<td>53.4</td>
<td>13.8</td>
</tr>
<tr>
<td>I actively participate when the Energizer delivers activities to my class.</td>
<td>17.2</td>
<td>41.4</td>
<td>24</td>
<td>17.2</td>
<td>1.7</td>
</tr>
<tr>
<td>I actively participate while I deliver activities to my class.</td>
<td>25.9</td>
<td>62.1</td>
<td>12.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>As a result of PS, I have noticed an improvement in my student’s fitness levels.</td>
<td>65.5</td>
<td>25.9</td>
<td>8.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>As a result of PS, I am more aware of the importance of PA.</td>
<td>62.1</td>
<td>31</td>
<td>18</td>
<td>1.7</td>
<td>0</td>
</tr>
<tr>
<td>I am confident to deliver ‘Huff &amp; Puff’ activities on the days when the Energizer is not here.</td>
<td>34.5</td>
<td>58.6</td>
<td>5.2</td>
<td>1.7</td>
<td>0</td>
</tr>
<tr>
<td>The activities delivered by the Energizer are appropriate and easy to manage with my class.</td>
<td>79.3</td>
<td>19</td>
<td>11</td>
<td>1.7</td>
<td>0</td>
</tr>
<tr>
<td>As a result of PS, I am more aware of the importance of healthy eating.</td>
<td>41.4</td>
<td>36.2</td>
<td>21</td>
<td>3.4</td>
<td>1.7</td>
</tr>
<tr>
<td>As a result of PS, I have noticed an improvement in my students eating habits.</td>
<td>22.4</td>
<td>34.5</td>
<td>20</td>
<td>10.3</td>
<td>0</td>
</tr>
</tbody>
</table>
Overall, more than half of teachers (60.3%, n=35), either agreed or strongly agreed that delivering 20 minutes extra daily MVPA was manageable, however, the level of agreement varied across schools (Figure 5.3). One teacher mentioned that the reason she found difficulty delivering 20 minutes additional daily MVPA was because it ‘meant leaving out a full lesson from one of the other subject areas’ (Teacher, S5).

Figure 5.3: Frequency of teachers who agree 20 minutes daily MVPA is manageable

Teachers largely agreed (98.3%, n=57) that the activities delivered by the Energizer were appropriate and easy to manage with their class and most teachers (93.1%, n=54) were confident in their ability to deliver intervention activities on their own on the days when the Energizer was not there. Following ‘Huff and Puff’ activities, almost three quarters of teachers (72.4%, n=42) reported that their students were more attentive in class, while in contrast, 13.8% (n=8) of teachers reported that their students were more boisterous in class. An interesting observation by a teacher in S4 was that “children are more distracted after 20 minutes straight, whereas they are more attentive after 5/10 minute bursts throughout the day.”

As a result of PS, 91.4% (n=53) of teachers had noticed an improvement in their students’ fitness levels and 61.1% (n=33) of teachers noticed improvements in their students’ eating habits. A teacher in S5 wrote, “I can see a huge improvement in overall fitness in the class and their lunchboxes.” Similarly, most teachers (91.3%, n=54) agreed that as a result of PS, they were more aware of the importance of PA, while only 64.4% (n=45) of teachers agreed that
they were more aware of the importance of healthy eating. This opinion is supported by a teacher in S5 who noted that, “I am an active person, and I eat healthy, but in addition to the children, I have learned a lot personally from (Energizer) about healthy eating.”

During the end of year review, all teachers and school staff surveyed (n=65) agreed that they would like PS to continue in their school, however, only one in four (25.92%, n=16) agreed that PS could continue successfully in their school without the presence of an Energizer. One teacher commented that it was “hugely beneficial to have an experienced coach to guide both the teacher and the children” (Teacher, S3), with another adding that it “would be great to have an Energizer in the school full time” (Teacher, S4).

Overall, PS was extremely well received by schools, with many teachers commending the projects content and staff for their work throughout the year. A teacher in S1 had the following to say; “Project Spraoi is an excellent project, delivered in a very positive and motivating way. Definite improvements in children’s attitudes to physical activity and fitness levels. Some great ideas that can be easily implemented within the school spaces and using school resources”.
Children’s interactions with PS as interpreted from their drawings (n=246) reflected the intervention’s three main components; physical activity (72.3%, n=178), healthy eating (8.2%, n=20) and sedentary time (4.5%, n=11). The remainder of drawings were categorised as feelings (10%, n=25) and other (5%, n=12).

Spending time with friends also emerged as a prominent feature of children’s interaction with PS with over half (57.4%, n=141) of drawings featuring a group of children playing together. The Energizer also featured when children reflected on their interactions with PS, with 9.8% (n=24) of children including the Energizer in their drawing.

A notable variation in themes and activities emerged between schools with each Energizer’s individual research objectives reflected in how children in their intervention school perceived
PS. A breakdown of identified themes across the five intervention schools is summarised in table 5.5.

Table 5.5: Descriptive of write and draw sample, energizer focus and identified themes

<table>
<thead>
<tr>
<th>School</th>
<th>N</th>
<th>Energizer Research focus</th>
<th>Theme (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Physical activity</td>
</tr>
<tr>
<td>S1</td>
<td>53</td>
<td>Fundamental movement skills</td>
<td>73.6</td>
</tr>
<tr>
<td>S2</td>
<td>55</td>
<td>PA and reduced sedentary time</td>
<td>75.5</td>
</tr>
<tr>
<td>S3</td>
<td>24</td>
<td>PA and reduced sedentary time</td>
<td>76.2</td>
</tr>
<tr>
<td>S4</td>
<td>59</td>
<td></td>
<td>87.9</td>
</tr>
<tr>
<td>S5</td>
<td>55</td>
<td>Healthy eating</td>
<td>67.3</td>
</tr>
</tbody>
</table>

In terms of activities, organised sport (41.9%) and games (27.2%) were the most frequently drawn activities by children across the five schools. Movement skills were most frequently drawn by children in S1 (41.5%) and S2 (74.5%) where the Energizer’s research focus was on improving fundamental movement skills, while healthy eating activities were most frequently drawn by children in S5 (29.1%) where the Energizers research focus was on improving healthy eating habits. The type of activities children associated with PS appears to align with each Energizer’s research focus, indicating that how the PS intervention was delivered and received in each school varied (Figure 5.4).

Most children (junior 83.3% (n=131); senior 98.8% (n=161)) accompanied their drawing with a short paragraph about ‘what Project Spraoi means’ to them. The most frequently used word by children to describe PS was ‘fun’ (32%). Other words that children commonly associated with PS included the Energizer (14.5%), exercise and fitness (12%), health (8%), and being outdoors (8%). Unusually, in S2, 14.58% of children described PS as PE time, instead of identifying it as a separate activity. This did not occur at any other school.
The content delivered and resources used by the Energizer also varied across schools (Table 5.6). The perceived quality of nutrition content by teachers and school staff also varied across schools (Figure 5.5), while the perceived quality of the physical activity content by teachers and school staff was similar across schools (Figure 5.6).

Table 5.6: Nutrition lessons delivered by Energizer

<table>
<thead>
<tr>
<th>Nutrition Lesson</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugary Drinks</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4 Food groups</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Healthy Breakfast</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Takeaways</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Food Demonstration(s)</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Parent Workshop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

Figure 5.4: Summary of activities children associate with Project Spraoi
Figure 5.5: Perceived quality of nutrition content

Figure 5.6: Perceived quality of physical activity content

5.4.4: Context
A summary of each school’s nutrition and PA practices was documented using a survey completed by class teachers of ‘testing classes’ (students involved in the impact evaluation of PS) to evaluate potential differences between intervention and control schools (Table 5.2). Although any number of undocumented differences between intervention and control schools have the potential to influence the interpretation of outcomes, Table 5.7 summarises...
the contextual factors and implementation practices included in the survey, which could have potential to influence the interpretation and effectiveness of PS on health outcomes among the evaluation cohorts.

Table 5.7: PA and Nutrition Profile of Intervention versus Control schools

<table>
<thead>
<tr>
<th>School</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERVENSION (INT)/ Control (CON)</td>
<td>INT</td>
<td>INT</td>
<td>INT</td>
<td>INT</td>
<td>INT</td>
<td>CON</td>
<td>CON</td>
</tr>
<tr>
<td>Teachers surveyed (n)</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Mean Weekly PE (mins)</td>
<td>62.86</td>
<td>68</td>
<td>60</td>
<td>90</td>
<td>80</td>
<td>55</td>
<td>62</td>
</tr>
<tr>
<td>Mean Weekly PA (mins)</td>
<td>49.86</td>
<td>53</td>
<td>33.33</td>
<td>62.5</td>
<td>25</td>
<td>30</td>
<td>44</td>
</tr>
<tr>
<td>Number of weekly PA sessions (n)</td>
<td>3.71</td>
<td>4.8</td>
<td>3.33</td>
<td>7.5</td>
<td>3.5</td>
<td>8.33</td>
<td>4.6</td>
</tr>
<tr>
<td>Mean duration of each PA session (mins)</td>
<td>21.14</td>
<td>19</td>
<td>10</td>
<td>7.5</td>
<td>7.5</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Uses PA as a reward in the classroom (n)</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Uses food as a reward in the classroom (n)</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Organised yard activities</td>
<td>Yes</td>
<td>Yes*</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Involved in Food Dudes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Involved in School Milk Scheme</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Involved in School Lunch Scheme</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Involved in National Dairy Week</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Involved in School Breakfast Club</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

*Wednesdays only

Interestingly, no significant difference was found between the mean amount of self-reported weekly PA delivered by class teachers in the intervention schools versus control schools (p>0.05) (Table 5.8). Similarly, no significant differences were found between the mean amount of self-reported PE delivered by intervention versus control class teachers (p>0.05) (Table 5.8). This cautiously suggests that the control cohort received a similar amount of weekly PA and PE as the intervention cohort, which may skew the interpretation of intervention outcome measures.
Another difference between schools which had the potential to affect the interpretation of outcomes is the involvement of three of the intervention schools (School 3, 4 and 5) in another health promotion initiative; ‘Food Dudes’, which is an initiative that encourages children to make healthier food choices. This means that any improvements in children’s nutritional knowledge and behaviours in these schools may not be directly attributable to PS, as we do not know the extent to which the ‘Food Dudes’ intervention may also have influenced outcomes.

5.4.5 Barriers and Facilitators
Contextual barriers and facilitators to intervention delivery was derived from key stakeholders, (Energizers, teachers, and children) through a combination of surveys, focus groups and semi-structured interviews. Despite each group of stakeholders’ unique perspective, barriers including a lack of time, curriculum constraints and weather were identified by all stakeholder groups as key factors inhibiting intervention delivery. Similarly, common facilitators to intervention delivery identified across all stakeholder groups included the Energizer, perceived/observed benefits of PS, PA competitions/challenges such as the ‘Stride for 5’, routine and the availability/quality of resources.

Table 5.9 provides an overview of the factors which stakeholders identified as positively or negatively affecting the implementation of PS, while Table 5.10 provides a summary of the differences between schools. Where possible factors identified as part of this study have been linked to the relevant categories identified in Durlak and DuPre’s (2008) model. This reporting structure was previously adopted by Naylor et al., (2015).
Table 5.9: Summary of the factors affecting the implementation of Project Spraoi

<table>
<thead>
<tr>
<th>Factors affecting implementation</th>
<th>Teachers (n=65)</th>
<th>Energizer (n=5)</th>
<th>Children (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Barrier</td>
<td>Facilitator</td>
<td>Barrier</td>
</tr>
<tr>
<td>1. Time (e.g., competing requirements, teacher overload) [^{iv}]</td>
<td>45</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2. Curriculum (pressure to deliver core subjects, preparation for exams) [^{iv}]</td>
<td>32</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3. Weather</td>
<td>10</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4. Class Management (student behaviour, etc)</td>
<td>4</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5. Availability/quality of programme resources (e.g. games, activity resources, nutrition lessons) [^{iii}]</td>
<td>9</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>6. Availability/quality of school resources (e.g. facilities, equipment, classroom space) [^{ii}]</td>
<td>8</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>7. Quality of training and technical support staff (Energizer) [^{iii},^{v}]</td>
<td>0</td>
<td>78</td>
<td>0</td>
</tr>
<tr>
<td>8. Supportive school climate (e.g., shared vision/ administrative support/teacher motivation) [^{i}]</td>
<td>0</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>9. Adaptability (flexibility to react to issues or individual circumstances, e.g. shorter activity breaks, cross curricular games) [^{iii}]</td>
<td>0</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>10. Teacher characteristics, engagement and motivation [^{ii}]</td>
<td>5</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>11. Perceived/observed benefits of PS (improved fitness, health, nutritional choices, FMS competency/ increased concentration) [^{ii}]</td>
<td>3</td>
<td>75</td>
<td>0</td>
</tr>
<tr>
<td>12. Competition and incentives (PA challenges/ prizes)</td>
<td>0</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>13. Lesson scheduling (programme structure, routine, integration within the school day) [^{iv}]</td>
<td>7</td>
<td>12</td>
<td>1</td>
</tr>
</tbody>
</table>

Superscript roman numerals refer to categories within the Durlak and DuPre model (Durlak and DuPre, 2008):

\[^{i}\] Community level; \[^{ii}\] Provider characteristics; \[^{iii}\] Characteristics of the intervention; \[^{iv}\] Organizational capacity; \[^{v}\] Prevention support system
### Table 5.10: Summary of the factors affecting the implementation of Project Spraoi across schools

<table>
<thead>
<tr>
<th>Factors affecting implementation</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B/F</td>
<td>B/F</td>
<td>B/F</td>
<td>B/F</td>
<td>B/F</td>
</tr>
<tr>
<td>1 Time (e.g., competing requirements, teacher overload)</td>
<td>10 0</td>
<td>12 0</td>
<td>14 0</td>
<td>12 0</td>
<td>11 0</td>
</tr>
<tr>
<td>2 Curriculum (pressure to deliver core subjects, preparation for exams)</td>
<td>13 0</td>
<td>11 0</td>
<td>11 0</td>
<td>8 0</td>
<td>9 0</td>
</tr>
<tr>
<td>3 Weather</td>
<td>3 0</td>
<td>4 1</td>
<td>4 0</td>
<td>1 2</td>
<td>4 2</td>
</tr>
<tr>
<td>4 Class Management (student behaviour, etc)</td>
<td>3 0</td>
<td>1 0</td>
<td>2 0</td>
<td>2 1</td>
<td>0 0</td>
</tr>
<tr>
<td>5 Availability/quality of programme resources (e.g. games, activity resources, nutrition lessons)</td>
<td>6 12</td>
<td>3 15</td>
<td>2 6</td>
<td>0 7</td>
<td>0 8</td>
</tr>
<tr>
<td>6 Availability/quality of school resources (e.g. facilities, equipment, classroom space)</td>
<td>3 1</td>
<td>5 0</td>
<td>4 0</td>
<td>0 5</td>
<td>2 1</td>
</tr>
<tr>
<td>7 Quality of training and technical support staff (Energizer)</td>
<td>0 18</td>
<td>0 26</td>
<td>0 13</td>
<td>0 10</td>
<td>0 23</td>
</tr>
<tr>
<td>8 Supportive school climate (e.g., shared vision/ administrative support/teacher motivation)</td>
<td>0 1</td>
<td>1 1</td>
<td>1 1</td>
<td>0 0</td>
<td>3 1</td>
</tr>
<tr>
<td>9 Adaptability (flexibility to react to issues or individual circumstances, e.g. shorter activity breaks, cross curricular games)</td>
<td>0 9</td>
<td>0 12</td>
<td>0 6</td>
<td>0 4</td>
<td>0 5</td>
</tr>
<tr>
<td>10 Teacher characteristics, engagement and motivation</td>
<td>2 3</td>
<td>4 2</td>
<td>2 2</td>
<td>0 5</td>
<td>0 4</td>
</tr>
<tr>
<td>11 Perceived/observed benefits of PS (improved fitness, health, nutritional choices, FMS competency/ increased concentration)</td>
<td>3 16</td>
<td>1 17</td>
<td>0 16</td>
<td>0 14</td>
<td>0 17</td>
</tr>
<tr>
<td>12 Competition and incentives (PA challenges/ prizes)</td>
<td>0 10</td>
<td>0 6</td>
<td>0 4</td>
<td>0 4</td>
<td>0 5</td>
</tr>
<tr>
<td>13 Lesson scheduling (programme structure, routine, integration within the school day)</td>
<td>2 3</td>
<td>3 8</td>
<td>1 1</td>
<td>1 1</td>
<td>2 1</td>
</tr>
</tbody>
</table>

* B = Barrier; F = Facilitator. Superscript roman numerals refer to categories within the Durlak and DuPre (2008) model:
  1. Community level; 2. Provider characteristics; 3. Characteristics of the intervention; 4. Organizational capacity; 5. Prevention support system
5.4.6: Adaptations

Adaptations to the PS intervention as recorded in the Energizers’ reflective journals (n=5) and Energizer questionnaire (n=5) were categorised as either innovation, drift or subversion. These adaptations, which are summarised in Figure 5.7 were implemented in response to teacher feedback or occurred as a result of the Energizers individual research focus within the larger PS team.

**Innovation**

"Skilled implementers actively attempting to make an intervention better fit"

- Multiple 5-10 minute activity breaks spread throughout the school day (All)
- Cross-curricular games (All)
- 'Active agent' - pupil responsible for reminding teacher of daily PA (S1 & S2)
- PA challenges e.g. Stride for 5 - leader board to motivate and monitor classes progress (All)

**Drift**

"Unintentional shortcomings, arising from barriers to implementation that deviate from the interventions core values and/or protocols"

- PS replacing PE - intervention delivered during PE time instead of in addition to PE (S2)
- Yoga (S3 & S4)

**Subversion**

"Implementers actively choose not to adopt aspects of the intervention which conflict with their values or theories of change"

- Energizers in S1 and S2 chose not to deliver the healthy eating component of PS in order to focus their efforts on FMS development (Energizer’s research focus)

Using the questions upon which the FRAME framework is based (Stirman et al., 2019), each adaption made to PS is further discussed in more detail below (Table 5.11 – Table 5.16).

**Table 5.11: Adaptation 1 - Shorter activity breaks**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>When did the modification occur?</td>
<td>During the implementation phase</td>
</tr>
<tr>
<td>Were adaptations planned?</td>
<td>Planned/reactive</td>
</tr>
<tr>
<td>Who participated in the decision to modify?</td>
<td>Teachers*, Energizers. *Teachers made the ultimate decision as to the format that worked best to implement activities with their class.</td>
</tr>
<tr>
<td>What was the goal?</td>
<td>Better integration of PS activities into teacher’s daily routine, considering limited available time.</td>
</tr>
<tr>
<td>What was modified?</td>
<td>Implementation activities – multiple 2-10 minute activity breaks were delivered throughout the day instead of one 20 minute PA block.</td>
</tr>
<tr>
<td>Level of delivery? (For whom/what was the modification made?)</td>
<td>Individual teachers</td>
</tr>
<tr>
<td>What is the nature of the modification?</td>
<td>Spreading (breaking up intervention content over multiple sessions throughout the day)</td>
</tr>
<tr>
<td>Fidelity to core components</td>
<td>Core components preserved</td>
</tr>
<tr>
<td>Reasons for modification</td>
<td>Organisation – Time constraints</td>
</tr>
</tbody>
</table>
In reaction to the time constraints expressed by teachers and the need to better integrate PS into part of the teacher’s daily routine, implementers (teachers and Energizers), in all schools, introduced multiple shorter activity breaks ranging from 2 to 10 minutes spread throughout the day as an optional strategy to accumulate extra daily MVPA. This innovation was viewed as a facilitator to intervention delivery by both teachers and Energizers, as shorter bursts of activity that could be used as brain breaks or as a transition between lessons were accepted as being more manageable than one 20 minute block of time.

“I found it hard to find the time to do the full twenty minutes. I found 5- or 10-minute breaks worked better” (Teacher, S3).

“Breaking activity up into smaller time slots was more successful” (Energizer, S2).

Table 5.12: Adaptation 2 - Cross-curricular games

<table>
<thead>
<tr>
<th>When did the modification occur?</th>
<th>During the pilot phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Were adaptations planned?</td>
<td>Planned/reactive</td>
</tr>
<tr>
<td>Who participated in the decision to modify?</td>
<td>Energizer, researcher, teacher</td>
</tr>
<tr>
<td>What was the goal?</td>
<td>Increase engagement; improve fitness</td>
</tr>
<tr>
<td>What was modified?</td>
<td>Content</td>
</tr>
<tr>
<td>Level of delivery? (For whom/what was the modification made?)</td>
<td>Individual teachers and child cohort</td>
</tr>
<tr>
<td>What is the nature of the modification?</td>
<td>Tailoring activities to cross over with curricular lessons</td>
</tr>
<tr>
<td>Fidelity to core components</td>
<td>Core elements preserved</td>
</tr>
<tr>
<td>Reasons for modification</td>
<td>Competing demands; time constraints</td>
</tr>
</tbody>
</table>

An innovation to the intervention used with varying frequency across schools were ‘Huff & Puff’ games, which integrated curricular subjects such as English, Irish and maths. These games aimed to help teachers overcome the curricular constraints and feeling of lost learning time by integrating traditional classroom-based lessons into ‘Huff & Puff’ games so that learning and exercise could happen simultaneously.

“Integrating with the curriculum really helped.” (Teacher, S3)

Students also reacted positively to the concept of cross-curricular games, as they felt they made the subjects more fun to learn and would help them to spend less time sitting at their desks during the day.
“Because you’re not sitting down, you’re being active and it’s fun and you learn more” (Student, S3)

“I think it would make the subjects more fun” (Student, S5).

Table 5.13: Adaptation 3 - Active Agent

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>When did the modification occur?</td>
<td>During the implementation phase</td>
</tr>
<tr>
<td>Were adaptations planned?</td>
<td>Planned/proactive</td>
</tr>
<tr>
<td>Who participated in the decision to modify?</td>
<td>Energizer, teacher</td>
</tr>
<tr>
<td>What was the goal?</td>
<td>Increase engagement</td>
</tr>
<tr>
<td>What was modified?</td>
<td>Implementation activities</td>
</tr>
<tr>
<td>Level of delivery? (For whom/what was the modification made?)</td>
<td>Child cohort and teacher cohort</td>
</tr>
<tr>
<td>What is the nature of the modification?</td>
<td>Adding elements</td>
</tr>
<tr>
<td>Fidelity to core components</td>
<td>Core elements preserved</td>
</tr>
<tr>
<td>Reasons for modification</td>
<td>Motivation &amp; readiness; increase compliance</td>
</tr>
</tbody>
</table>

In S1 and S2, an innovation to the intervention, and facilitator to implementation, was the appointment by the Energizer (with teacher’s consent) of two ‘active agents’ in the class each week. These ‘active agents’ were given responsibility to remind teachers to do the daily exercises to build towards the intervention goal of 20 minutes extra daily MVPA. These were identified by teachers in S1 and S2 as a welcome reminder, with some teachers also noting that the extra responsibility had a positive impact on the children, boosting their confidence and attitude towards PA.

“Great having girls who led and reminded teachers about the daily exercises” (Teacher, S2)

“Active agents were a great way of promoting PS throughout the week” (Teacher, S1)

“Some were exercise leaders in their classes which boosted confidence and energised their thinking” (Teacher, S2).

Both Energizers in S1 and S2 also identified the ‘active agents’ as facilitators to intervention delivery in their schools.
<table>
<thead>
<tr>
<th><strong>Table 5.14: Adaptation 4 – PS replacing PE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>When did the modification occur?</strong></td>
</tr>
<tr>
<td><strong>Were adaptations planned?</strong></td>
</tr>
<tr>
<td><strong>Who participated in the decision to modify?</strong></td>
</tr>
<tr>
<td><strong>What was the goal?</strong></td>
</tr>
<tr>
<td><strong>What was modified?</strong></td>
</tr>
<tr>
<td><strong>Level of delivery? (For whom/what was the modification made?)</strong></td>
</tr>
<tr>
<td><strong>What is the nature of the modification?</strong></td>
</tr>
<tr>
<td><strong>Fidelity to core components</strong></td>
</tr>
<tr>
<td><strong>Reasons for modification</strong></td>
</tr>
</tbody>
</table>

The intervention’s theory of change specifically states that 20 minutes MVPA should be delivered daily by the teacher/Energizer, outside of timetabled PE. The problem that arose when PS was scheduled as part of PE is that the stakeholders involved began to blur the lines between the two and ‘Huff & Puff’ became a part of PE instead of as a stand-alone activity, as it is intended.

In S2, and anecdotally during the first year of intervention in S1, the Energizers’ weekly slot with each class were during their scheduled PE time (due to limited access to the shared sports hall). This caused drift from the PS intervention’s theory of change, with teachers and students often confusing PS with PE and using the two terms interchangeably. Some even viewed PE as being outsourced to the Energizer and no longer part of their responsibility.

“**PE is outsourced and therefore teachers don’t view it as part of their remit**” (Energizer).

“**The kids like a change of teacher for PE**” (Teacher, S2).

“**I like doing PE with (Energizer)”** (Student, S2).

When asked what improvements could be made to PS, some teachers in S2 (n=3), suggested that PS only covers the games and athletics strands of the Irish PE curriculum and that it should branch out to include the gymnastics strand also.

“**Including gymnastics as it covers the athletics and games strands, but I would like it to cross over to gymnastics also. Other than that, it is an excellent project covering all aspects of the PE curriculum.”** (Teacher, S2)
Table 5.15: Adaptation 5 - Yoga

<table>
<thead>
<tr>
<th>When did the modification occur?</th>
<th>During the implementation phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Were adaptations planned?</td>
<td>Planned/reactive</td>
</tr>
<tr>
<td>Who participated in the decision to modify?</td>
<td>Energizer</td>
</tr>
<tr>
<td>What was the goal?</td>
<td>Improve fit with recipients</td>
</tr>
<tr>
<td>What was modified?</td>
<td>Content</td>
</tr>
<tr>
<td>Level of Delivery? (For whom/what was the modification made?)</td>
<td>Targeted child cohort</td>
</tr>
<tr>
<td>What is the nature of the modification?</td>
<td>Tailoring intervention activities</td>
</tr>
<tr>
<td>Fidelity to core components</td>
<td>Core elements changed</td>
</tr>
<tr>
<td>Reasons for modification</td>
<td>Social context; behavioural issues</td>
</tr>
</tbody>
</table>

Yoga was delivered by the Energizer in S3 and S4 to assist with class management, specifically to help with behavioural issues settling children in a classroom setting. While it is acknowledged that this activity was introduced to the intervention to assist an identified problem, yoga (light PA) does not align with the PS intervention theory which requires 20 minutes of moderate-vigorous PA. If implemented in addition to 20mins daily MVPA, then yoga is a welcome addition to PS, however, if it displaces daily MVPA, then this drifts from a core element of the intervention. If yoga was listed as an activity in the teacher PA log, it was not included in the teacher’s overall dose delivered for that month.

Table 5.16: Adaptation 6 – Omitting nutrition component

<table>
<thead>
<tr>
<th>When did the modification occur?</th>
<th>During the implementation phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Were adaptations planned?</td>
<td>Planned/proactive</td>
</tr>
<tr>
<td>Who participated in the decision to modify?</td>
<td>Energizer, researcher</td>
</tr>
<tr>
<td>What was the goal?</td>
<td>Improve outcomes (related to the research goal)</td>
</tr>
<tr>
<td>What was modified?</td>
<td>Content; contextual – format was changed</td>
</tr>
<tr>
<td>Level of Delivery? (For whom/what was the modification made?)</td>
<td>School level; individual Energizers</td>
</tr>
<tr>
<td>What is the nature of the modification?</td>
<td>Removing/ skipping elements</td>
</tr>
<tr>
<td>Fidelity to core components</td>
<td>Unknown</td>
</tr>
<tr>
<td>Reasons for modification</td>
<td>Researcher focus/preference; mission; time constraints; competing demands</td>
</tr>
</tbody>
</table>

The Energizer in S1 and S2 chose to omit the nutrition lessons from the PS intervention delivered, in order to focus intervention activities on the development of FMS, which was the Energizer’s research focus. Additional FMS specific activities were delivered in place of healthy eating lessons.
5.5 Discussion
The aim of this study was to explore the extent to which PS was delivered as intended across five intervention schools and examined the processes through which PS and each of the school contexts adapted to one another throughout the course of an academic year. Overall, the findings of this study highlight that simply delivering an intervention as described on paper is not straight forward. Across all schools, intervention fidelity was generally low with as few as 5.1% of teachers meeting the PS target of 20 minutes extra daily MVPA in November and only 16.4% meeting the target in May. Generally, the mean amount of extra daily MVPA that teachers managed to deliver in addition to PE varied between 10.39 and 16.22 minutes across schools. This represents roughly 50 – 80% of the prescribed PS intervention.

Naylor and colleagues, (2006) encountered similar issues with intervention fidelity, reporting that during the ‘Action Schools! BC’ intervention, teachers only managed to deliver on average two-thirds of the prescribed 15 minutes of additional daily PA. Similarly, Holt et al., (2013) reported that at the beginning and midpoint of the school year, only 40% and 4% of elementary school teachers in the Midwest met the requirements of a district mandated 20-minute daily PA policy in addition to PE and recess. However, despite low fidelity to the district policy five days per week, 60% of teachers successfully implemented the policy three days per week, suggesting that potentially an MVPA policy delivered 3 days per week would provide a more attainable target for schools (Holt et al., 2013).

Other PA intervention studies suggest amending the duration of the prescribed daily MVPA instead of the number of days, suggesting that 10-15 minutes additional daily MVPA would be an attainable and more sustainable target for primary schools (Naylor et al., 2006; Ryde et al., 2018). Based on the results of this study, it seems that prescribing 20 minutes every day may be overreaching and if the prescribed daily PA dose was closer to 15 minutes, intervention fidelity could be much higher.

In April, there was a significant peak in the mean amount of daily MVPA delivered by teachers, with 42.9% (junior =50%; senior =35.5%) meeting the PS target. This peak coincided with a 1km running challenge, which was a PS initiative in collaboration with a sports shoe brand. Energizers mapped a 1km route around each school and teachers were challenged to undertake this route daily with their class. The classes and teachers who were deemed by the Energizer to put in the most effort or improve their class time the most over the course of the
month were rewarded with entry into a lottery to win a prize courtesy of the sports brand partner. It was clear from the PA logs, questionnaire, and focus group data, that teachers found both the competition and the prize incentive of a PA challenge to be a facilitator to the overall PS intervention goal of delivering 20mins additional daily MVPA.

Other PA challenges undertaken as part of the PS intervention which implementers quoted as facilitating additional daily MVPA were the ‘Stride for 5’ and classroom-based Christmas themed challenge, the ‘12 Days of Fitness’. These findings support those of a systematic review by Barte et al. (2017) which reported that interventions that placed conditional reward incentives on total physical activity behaviour, including duration and intensity, have positively influenced PA levels and health outcomes in the short term (Barte et al., 2017). However, there is need for further research to investigate the long-term effects of reward incentives as currently it is unclear whether this strategy and the positive effects of incentives on PA behaviours are sustainable over time.

Despite Energizers modelling ‘huff and puff’ and/or healthy eating lessons for 20minutes once a week, teachers had autonomy on when and how they delivered PS every other day of the week. The overall MVPA dose delivered by teachers varied significantly across schools (p=0.024, n²=0.275) with S1 delivering the most extra daily MVPA (16.223 mins) and S3 delivering the least (10.386 mins). Given that a dose-response relationship exists between PA and its associated health benefits, specifically, improvements in health outcomes tend to increase in line with increased levels of PA, it is likely that schools who received a greater amount of extra daily PA (higher fidelity) would benefit from greater improvements in health outcomes than schools who demonstrated lower levels of fidelity (Foulds et al., 2014; Loprinzi et al., 2013; Williams, 2013).

Some of the teachers in S2 stated that they delivered PS as part of the compulsory one hour of weekly physical education time, which could offset the benefits of having PS as a stand-alone activity, as it is intended. Furthermore, the weekly time slot allocated to the Energizer in S2 was during scheduled physical education time, causing PS activities to replace physical education time instead of being delivered in addition to physical education. This ‘drift’ from the intended PS intervention caused some teachers to view physical education as being outsourced to the Energizer and no longer part of their remit. Children in S2 also started to
align PS activities with physical education, often describing their time with the Energizer as physical education time, instead of as an independent activity.

Similarly, in S3, the Energizer noted that some teachers viewed PA as being outsourced for the duration of the intervention and didn’t comply in their role as implementers of intervention activities on the remaining days of the week. Children in S3 supported this opinion commenting that they ‘only do Spraoi when the Energizer is here’. Balancing teacher autonomy with intervention fidelity presented a challenge across many schools, as Energizers struggled at times to get teachers to commit to deliver intervention activities, this inevitably reduced the amount of daily MVPA received by children. Previous research suggests similar findings with unsupportive school environments said to be related to poor implementation of school-based PA interventions (Masse et al., 2012; Naylor et al., 2006). For example, in a cross-sectional survey of 720 principals and teachers in Canada whose schools were taking part in a comprehensive school-based health promotion programme, which included implementing 15 minutes of PA each day, schools who reported greater levels of support from administrative staff, as well as teachers and parents, were two times more likely to implement the programme compared to those who reported lower levels of support (Masse et al., 2012).

An innovative adaptation to address this issue was the appointment by the Energizer, with consent from the class teacher, of an ‘active agent’ in the class each week, a student responsible for reminding the teacher of daily PA on the days when the Energizer wasn’t there. As well as providing a helpful reminder for teachers on the days when the Energizer was not there, this solution also empowered children to take a leadership role in intervention delivery. It has previously been reported that health promotion programmes and initiatives are most successful when pupils are given a central role in delivery (Day et al., 2019). For example, it was reported that pupils who were given leadership roles in the Food Dudes programme, valued the responsibility and encouraged their peers to participate (Day et al., 2019).

Another strategy that facilitated the delivery of PS was based on scheduling and helping teachers to establish a routine to implement PA at scheduled times during the day. For example, in some schools, the Energizer provided teachers with a PS activity timetable with short bursts of activity (<5 minutes) scheduled throughout the day. This schedule helped to establish a daily routine in the classroom, which integrated PA breaks in between curricular
subjects. This finding is consistent with that of Malden et al., (2019) who reported that some teachers delivering the ‘Daily Mile’ found establishing a routine to complete the run at a set time allowed them to better adopt the intervention as part of their school day.

Although a detailed outline of PS and the expectations of all involved was signed by school principals prior to the beginning of the intervention, policing of teacher fidelity became an issue throughout the course of the year in some schools. Outsourcing of physical education and/or PA was never the intention of PS, and yet some teachers viewed the introduction of a PA specialist into the school as an opportunity to step back from their role in delivering both daily PA and, at times, the PE curriculum. Support from principals and the senior leadership staff towards health promotion programmes in schools, has been reported to help sustain staff engagement and build an intervention’s capacity for creating positive and lasting change (Day et al., 2019). Therefore, it is crucially important that both the principal and the appointed lead PS teacher reinforce the delivery of intervention activities by all staff in the absence of the Energizer. It is also important that Energizers and class teachers maintain a collaborative relationship, in which teachers engage with, and are supported in their role as implementers, of PS.

Many factors influenced how PS was delivered and adapted in each unique school environment in order to achieve better contextual fit. These included each Energizer’s individual research focus and both the common and individual barriers and facilitators to PA posed by each school context. The duel responsibilities of each Energizer as both an implementer and a researcher of PS resulted in some variations to how the intervention was delivered across schools, as each Energizer’s implementation of PS was focused towards a specific research objective. In S1 and S2, the Energizers adapted the PS intervention by opting to forego the healthy eating stem of PS in order to focus intervention activities towards improving FMS, as this was their primary research objective. Meanwhile in S5, the Energizer implemented more healthy eating sessions than other schools as their research was focused toward improving children’s healthy eating habits. These variations in intervention delivery made comparisons of the impact of PS on children’s nutritional knowledge across intervention schools impossible, as the dose of healthy eating lessons delivered was too inconsistent to provide a fair evaluation. Instead, intervention schools could only be compared with their control school counterparts.
Despite their different contexts, three common barriers faced by all schools were: a lack of time in the school day, curriculum constraints and weather. As priority was generally placed on academic lessons across all schools, teachers sometimes felt under time pressure with the number of curricular subjects that had to be covered in a single day alongside implementing the additional 20 minutes daily PA. Many teachers expressed concerns over the potential negative consequences of lost learning time due to PS and the additional time pressures that PS created in an already overcrowded curriculum, a finding which is supported by studies of other school-based PA initiatives (Holt et al, 2013; Day et al, 2019). The PA logs alongside subjective comments collected via questionnaires and focus groups indicated that teachers struggled to deliver PA every day, noting that at certain times of the year academic lessons, exams and/or events including school shows and preparation for religious celebrations took priority. This finding aligns with historic reports that increasing focus on academic achievement decreases PA opportunities in schools (Howie et al., 2012).

In order to overcome this inherent contextual barrier and ease teachers’ concerns over existing curricular time constraints, some Energizers adapted their delivery of PS to include a variety of cross-curricular games. Studies have shown that implementing PA within the traditional academic curriculum increases daily energy expenditure (Holt et al., 2013) and enhances academic achievement in elementary school students (Howie et al, 2012). Therefore, this adaptation was deemed innovative and was identified by both teachers and Energizers at two schools as a key facilitator to the delivery of daily MVPA. However, despite evidence that PA can have a positive effect on measures related to academic performance (Rasberry et al., 2011; Howie et al., 2012; McPherson et al, 2018), there are also contrasting studies which have demonstrated a stronger association between academic achievement and sedentary time than with PA (Dumuid et al., 2017; Maher et al., 2016). These conflicting findings highlight the fact that at present, not enough is known regarding the optimum balance of sedentary time and PA for academic performance. However, with academic achievement under constant scrutiny, providing evidence to assess whether PS promotes cognition and supports academic performance could assure teachers that the time they invest in daily PA would produce additional educational benefits. Future evaluations of PS or similar school-based PA interventions should therefore consider incorporating measures of academic performance into their design.
Similar to other school-based PA interventions, weather and the availability of facilities and equipment were identified as influential factors in the implementation of PS. Lack of appropriate clothing was also identified as a barrier in poor weather with some teachers referring to the fact that some children did not have a rain jacket or appropriate footwear to exercise outside in the rain. These findings are consistent with other school-based PA interventions (Ryde et al., 2018). Unsurprisingly, weather had a greater effect in the four schools who identified their access to facilities as barriers to PA. It was clear from the PA logs that school 4, who had the best facilities of the five schools evaluated, including a large indoor multisport hall and all-weather pitch in addition to a large yard and playground, were able to deliver greater levels of daily MVPA during the winter months (Table 5.3). Furthermore, in contrast to other schools, teachers in school 4 identified their access to on-site facilities as facilitators to PS, enabling implementation of intervention activities regardless of adverse weather conditions.

Overall, teacher’s attitude towards PS was positive and the intervention was widely praised by all stakeholders. Following ‘Huff and Puff’ activities, almost three quarters of teachers (72.4%) reported that their students were more attentive in class. In addition, most teachers (91.3%) agreed that as a result of PS, they were more aware of the importance of PA, and 64.4% of teachers agreed that they were more aware of the importance of healthy eating. Although every teacher experienced limited time and curricular pressures as a barrier, some teachers prioritised the intervention and delivered it despite these constraints, perhaps because of the value they placed on it (Naylor et al, 2015). For teachers, the immediate visible benefits of PA in refocusing and re-energising the children appeared to be of importance and may contribute towards teachers’ continued delivery of PS beyond the intervention period. Similar findings were reported by Holt et al. (2013) who evaluated the effect of a 20-minute PA policy in primary school children in the United States of America. Teachers in this study also noted positive classroom behaviour immediately after the PA had been implemented. Whilst longer term health outcomes such as improved fitness or improved body composition might be desirable to policy makers, the acute effects of PS may be more important to encourage continued participation in the intervention by teachers.
5.5.1 Strengths and limitations

One strength of the current study is that, unlike many other studies, it refers to a large amount of interview data containing the perspectives of a diverse range of primary agents involved in intervention delivery. The contribution of a diverse range of stakeholders, including Energizers, teachers and children allowed for the evaluation of PS from multiple perspectives and to triangulate findings. Triangulation using multiple data collection tools to measure the same evaluation dimension complimented with the contributions of multiple stakeholders, has been reported to improve the reliability and trustworthiness of findings (Shenton et al., 2004). In addition to presenting the diverse range of challenges faced when attempting to implement health promoting changes in school settings, our study also presents recommended strategies for overcoming the barriers identified and specific recommendations for future school-based health promotion programmes.

Similar to Holt et al., (2013) and Griffin et al., (2014), a limitation of this study was the inconsistent completion of the PA log by teachers. While the majority of teachers returned completed logs regularly (74%), overall completion of the logs was at times erratic and we cannot determine the extent of implementation of the intervention or the types of activities, if any, of those teachers who did not return the PA log or who returned logs with incomplete data. In addition, although this study included the contributions of many stakeholders in the school context, a limiting factor was the omission of parent’s perspectives. Their perspectives could provide important additional insights for the development of primary school-based health promotion programmes in the future.

5.6 Conclusion

Overall, the findings of this study help to bridge the gap between research and practice by providing data to aid interpretation of the outcomes of a primary school-based health promotion intervention and also to explain potential variances between schools. The individual research focus of the Energizer, the varying degrees of fidelity among teachers and the uniqueness of each school context resulted in much variability in how PS was delivered and received by key stakeholders across the five intervention schools. Furthermore, the importance of identifying barriers to intervention which has become increasingly prevalent in the literature is again highlighted here (Schneider et al, 2009; Naylor et al., 2015; Dyrstad et al., 2018). Future researchers should take into consideration during the planning stage of
complex interventions in a school context, the barriers identified in this study and similar studies which may inhibit implementation in order to pre-empt potential pitfalls throughout the course of the school year. Indeed, the insights gained from this study will also aid in optimising the continued delivery and expansion of PS in the future.
Chapter 6: Discussion & Implications for Future Research
6.1 Introduction
The aim of this study was to evaluate the processes by which PS achieves its intended effects in context. This included examining how PS was implemented and the extent to which it was delivered as intended across intervention schools (implementation fidelity), and identifying the contextual factors that facilitated or acted as barriers to the implementation of intervention activities. Secondary aims included delivering a step-back approach to PS over the course of three years, to examine its sustainability and evaluate the moderating role of the Energizer on pre-specified health outcomes among a child cohort. This information is crucial in the translation of outcomes and the transfer of PS, as a research intervention, into real-world practice.

The purpose of this chapter is to summarise the key findings of this study and detail the practical implications of these findings in order to provide recommendations for future research; including a proposed framework for planning and implementing comprehensive process evaluations. These considerations for future researchers are based on the learnings of the tailored methodology for process evaluation of the PS intervention, described earlier in this thesis (Chapter 3). The considerations outlined for future process evaluation in a primary school setting described in this chapter are segmented into four key distinct, but related, stages of the intervention process, (i) Pre-intervention planning (section 6.4), (ii) intervention design (section 6.5), (iii) active intervention monitoring (section 6.6), and (iv) post intervention evaluation (section 6.7).

6.2 Summary of findings
In terms of how the intervention was implemented, a key finding of this study was the significant variability observed in how PS was delivered across schools. Chapter 5 outlined the significant differences in the daily PA dose delivered by teachers across schools (p=0.024, n²=0.275), with S1 delivering the highest amount of extra daily MVPA (16.223 mins) and S3 delivering the least (10.386 mins) (section 5.4.1). There were also variances in the quantity and perceived quality of nutrition content delivered by Energizers across schools with S5 delivering the most nutrition-based lessons and S1 omitting its delivery in order to focus efforts, instead, on improving FMS (Table 5.6 & Figure 5.5). In addition, the weekly Energizer contact time varied across schools, with S1 and S2 having two contact days per week with each class (2x20min Huff & Puff), while the other schools only had 1 contact day with each
The findings of this study suggest that decreased Energizer contact can have a significant impact on student’s PA levels, with 2 days better than 1, and 1 day better than none (Chapter 4). Based on this, it is conceivable that children in S1 and S2 may have been more active than other schools due to increased Energizer contact, and less reliance on teachers to deliver intervention activities.

Throughout the course of the intervention several challenges were encountered which inhibited the delivery of PS. A key barrier shared by all schools was curriculum constraints due to the overcrowded Irish primary school curricula; with teachers required to deliver 11 different subjects. All stakeholder groups (Energizers, teachers and children) recorded that the cramped curriculum contributed greatly to the second key barrier; a lack of time in the school day. Bad weather, coupled with a lack of classroom space and inadequate access to suitable facilities for indoor exercise, also presented a barrier to intervention delivery; particularly during the first half of the academic year.

In addition to the challenges faced by the school context, a number of factors that facilitated the implementation of PS were also identified. Some of these facilitators emerged as a result of mutual adaptation of intervention activities and the school to each other. These included the support of the Energizer, routine, curriculum integration, PA challenges and breaking the 20minute PA block down into shorter activity breaks, spread throughout the day (section 5.4.5).

The secondary objectives of this study were to evaluate the sustainability of PS through a step-back approach to intervention delivery. The findings reported in chapter 4 suggest that PS has lasting effects, with a step-back approach to PS shown to positively influence children’s health with significant decreases in BMI (junior cohort), BMI z scores (both cohorts), and CRF (senior cohort) observed over the course of a three-year intervention (section 4.4.1). The findings of this study also indicate that PS can have lasting positive effects on student’s PA levels, with the children in both junior and senior cohorts found to be significantly more active at intervention end in year three, compared to baseline (prior to the introduction of PS) (section 4.4.2). However, it was notable that after an initial increase during the first year of PS, the MVPA levels of both the junior and senior cohorts decreased over the course of year 2 and 3 of the intervention. Although this pattern could have been partly attributed to novelty
bias (Persaud et al., 2019), it was also likely that the step-back approach to intervention played a role, as the linear decrease in MVPA aligned with the reduced Energizer contact each year. Although the Energizer was largely praised as the main facilitator to PS, interestingly, in year three of the step-back approach, in which the school had no Energizer contact, most teachers (8/11) identified the “lack of Energizer contact” as a barrier to intervention delivery. Furthermore, when the Energizer no longer had a presence in the school, it was noted that the intervention was no longer prioritised. This aligns with the literature, which has shown that lack of effective and sustained leadership from a programme coordinator often results in programmes not being prioritised and staff not being encouraged to use programme resources (Day et al., 2019).

Finally, perhaps one of the main findings of this study, were the learnings taken from the development and implementation of a robust process evaluation methodology which was first rigorously piloted in school A before being expanded to all intervention schools in the following year. A key output of these methods was the design and use of a spider-gram based on the three themes for process evaluation outlined by Moore et al., (2015) to visualise and support the planning of process evaluation methods (Chapter 3). The practical implications of these learnings for future researchers will be described throughout the rest of this chapter.

6.3 Implications for future research
Introducing complex interventions such as multi-component health promotion interventions into a primary school setting, a context which itself is widely recognised for its complexity, is likely to expose an almost infinite number of uncertainties which no evaluation may ever be able to explain completely (Moore et al., 2019; Keshavarz et al., 2010). Unlike many trials, which are delivered under ideal and controlled research conditions, school-based interventions are subject to the influence of real-life factors; many of which are out of the control of the researcher but can affect the implementation and overall study’s outcomes. Schools have been described as complex adaptive systems in the literature (Keshavarz et al., 2010) because the individual agents (e.g. students, teachers) within the system are dynamic, extremely interactive and adaptive. The interactions of these agents, alongside other contextual school factors, can influence how interventions are implemented (Clarke, 2010; Moore et al., 2019).
In recent years, more research has emerged highlighting the impact of context and the variability in implementation of PA interventions across schools, even when schools are located within close proximity of one another (Marchant et al., 2020; Avitsland et al., 2020). This variability not only challenges the comparability of intervention outcomes across schools, but also the overall interpretation of outcomes to assess the effectiveness of the intervention itself (Avitsland et al., 2020). Indeed, when the outcomes of a school-based intervention are not as expected, researchers are often left to ponder whether the unexplainable results were as a result of poor intervention design or poor implementation.

As described in the introduction to this chapter, the following sections outline the considerations for implementing a process evaluation methodology for future researchers, based on the learnings from PS. These are discussed in four stages; (i) pre-intervention planning, (ii) intervention design, (iii) active intervention monitoring, and (iv) post intervention evaluation.

6.4 Pre-intervention planning
Based on the learnings from PS, the findings indicate that process evaluation should be part of the earliest discussions in the planning phase for new interventions. However, choosing a process evaluation methodology can be challenging, given the wide range of almost indistinguishable frameworks and methodologies reported in the literature (Moore et al., 2015). If one takes a broader view of process evaluation, it typically includes measures of how the intervention was implemented and what contextual factors influenced implementation.

6.4.1 Mapping your methods
A key output of this study (Chapter 3) was the design of a spider-gram to illustrate the planning of process evaluation methods using the three themes for process evaluation identified by Moore et al., (2015): (i) implementation, (ii) context and (iii) mechanisms of impact (Figure 3.3). This mapping exercise can act as a useful starting point for future researchers in the pre-intervention planning phase to identify the necessary evaluation dimensions, suitable data collection tools and relevant stakeholders to be included in their process evaluation methodology. It also allows researchers to visualise the linkages between the relevant process evaluation dimensions, data collection tools and stakeholders to allow for triangulation of data, which has been reported to improve the trustworthiness of findings (Griffin et al., 2015; Shenton et al., 2004).
When mapping out a process evaluation methodology, the findings of this study recommend segmenting the three themes into 6 evaluation dimensions including fidelity, dose, adaptations, barriers and facilitators, activities and interactions. Although each of these three themes for process evaluation can be defined and measured in a variety of different ways, in this study implementation was defined using the evaluation dimensions identified by Linnan and Steckler (2002) (fidelity, dose and reach). However, the number of people who engage with or participate in the intervention (reach) may not always be a necessary measure in school-based research. In the case of PS, and similarly the ‘HEALTHY’ study conducted by Schneider et al., (2009), the planned intervention was delivered using a whole-school approach, whereby students and/or individual classes were not given the opportunity to opt out of intervention activities. Therefore, the ‘reach’ evaluation dimension was deemed to be fixed because the intervention was delivered to all students through changes to the school environment (Schneider et al., 2009). Researchers should consider when mapping out their process evaluation methodology whether or not the reach evaluation dimension will be fixed throughout.

Following the agreement of dimensions to be evaluated, suitable mixed methods tools and relevant stakeholders to be included in the data collection process need to be identified. Available resources should be a key consideration in the selection of data collection tools and the number of stakeholders to be targeted (O’Cathain et al., 2019). Process evaluation requires ongoing evaluation throughout the course of the intervention, which is demanding of researcher’s time and so selecting methods that meet the researchers’ available resources, while maximising the quality and not quantity of data collected, is an important consideration that shouldn’t be overlooked. In this study, quantitative methods were used to examine pre-specified intervention hypotheses relating to implementation of key intervention activities (Grant et al., 2013). For example, PA logs were used on an ongoing basis to quantify the amount of extra daily PA delivered by teachers, in order to examine whether the intervention (20mins extra daily MVPA) was being delivered as intended (Grant et al., 2013). Meanwhile, qualitative methods such as focus groups and interviews were selected as more flexible tools for examining facilitators and barriers to implementation, unexpected outcomes and participant’s interactions with intervention activities (Schneider et al., 2009).
6.4.2 Understanding the school context

In the last decade the integral role of process evaluation in the study of school-based interventions has been highlighted. Process evaluations of school-based interventions are beginning to be reported more regularly and this data can provide researchers with a useful basis on which to plan future interventions. When consulting the literature in the planning stage prior to intervention design, the findings from this study recommend that future researchers should identify the factors associated with successful implementation and those that hinder implementation (section 5.4.5), as well as the contextual factors which facilitate and limit schools as settings for intervention (section 2.6.6).

Considerations such as time constraints due to the pressures of fulfilling a crowded curriculum should be top of the list when it comes to planning new interventions. In this study, all stakeholder groups (Energizers, teachers and students) in PS recorded that the crammed curriculum contributed greatly to the second key barrier; a lack of time in the school day (Table 5.9). Indeed, 70% of teachers expressed the view that the time pressures created by the already crammed curriculum, preparation for standardised tests and other school events, left little time in the school day to deliver extra daily PA. This finding supports that of Marchant et al., (2020) and the systematic review conducted by Naylor et al., (2015) who reported that time constraints was the most frequently (23/29 studies) noted barrier that influenced implementation of PA interventions in schools. Griffin et al., (2015) also highlighted the effect that time constraints has on the evaluation component of the intervention with the ongoing requirements of the process evaluation data collection in particular becoming, at times, burdensome for schools. The findings from this study support the recommendation by Griffin et al., (2015) that process evaluation data collection tools should be used to maximise impact; while minimising any burden on teachers and school staff. This can be achieved through condensing tools like PA logs and questionnaires to a single A4 page, or using online/digital versions that do not create additional paperwork for teachers.

In their review of school-based PA interventions, Naylor and colleagues (2015) identified 20 factors that could limit implementation of school-based PA interventions. Although limited time was the most frequently mentioned factor, this was followed closely by a lack of resources, lesson scheduling and weather. Similarly, in this study, bad weather, combined with limited access to suitable facilities for indoor exercise, also presented a barrier to intervention delivery, particularly during the first half of the academic year (section 5.4.5).
Students noted that bad weather prevented them from going outside to exercise, while teachers elaborated to explain that due to a lack of classroom space and limited access to an indoor hall, bad weather made PS more difficult to implement. Several studies have found relationships between different weather variables and children’s PA (Atkin et al., 2016). Rainfall has been associated with decreased activity (Duncan et al., 2008; Bélanger et al., 2009; Harrison et al., 2011; Goodman et al., 2012; Harrison et al., 2015). For example, Harrison and colleagues analysed a sample of English children aged 9-10 years old (n=1,794) and found they undertook almost 15 min less MVPA on the wettest days compared to days with no rain (Harrison et al., 2015). Interestingly in PS, weather was more prevalent as a barrier to PS in the four schools who identified their lack of facilities as a barrier also. Furthermore, the school who identified their access to facilities as a facilitator to the intervention (S4) reported being more capable of delivering additional PA than most of the other schools during the winter months, when the weather was at its poorest (Table 5.3).

Given the influence of these barriers to implementation, the outcomes from a school-based cluster randomised controlled trial (RCT) like PS may, therefore, have more to do with the influence of the specific school context than the intervention itself.

6.4.3 Profiling the school setting and practices
The individuality of schools as settings for intervention makes them challenging research settings. Contextual factors identified in this study such as time and curricular constraints, access to suitable facilities and resources, and teacher engagement, allow much potential for variability in how interventions are delivered (Chapter 5) and, as mentioned in the previous section, this can influence overall outcomes of the intervention itself. Indeed, in the longitudinal study of PS described earlier in this thesis (Chapter 4), the need to conduct an in-depth process evaluation was primarily motivated by a lack of understanding of the control school context and the activities undertaken by the control cohort, which made it difficult for the previous researcher to interpret and explain results (Delaney et al., 2015). To overcome these challenges, future researchers should consider profiling all interested school’s individual settings prior to recruitment into the intervention, to identify and understand each school’s context; including any potential barriers and/or facilitators, health promotion activities/initiatives they are involved in and their practices in relation to PA and PE. In PS, this was achieved through a school stock take survey of available facilities and resources to catalogue the physical setting and a PA and nutrition profile questionnaire (described in
section 3.3) to understand each school’s individual practices in relation to the delivery of weekly PA and PE, nutrition lessons, and any other initiatives running in the school related to health promotion (Appendix C).

In section 5.4.4, data from the school profiles revealed that the control cohort had access to superior facilities than the intervention cohort (Table 5.1) and that at the end of the school year there were no significant differences in the amount of weekly PA and PE delivered in the control versus intervention schools. Although it was hypothesised that the intervention cohort would receive a greater dose of weekly PA than the control cohort as a result of intervention activities, this did not turn out to be the case because the control school teachers delivered additional PA weekly outside of PE as part of their standard school routine and overall school ethos toward PA and health. In addition, three of the intervention schools (School 3, 4 and 5) were involved in another health promotion initiative; ‘Food Dudes’, which is an initiative that encourages children to make healthier food choices (Table 5.7). This means that any improvements in children’s nutritional knowledge and behaviours in these schools may not be directly attributable to PS, as we do not know the extent to which the ‘Food Dudes’ intervention may also have influenced outcomes.

In addition, the school stock take survey revealed that one intervention school (S4) had access to considerably better facilities than the other intervention schools (Table 5.1) and when surveyed this was identified by both teachers and the Energizer as an enabling factor which facilitated the delivery of intervention activities. Meanwhile all other intervention schools identified a lack of facilities as a barrier to the PS intervention (Table 5.10). This aligns with the findings of Avitsland et al., (2020) who suggested that school’s access to suitable facilities could be used as a pre-determinant of their likelihood to successfully implement a PA intervention. Consequently, the findings of this study support the literature (Avitsland et al., 2020) and reinforce the need to document each school’s contextual characteristics and understand their working practices and school priorities prior to recruitment into the intervention. This data can then be used to help inform the final intervention design.

6.5 Intervention design
In this study, the design of the PS intervention was based on the proven methodology of the PENZ intervention. In lieu of any process evaluation data from PENZ, the PS research team relied on training and ongoing communication with the PENZ team throughout to understand
how the intervention was to be delivered and to address any challenges faced (Chapter 3). The absence of process evaluation data from PENZ is an inherent weakness of that intervention. Best practice suggests that careful consideration is needed in the development of complex interventions so that new interventions have a better chance of being effective when evaluated and being adopted widely in the real world when the research phase has ended (O’Cathain et al., 2019).

6.5.1 RCT versus matched pairs
Once interested schools are identified and profiled as described in section 6.4.3 above, future researchers should consider the study design and what methods will be used to recruit relevant intervention and control schools. Although randomised control trials (RCTs) are regarded by many as the gold standard for evaluating the effectiveness of public health interventions (Moore et al., 2015), they may not always be the most suitable intervention design format for school-based research (Avitsland et al., 2020). The causal interpretations from RCTs are founded on outcome comparisons between an intervention group and a control group and are contingent on randomisation in the selection of the evaluation sample to eliminate differences in any observed or unobserved variables between the groups (Kendall, 2003). Cluster RCTs including PS (Copping et al. 2016), often use inclusion criteria such as size, geographic location, demographics and socio-economic status during the intervention design phase to identify and group suitable schools to participate in the intervention prior to randomised selection (Dron et al., 2021). However, as previously mentioned, the findings from this study indicated that a variety of contextual factors including access to facilities and school practices in relation to the provision of weekly PA and PE varied greatly between schools and these caused systematic differences which limited the comparability of outcomes between the intervention cohort and the control cohort (section 5.3.1 and 5.4.4) (Durlak and Dupre, 2008). To avoid these contextual differences, Avitsland et al., (2020) has advocated for a matched pairs design in school-based research, using predefined contextual inclusion criteria such as facilities and available resources to recruit and pair suitable schools who are more likely to be capable of accommodating a PA intervention. The view of Avitsland et al., (2020) is that certain schools limited ability to implement intervention activities was predetermined from the outset based on contextual factors such as access to facilities and that researchers cannot expect an outcome to change if the intervention school is unable to accommodate the intervention.
The approach recommended by Avitsland et al., (2020), which suggests only including schools deemed capable of accommodating the intervention, could improve the interpretation and comparability of outcomes because it would likely result in fewer implementation differences between schools. However, this approach would also reduce the representativeness of the included schools and the generalisability of any outcomes to the wider population (Avitsland et al., 2020). To overcome this challenge, instead of using available facilities as inclusion criteria to recruit schools, the findings of this current study suggest that these contextual factors be used to group schools into tiered clusters. In this format, schools deemed to have the most favourable attributes that may pre-determine successful implementation in terms of access to facilities and resources, teacher engagement and school policies and practices toward PA and health be included in a comparative evaluation in the top tier. Schools with fewer favourable contextual attributes could then be evaluated comparatively in a lower tier(s). If comparative evaluations between intervention and control schools were restricted to within the boundaries of each tier, then this would likely level the playing field between matched intervention and control schools, with fewer implementation differences which would allow for easier interpretation of results. This format could also assist researchers in identifying the true impact of contextual factors on outcomes, by identifying any significant variances in the effectiveness of the intervention between tiers.

Ultimately, if an intervention is to be generalisable to the wider population, then the research needs to be fully inclusive of all schools and utilising a tiered system based on contextual factors could allow researchers to confidently interpret the results of a comparative analysis and distinguish the effectiveness of the intervention across tiers; making recommendations accordingly.

6.5.2 Stakeholder involvement
The intervention design process should be ‘dynamic, iterative, creative, open to change and forward looking to future evaluation and implementation’ (O’Cathain et al., 2019, p.2). This process is often shifting with researchers going back and forth between reviewing evidence, drawing on existing theory and consulting with relevant stakeholders. The rationale for involving relevant stakeholders from the start, and indeed working closely with them throughout, is that due to their experience and familiarity with working or learning in their individual school context, they can help researchers to identify priorities, understand the challenges and help find innovative and workable solutions that may make a difference to
future implementation of the intervention on a wider scale in the real world (NIHR INVOLVE, 2018).

In practice, even when researchers are adopting a proven intervention, (as was the case with PS which was based on the internationally recognised PENZ), it is recommended that these pre-defined approaches are applied flexibly to new contexts taking into consideration the views and needs of local stakeholders (O’Cathain et al., 2019). Indeed, engaging the relevant stakeholders of the new intervention, including the intervention practitioners, teachers, school staff, and even participants (students and parents) in the design phase can improve the feasibility and acceptability of the resultant approach (O’Cathain et al., 2019). As previously mentioned (section 6.4), the individuality of schools, even those located within close geographic proximity can introduce significant variability and so it is important that stakeholders are consulted and that the intervention is designed to meet their individual school needs in terms of available resources and facilities, and that the intervention aligns with their school ethos and priorities in order for it to have a better chance of being adopted and implemented successfully.

During the intervention design phase of PS, as described in Chapter 3, the Energizer (who had joint responsibilities as both the interventionist, researcher and evaluator) undertook a needs analysis focus group with school staff, which identified priority areas of improvement relating to PA and nutritional habits for each recruited school (Coppinger et al., 2016). As described in Chapter 3 (section 3.3), this bottom up approach resulted in the development of a tailored action plan which was unique to each school. Although the core components of the PS intervention were mandated by the research team, consideration was given during the stakeholder consultation to tailor the intervention to make it more synergistic with each schools’ priorities, goals and processes (Sport Waikato, 2011). For example, in school A described in Chapter 4, a key priority of the school identified during the needs analysis was to deliver the PS intervention with minimal disruption to the school day and curricular class time. The resultant action plan developed and agreed by the teachers in school A in collaboration with the Energizer was to integrate the mandated 20 minutes of additional daily MVPA, where possible, within curricular subjects. This motivated the Energizer to work with teachers and school staff to develop a PS games resource for cross-curricular activities, a sample of which is available in Appendix E. At regular intervals the content of the intervention was
continuously evaluated and adapted if necessary; based on reflections and feedback from participating schools. Each school’s programme was flexible and unique in its design, with the aim of the intervention being tailored not only to meet the needs of each individual school, but also the interventionist (Energizer) throughout the delivery process.

Although PS was based on PENZ, and used similar intervention and evaluation material, a key difference was that the PS intervention and evaluation were research driven, in that each Energizer also acted as a postgraduate researcher and focused their study on a specific outcome in more detail (such as improving FMS) to that of the original PENZ programme/evaluation. This tailoring of intervention delivery in the design stage to support the Energizers’ research focus, essentially resulted in each school receiving different interventions, and at times this resulted in the omission of core intervention components which limited the comparability of outcomes (section 5.5). Ultimately in this study the integrity of the larger PS intervention evaluation was compromised, as any comparative analysis between all five schools was limited by the significant differences in the content and dose delivered. Future research should therefore aim to utilise stakeholder consultation to tailor the interventions’ components to their specific schools’ needs and context, whilst still adhering to the intervention’s overall theory of change. This consideration will be further discussed in section 6.6.2.

6.6 Active intervention monitoring
Unlike impact evaluation which normally includes the measurement of pre-defined outcomes at the beginning and end of the intervention, an effective process evaluation requires frequent ongoing data collection throughout the course of the intervention (Moore et al., 2015). This allows researchers to track the intervention’s implementation in individual schools and classrooms throughout the school year, identifying how the intervention is being delivered, received, and adapted by stakeholders and what contextual factors affect it at different points. Despite moderate to low fidelity, in this study ongoing use of PA logs by teachers revealed encouraging signs that PS was gradually being adopted more effectively into each teacher’s daily routine throughout the course of the school year, with the mean amount of daily MVPA delivered by teachers reported to have significantly increased by 6.76 minutes (p=0.000, $n^2=0.57$) between November and May (section 5.4.1). While this progressive increase over time was likely attributable to the mutual adaptation of
intervention activities to the school context, we must also consider that the increase could be attributed to the different seasons, with better weather more likely in May than November, which could provide greater PA opportunities (Atkin et al., 2016; Harrison et al., 2015). Consequently, the findings of this study advocate that future researchers should plan to conduct ongoing monitoring of the intervention throughout, as otherwise notable changes to implementation, context, or stakeholders’ attitude toward the intervention may be missed, and this could limit the interpretation and translation of outcomes at a later stage. To facilitate the need for ongoing monitoring of the intervention process, the findings of this study advocate for involving the researcher in the implementation process and utilising their close proximity to the intervention to document the process on an ongoing basis throughout the school year. This will be discussed further in the next section.

6.6.1 Involving the researcher in the implementation process

Similar to the action research methods used in the ‘Health Promoting Schools of the Future’ initiative (Bartelink et al., 2018), PS achieved its effects through embedding a researcher in the intervention, who simultaneously carried out the duties of the Energizer, researcher and evaluator (Bartelink et al., 2018; Waterman et al., 2000). As a result, evaluation was no longer merely an external observation of the PS strategies to implement health promoting changes but indeed the research became one of the intervention strategies itself, with each Energizer’s research focus clearly reflected in how they delivered PS in their respective school(s). As highlighted by Bartelink et al., (2018), the attitude of the researchers in an action research approach is different because they are no longer neutral and fully objective, but join teachers and school staff in the discussions around the implementation process and give support to the teachers whenever possible on the basis of their professional knowledge, skills, and experiences, as well as the results of the monitoring data (Patton, 2011). Central to the successful implementation of PS was the positive impact that the Energizer had on both teachers and students across all schools as a facilitator of intervention activities. Notably, the perceived high-quality delivery of intervention activities by the specialist PA interventionist and their responsiveness to the needs of not only the individual school but also the individual classes distinguished them as an invaluable resource to the intervention and set PS apart from other health promotion initiatives.

What emerged as a result of the close proximity between the Energizer (researcher) and school stakeholders in PS was a highly adaptable intervention, which quickly responded to
the ever-changing needs of the participating schools, individual teachers, and students. Indeed, the ongoing monitoring and feedback loops, including relevant stakeholders, allowed the Energizer to both support and evaluate the process of change during the active intervention phase (Bartelink et al., 2018). Based on these experiences from PS, future researchers should consider embedding a suitable researcher into the active intervention phase to facilitate and support intervention delivery and evaluation.

6.6.2 Monitoring adaptations
As described in Chapter 2 (section 2.2.3), understanding what, how, and when modifications occur is a vital aspect of the intervention evaluation because the process of implementing complex interventions is dynamic and ever changing in fast paced settings such as schools (Chambers et al., 2013). Adaptations to interventions may occur for a variety of purposes with differing implications on implementation and outcomes (Stirman et al., 2019). Some innovative adaptations may enhance outcomes, particularly if they more closely align the intervention with the needs of the school. In fact, modifications that focus on increasing the fit of the intervention with the individual school setting can lead to improved stakeholder engagement, acceptability, and outcomes (Stirman et al., 2019). However, adaptations that drift from or remove core components of an intervention, or fail to align with stakeholders needs, may be less effective (Kumpfer et al., 2020).

In the case of PS, this study identified innovative adaptations that facilitated implementation and included breaking the 20 minutes daily MVPA down into multiple shorter activity breaks, integrating cross-curricular activities, establishing PS as part of a daily routine, organising PA challenges and the appointment with the teacher’s consent of an ‘active agent’ each week (a student responsible for reminding their teacher to complete daily PA). These successful adaptations, which are discussed further in Chapter 5 (section 5.4.6), were made midway through the intervention as a result of ongoing feedback and discussion between the Energizer and the teachers/school staff to overcome significant barriers such as curricular time constraints. The implications of these adaptations were a positive change in teachers’ attitudes toward the intervention and, in some cases, an increase in the PA dose delivered. Less effective adaptations, such as the intervention PA component ‘Huff & Puff’ replacing PE, and omitting nutrition content, compromised core components of the intervention, which had negative implications on outcomes and the comparability of schools (section 5.4.6).
To date, inconsistent reporting of adaptations has resulted in uncertainty regarding their impact, if any, on implementation and resultant changes to health outcomes. This lack of data further complicates researchers’ understanding of the extent to which interventions can be adapted but still remain effective (Baumann et al., 2017). During the active intervention phase, future researchers should plan to document all adaptations to both the content and delivery of the intervention; including the reasoning behind the adaptation and the relevant stakeholders who were involved in the decision to adapt (Stirman et al., 2019). As was successfully implemented in PS (Section 5.4.6), this data, coupled with ongoing qualitative feedback from stakeholders on the implications of the adaptation, will allow future researchers to understand which types of modifications can maximise implementation success if the intervention is expanded to a wider context in future (Baumann et al., 2017; Stirman et al., 2019).

6.7 Post intervention evaluation
Although impact evaluation can tell us if the planned intervention is effective, PS supports previous research (Moore et al., 2019) and has shown that more importantly, process evaluation allows researchers to explain why and how an intervention was successful or not in achieving its’ intended outcomes. In this study, strategies such as the weekly support of a PA specialist (Energizer), integration of additional PA into the curriculum through the provision of cross-curricular games, utilising shorter activity breaks instead of a full 20-minute PA block and empowering children through the use of an ‘active agent’ were identified as practical solutions that facilitated the delivery of PS (section 5.4.5 & 5.4.6). Consequently, if we consider the purpose of school-based health promotion research as a means to advocate for effective and workable real-life strategies to promote physical activity and healthy habits in children, one could argue that the data from a process evaluation, which enables researchers to understand what factors are associated with successful implementation, and linking these to outcomes, could be considered more valuable than the measured impact of the intervention alone on pre-defined outcomes.

6.7.1 Linking implementation with outcomes
According to Moore et al., (2015), in addition to reporting how an intervention was implemented in practice, post intervention evaluations should aim to link process evaluation measures with outcomes to determine why and how an intervention was effective in achieving its results. This does not necessarily involve strict comparisons of fidelity and dose,
but instead is based on the idea that in a specific context small changes may produce large effects on outcomes (a ‘tipping’ point) (Patton, 2011; Van Kann et al., 2015), and that better implementation of a change (higher fidelity) does not always guarantee greater effect (Moore et al., 2015). Particularly in schools with a low baseline level of PA and little prior involvement in health promoting initiatives, small changes can have significant and lasting effects. In PS, intervention fidelity was moderate to low, with as few as 5.1% (n=3) of teachers meeting the intervention target of 20 minutes extra daily MVPA in November and only 16.4% (n=10) meeting the target in May. Generally, the mean amount of extra daily MVPA that teachers managed to deliver in addition to PE varied between 10.39 and 16.22 minutes across schools. This represented roughly 50-80% of the prescribed PS intervention. However, based on the literature, it seems expecting perfect or near-perfect implementation of an intervention is unrealistic (Holt et al., 2013; Naylor et al., 2006). Indeed, positive results have often been obtained by interventions with implementation levels around 60% and generally few interventions have attained implementation levels greater than 80% (Holt et al., 2013; Durlak and DuPre, 2008). Despite PS schools only implementing between 50% and 80% of the prescribed intervention, positive results were observed in the prevalence of overweight and obesity among children involved in PS, as well as a wide range of health markers including waist circumference, cardio-respiratory fitness, PA levels, fundamental movement skills and dietary behaviours of Irish primary school children (O’Leary et al., 2018; Bolger et al., 2018; Merrotsy et al., 2018). While we could consider that a dose-response relationship exists, and more pronounced results might have been achieved if greater levels of fidelity were exhibited across PS schools, contextual factors may pre-determine and limit a school’s capacity to implement the intervention fully (Avitsland et al., 2020). Therefore, perhaps more importantly, future researchers should aim to identify the individual ‘tipping point’ for the implementation of the intervention in each participating school. This data would allow schools to understand the minimum level at which the intervention needs to be implemented as intended to achieve its intended effects, in a specific context.

6.7.2 Feasible fidelity
The findings of this study, identified that multiple adaptations were made to PS throughout the course of its implementation (section 5.4.6.). In support of the current literature, the findings from this study recommend that during the post intervention evaluation, adaptations made to the implementation of intervention components must be examined to ensure that
they align with the theory of the intervention and do not conflict with intervention fidelity (Hawe et al., 2004). Baumann et al., (1991) suggested that there is a range of ‘feasible fidelity’ within which varying levels of adaptations are made without affecting an intervention’s core component(s), as well as a point of ‘dramatic mutation’, at which point the intervention is no longer recognisable or effective. Although many of the adaptations identified during this study were deemed to be positive innovative modifications, which facilitated implementation and contextual fit, the omission of the nutrition component and the replacement of PE by ‘Huff & Puff’ could be considered less effective ‘dramatic mutations’ (section 5.5). While schools should be afforded the freedom and flexibility to adapt interventions during the implementation phase to achieve better contextual fit, the post intervention evaluation should assess the implications of any documented adaptations to intervention components on implementation and resultant outcomes. Based on this assessment, recommendations should then be made to (i) highlight innovative adaptations that may assist future implementation and (ii) clearly define the extent to which core components can be altered without reaching a point of dramatic mutation, whereby the intervention is no longer effective.

6.8 Strengths & Limitations
The main strength of this study is its contribution to the literature of process evaluations of school-based interventions, both in Ireland and abroad. The lessons learned during the rigorous piloting and expanded implementation of process evaluation methods during this study formed the basis for the practical recommendations for future researchers, outlined earlier in this chapter. These considerations, accompanied with the spider-gram mapping tool (Figure 3.3.) that was designed during this study, will provide future researchers with a set of ‘building blocks’ with which they can construct future evaluations of their own. It is hoped that these tools will encourage future researchers to consider process evaluation as an integral part of future interventions and improve the quality of reporting.

Another strength of the current study is that, unlike many other studies, it refers to a large amount of qualitative data containing the perspectives of a diverse range of primary agents involved in PS. The contribution of a diverse range of stakeholders, including Energizers, teachers and children allowed for the evaluation of the intervention from multiple perspectives and the triangulation of findings. Triangulation using multiple data collection
tools to measure the same evaluation dimension, complimented with the contributions of multiple stakeholders, improves the reliability and trustworthiness of our findings (Griffin et al., 2015; Shenton et al., 2004). In addition, this triangulation allowed the study to portray a full picture of how the PS intervention was both delivered and received from the perspectives of stakeholders at different levels, which had positive implications for the delivery, interpretation of outcomes and future recommendations for PS as a workable intervention going forward into the real-world.

Thirdly, in line with recommendations from the literature which suggest that process evaluation must move beyond simple measures of acceptability and fidelity, this study also included detailed contextual information (Langford et al., 2015). Good contextual fit occurs when implementers, recipients, and other stakeholders (e.g. parents, teachers), identify an intervention as acceptable, doable, effective, and sustainable in their local setting (Hayes et al., 2019). In addition to presenting the diverse range of contextual barriers faced when attempting to implement PS in the primary school setting, this study also presented several innovative adaptations and specific recommendations for future school-based health promotion programmes. These strategies can be used as a guide to facilitate the implementation of future school-based health promotion initiatives.

A limitation of this study is that a detailed process evaluation was not planned from the outset and so there was a need to plan and pilot methods during the active intervention phase in year 2 of the intervention implementation in school A (Chapter 3). This was because the need for an in-depth process evaluation emerged organically during the study following unexplained improvements in the control cohort and the previous researcher’s inability to interpret results after year 1 (Delaney et al., 2015). Although the delayed implementation of a process evaluation methodology in year 2 and year 3 allowed the researchers to gain much needed insights into the school context, intervention implementation, and its related outcomes, the lack of process evaluation data from the first year of intervention created gaps which limited the overall interpretation of results in the longitudinal data set described in chapter 4. One could also speculate that if a robust process evaluation had been planned in advance and implemented from the outset in PS, contextual barriers could have been identified earlier and minimised through innovative adaptations, leading to better implementation and, perhaps, more successful outcomes.
A second limitation of this study was the reliability of the self-report data used. It must be noted that while teachers were instructed to complete PA logs weekly to the best of their ability throughout the active intervention phase to monitor dose delivered, the accuracy of reporting, due to the self-measure nature of the logs, is not known. Similar to Holt et al., (2013) and Griffin et al., (2015), a further limitation to using PA logs was the inconsistent completion of the PA log by teachers. While the majority of teachers returned completed logs regularly, overall completion of the logs was at times erratic and we cannot determine the extent of implementation of the intervention or the types of activities, if any, of those teachers who did not return the PA log or who returned logs with incomplete data.

Lastly, although this study included the contributions of many stakeholders in the school context, a limiting factor was the omission of parents’/carers’ perspectives. Their perspectives could provide important additional insights for the development of primary school-based health promotion programmes in the future. Given that the school is only one of the Microsystems that a child interacts with daily, the insights of parents/carers could highlight the ability of the intervention messages to infiltrate into children’s home environment and what behavioural changes, if any, occur as a result. Therefore, understanding changes in children’s home environment, community or any of their other Microsystems, and how they interact with the intervention at school could further aid the interpretation of the impact of outcomes (Gubbels et al., 2014).

6.9 Conclusions
The overall findings from this research suggest that when interpreting the results from a complex school-based intervention like PS, the data from the process evaluation represented an invaluable tool to aid the interpretation of results, particularly when there was significant variability in the implementation process. Certainly, the findings of this study have helped to bridge the gap between research and practice for PS by providing data to aid the interpretation of the outcomes, explain potential contextual and implementation variances between schools and suggest workable strategies to facilitate the intervention’s successful implementation and wide-scale adoption in future.

Traditionally, process evaluations have been under reported in the literature, with many school-based RCTs focused on attempting to answer the question ‘what works?’. However, through combining an RCT with a robust process evaluation, this study has shown that
researchers are equipped to answer ‘why and how PS worked?’ and importantly ‘under what circumstances was PS effective?’ The rigorous piloting of methods for process evaluation undertaken as part of this study, culminated in the design of an easy to use tool for planning future process evaluations and also informed a practical set of guidelines for future researchers to follow. Therefore, this study provides a meaningful contribution to the literature which will not only support future researchers to plan simple, yet, robust process evaluations of their own, but will assist them in designing and reporting more workable intervention strategies that are feasible for real-world adoption and large-scale implementation.


Danielzik, S., Czerwinski-Mast, M., Langnase, K., Dilba, B., and Muller, M.J., (2004) “Parental overweight, socioeconomic status and high birth weight are the major determinants of overweight and obesity in 5-7 y-old children: baseline data of the Kiel Obesity


Duncan, S., White, K., Mavoa, S., Stewart, T., Hinckson, E., & Schofield, G., (2016) “Active Transport, Physical Activity, and Distance Between Home and School in Children and


Wedderkopp, N., Weston, K.L., Yin, Z., Zhixiong, Z., Lonsdale, C., del Pozo cruz, B., (2021), “School-based interventions modestly increase physical activity and cardiorespiratory fitness but are least effective for youth who need them most: an individual participant pooled analysis of 20 controlled trials”, *British Journal of Sports Medicine*, (Published Online First), http://dx.doi.org/10.1136/bjsports-2020-102740


Larouche, R., Saunders, T. J., Faulkner, G., Colley, R., & Tremblay, M, (2014) “Associations between active school transport and physical activity, body composition, and...


Martin, R. and Murtagh, E. M. (2015) 'Preliminary findings of Active Classrooms: An intervention to increase physical activity levels of primary school children during class time', Teaching and Teacher Education, 52, 113-127. ISSN: 0742-051X, http://dx.doi.org/10.1016/j.tate.2015.09.007


McKenzie, (2015) “SOFIT (System for Observing Fitness Instruction Time – Description and Procedures manual”, School of Exercise and Nutritional Sciences San Diego State University, [online], available:


Stewart-Brown, S. (2006) “What is the evidence on school health promotion in improving health or preventing disease and, specifically, what is the effectiveness of the health promoting schools’ approach?”, Copenhagen, WHO Regional Office for Europe,


Wanner, M., Martin, B.W., Autenrieth, C.S., Schaffner, E., Meier, F., Brombach, C., Stolz, D., Bauman, A., Rochat, T., Schindler, C., Kriemler, S., Probst-Hensch, N, (2016) “Associations between domains of physical activity, sitting time, and different measures of overweight and obesity”, *Preventive Medicine Reports*, 3, 177-184, ISSN 2211-3355. [https://doi.org/10.1016/j.pmedr.2016.01.007](https://doi.org/10.1016/j.pmedr.2016.01.007)


European-Region countries and the impact of effective interventions: a modelling study”, *BMJ Open* 4, e004787, [http://dx.doi.org/10.1136/bmjopen-2014-004787](http://dx.doi.org/10.1136/bmjopen-2014-004787).


Appendix A: Memorandum of Understanding and Needs Analysis
A.1 Memorandum of Understanding

Project Spraoi Memorandum of Understanding

between

School A

and

Cork Institute of Technology, provider of Project Spraoi

Aim: To confirm our commitments to the goals of Project Spraoi and outline expectations, roles and responsibilities.

Background

Project Spraoi is aligned to the goals of the Exercise & Health Research Cluster in Cork Institute of Technology (CIT) and in so doing aims to improve children’s overall health; through the promotion of physical activity, health eating and a reduction in sedentary time. A key element is thorough evaluation.

Objectives

Healthy Eating

▪ To encourage and promote water as the best drink
▪ To encourage the consumption of milk and other high calcium foods every day
▪ To encourage an increase in fruit and vegetable consumption
▪ To advocate for and encourage a reduction in the amount of high energy/low nutrient food
▪ To encourage and advocate for an increase in availability of healthy choices at school and decrease in availability of high energy/low nutrient foods
▪ To increase the awareness of the importance of breakfast and encourage a breakfast habit
▪ To work towards consistent nutrition messages in all aspects of school

Physical Activity

▪ To encourage a minimum of 20 minutes quality daily physical ‘huff and puff’ activity
▪ To advocate for and encourage organised lunchtime physical activity at least twice a week
▪ To encourage and advocate for at least five minutes of ‘home play’ every day
▪ To encourage a reduction in sedentary time especially screen time if over two hours a day
▪ To raise awareness of incidental activity opportunities at home and school
▪ To raise awareness of the importance of children learning fundamental movement skills and movement literacy
Whole School Approach

Project Spraoi involves a ‘whole school approach’ that works towards developing an ethos and environment that supports learning and promotes health and wellbeing for all. The programme consults and encourages participation of all within the wider school community.

This includes:
- Principal, teaching staff and Board of Management commitment
- Involvement of whole school community in policy development
- Celebrating achievement
- Working in partnership with parents/guardians/family and the local community
- Giving pupils greater responsibility in the school
- Addressing staff health and well being
- Improving the school environment
- Working in partnership with external agencies
- Planning and delivery of a programme that meets the needs of all pupils

School A are committed to a one year trial of Project Spraoi from September 2014 to September 2015.

The amount of resources offered to schools will be relative to identified needs and capacity and commitment of the school. On-going process and outcome evaluation of the programme will be carried out as required by Cork Institute of Technology.

Project Spraoi agrees to the following responsibilities:

1. Each Project Spraoi school will have an Energizer assigned to their school as a key contact. Typically, the Energizer will spend no more than one day per week in the school in this the second year of the intervention.

2. The Energizer will be able to share best practice and innovative ideas from all schools involved in the project.

3. Energizers are available to support schools and school communities with any initiatives that will lead to long term sustainability of increased physical activity and improved healthy eating.

4. It is expected that Project Spraoi will become an integral part of the school.

5. There will be a focus on assisting each school to take ownership of their own plans and initiatives.

6. Energizers will act in a number of roles, they may be:
   - Catalysts
   - Facilitators
   - Coordinators
   - Ideas people
   - Strategists
   - Negotiators
   - Project supporters
7. Energizers will provide an annual written and oral report outlining achievements to the Principal.

8. Energizers understand that a schools’ action plan is a flexible document and can be modified or expanded as required. Schools are able to determine the scope of their Spraoi plan and make decisions about priorities each term. Each school owns their plan.

9. Energizers are members of the Exercise and Health Research Cluster at CIT and are postgraduate researchers. In the event of an Energizer leaving CIT a replacement Energizer will, where feasible, be appointed to the school.

The school agrees to the following responsibilities:

1. The Principal and the Board of Management support and endorse the school’s involvement in Project Spraoi by signing this agreement.

2. To appoint a lead teacher who will work closely with their Energizer.

3. Schools are also encouraged to set up a ‘working group’ with representation from teachers, support staff, parents and children.

4. Taking part in a needs analysis that involves teachers and students.

5. All teachers, board members and parents have the opportunity to attend a Project Spraoi information session.

6. To develop in conjunction with their Energizer, an action plan, and a term by term implementation plan. The content of such a plan will be determined by the physical activity and nutrition needs of the school, their children, teachers and the wider school community. The implementation plan will be supported by Spraoi.

7. Over time to take ownership of the goals of Project Spraoi and work towards sustainable policies and procedures where physical activity and healthy eating are a part of the school culture.

8. To work towards using a ‘whole school approach’ with a focus on the sustainability of Project Spraoi goals and outcomes.

9. To provide adequate time and resources for their teachers to implement the Project Spraoi action plan effectively. This would include, as required:
   - Meetings in school
   - Time at staff meetings
   - Workshops for all teachers
   - Time for planning programmes and developing physical activity and nutrition opportunities

10. To support the key messages and goals of Project Spraoi as specified on page one.
11. To support the standardised components of Project Spraoi, such as tip sheets, nutrition nuggets (newsletter snippets) and home play tasks

12. To support regular professional development of teachers. Professional development will be delivered at no cost to the school by the Energizer or other trained presenters recruited by Project Spraoi. Professional development could be delivered to large or small groups and could take place after school, before school, lunch time or during teacher release times. The Energizer is also able to work with individual teachers on modelling sessions to support and enhance teacher’s skills and confidence.

13. To support the initial collection of baseline data in September/October 2014 and follow up data in May/June 2015

**Evaluation**

Participation in the school-based components of Project Spraoi would be seen as normal school activities. The information collected will not be identifiable to individual children and can be gathered within the context of the school day.

*Evaluation may involve:*

- All children in senior infants and fourth class being asked to participate in a 550m run.
- All children in senior infants and fourth class being asked to have their height, weight, waist and upper arm circumference, blood pressure, and a measure of body fat (through specialised scales) taken.
- Some/All children in first and fifth class being asked to wear an activity monitor for seven days in order to monitor levels of physical activity.
- Questions to principal/lead teacher on different topics including: knowledge and attitudes of teachers, school’s nutrition and activity resources, transport to and within school, curriculum, canteen/shop and the availability of after-school activities.
- Teacher interview & physical activity profile to assist in school programming.
- Food and Drink Survey to be sent home and completed by parent/guardian.
- Questionnaires to all school stakeholders (students, principal, teachers, school support staff, parents/guardians, members of the Board of Management) to aid in the process evaluation.

**Thank you for your participation!**

Please sign below if you agree to the terms outlined above

Signed (Principal)………………………………………………………………………………….Date………………………………..

Signed (Energizer)………………………………………………………………………………..Date………………………………..

Signed (CIT supervisor)………………………………………………………………………….Date……………………………….
A.2 Intervention Schools Needs Analysis Survey

**NEEDS ANALYSIS**

**NUTRITION**

What do we do well?

What would we like to improve on?

What else can I do to help you?

© This resource was developed by Sport Wales 2012.
PHYSICAL ACTIVITY

What do we do well?

What would we like to improve on?

What else can I do to help you?
A.3 Action Plan for 2014/15 intervention

Action Plan for School A

The proposed structure of this Project Spraoi study is as follows.

The new Energizer will be a ‘consultant’ for the school and will deliver elements of the intervention on a less regular basis than the previous Energizer. The Energizer will come into the school once per week, to every class, to deliver elements of the intervention; physical activity and nutrition.

Physical activity (Huff n' Puff)

- Develop a Project Spraoi resource package for teachers
- Incorporate the huff n' puff games into the PE curriculum
- Get teachers to identify what element(s) of the PE curriculum they do not feel confident in delivering. Energizer will then look to assist or organise workshops to upskill teachers.

Sedentary behaviour

- Provide pupils with after school physical activity challenges as homework

Nutrition

- Deliver the presentations to parents
- Deliver a presentation on food labelling
- Update the healthy eating policy in the school
- Focus on restricting sugary drinks in the school and encourage pupils to drink more water and milk
- Change current practice of providing unhealthy foods as a prize for pupils
Appendix B: Parent/Guardian Consent Forms and Information Sheets
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 teacher’s 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 first/fifth 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, physical fitness 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 30 minutes and will be carried out during school time, with their class teacher present.
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 2014 (October 2nd & 3rd) and again in June 2015. We will notify you the dates of the measurements in June 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 your child takes good care of them.

Will the information collected be 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 very much for taking the time to read this.
B.2 Impact evaluation: Consent Form for Parent/Guardian 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:
Yvonne O’Byrne   Joan Dineen & Tara Coppinger
Researcher   Supervisors
Dept of Sport, Leisure & Childhood Studies,     Dept of Sport, Leisure & Childhood Studies,
Cork Institute of Technology     Cork Institute of Technology
E: yvonne.obynne@mycitt.ie   E: joan.dineen@cit.ie   E: tara.coppinger@cit.ie
Dear Parents/Guardians,

As you know, during the 2013/14 school year, Cork Institute of Technology, in conjunction with Scoil Bhailenóra worked together on a research project called “Project Spraoi” and are continuing to do so in 2014/2015. Your child played a vital role in the project, which is investigating if a school based health promotion intervention can improve healthy lifestyle habits in children.

As part of this project last year, you were asked to sign a consent form stating that you agree to your child participating in the following:

- Having their height, weight, waist circumference, blood pressure, physical fitness and body fat measurements taken. These measures took about 30 minutes to complete.
- Answering a short questionnaire on physical activity and food awareness.
- Wearing an accelerometer for 7 days, during all waking hours with the exception of when swimming or bathing.

We would like to invite your child to participate in Project Spraoi again this year. This would involve a repeat of the same measurements being taken on two separate occasions, just like last year; once in October 2014 and again in June 2015. All physical measurements will be carried out during school time, with their class teacher present and will be kept confidential. You may also be asked to complete a short parent questionnaire.

The procedure will be very similar this year and if you are happy for your child to continue to participate in this project, you do not need to reply to this communication. If you do wish to withdraw your child from participation in the project, or if you did not consent last year and wish for your child to be included this year, please contact Yvonne (Project Coordinator for 2014/2015) before Thursday 2nd October 2014.

Thanking you in advance,

Yvonne O’Byrne

Yvonne O’Byrne

Dept. of Sport, Leisure & Childhood Studies,
Cork Institute of Technology,
Bishopstown,
Cork.

Email: yvonne.obyrne@mycit.ie
Parent/Guardian Information Letter

Student focus groups - We value your child’s voice

As you know, since October 2013, Cork Institute of Technology, in conjunction with Scoil Bhailenóra, have been working together on a research project called “Project Spraoi,” and are continuing to do so in 2014/2015. Your child plays a vital role in this project which is investigating if a school-based health promotion intervention can improve healthy lifestyle habits in children.

Project Spraoi is currently being evaluated to determine its feasibility in Cork primary schools. As part of this evaluation, we are carrying out informal focus groups with a randomised sample of students to gauge their unique viewpoint and feedback on Project Spraoi. Your child is a key stakeholder in Project Spraoi and as such, his/her feedback is invaluable to the future development of this health promotion intervention.

“By paying attention to children, exploring their meaning-making in physical activity in an attempt to understand what motivates them to be physically active, we may stand a better chance of meeting their needs, thus combating physical inactivity” (Patton et al, 2013).

What is involved?

Your child is one of two students from his/her class that has been randomly selected to take part in an informal focus group with a Project Spraoi coordinator, “Energizer”, from another Cork primary school. Project Spraoi coordinators are Garda vetted and have received ethical approval from Cork Institute of Technology. Students will be asked to give feedback on their enjoyment of the different components of Project Spraoi and suggest any improvements that they think could be made to the project in the future.

Focus group sessions will be recorded using a voice recorder for data collection purposes. All data collected will be confidential and stored securely in a restricted access office. Individual students will be anonymised using coded name labels for the purpose of data collection. Data collected will be used in an MSc thesis with the hope of being published in scientific literature at a later date.

What do I need to do?

If you are happy for your child to participate in this focus group, please fill out and return the attached consent form. If you have any queries or would like to find out more about Project Spraoi, you can find contact details on the attached consent form.

Thank you for taking the time to read this
Parent/Guardian Consent
(Complete if you are a parent, caregiver or relative and you consent to your child taking part in this evaluation).

As a parent/caregiver of ____________________________ (child’s name),

I hereby consent to my child taking part in this evaluation.

Signed: ____________________________________________

Child Consent
(Complete if you are the child and if you wish to take part in this evaluation)

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: __________________________

If you require further information please contact:
Yvonne O’ Byrne
Researcher
Dept. of Sport, Leisure & Childhood Studies,
Cork Institute of Technology
E: yvonne.obyrne@mycit.ie

Tara Coppinger, Joan Dinneen
Supervisors
Dept. of Sport, Leisure & Childhood Studies,
Cork Institute of Technology
E: joan.dinneen@cit.ie  E: tara.coppinger@cit.ie
Appendix C: Process Evaluation Data Collection Tool
This Appendix will include blank templates of the process evaluation data collection tools used throughout this study. As these tools were piloted during the preliminary study (2014/15), some of the templates included in this appendix will have multiple versions, which evolved throughout the course of the pilot study in response to stakeholder feedback.

C.1 Physical Activity Logs

The PA log was first introduced to School A towards the end of the first year of intervention (2013/14) by the previous researcher (Delaney et al., 2015). Despite poor completion rates reported by Delaney et al., (2015), this first version was again used for the first month of evaluation in (November 2014), as a trial, with feedback sought from the lead teacher after the first four weeks.

Feedback from teachers on version 1 of the PA log:

- Unsure if meant to write the PA duration in minutes or clock time, for example 10:00 -10:20.
- Forget to complete every day and sometimes can’t remember the exact times.
- Need clarification on what ‘other’ activities might include.

Feedback from Energizer:

- Need a name/room number in addition to class to identify the teacher.
- All teachers completed the logs in the first two weeks but then compliance decreased.

In response to this feedback, the PA log was revised. The second version of the tool was prepared and administered to teachers in December 2014. Feedback was again sought from the lead teacher following consultation with other class teachers after 4 weeks at the end of January.

Feedback from teacher on version 2 of the PA log:

- Takes too long to complete everyday
- Would prefer not to have to put name on sheets as they are collected in post box in staff room and don’t want to feel ‘judged’ by colleagues.
- Is a digital version possible? Some teachers prefer to do all their paperwork online.

Feedback from Energizer on version 2 of the PA log:

- It would be useful to know if children have had yard time. The school yard doubles as a church carpark so some days due to church services or bad weather children don’t get to go to yard, reducing daily PA opportunities.

In response to this feedback, the PA log was again revised. The third version was designed to minimise completion time by using a ‘tick the box’ style. To anonymise logs, each teacher was assigned a unique code, for example ‘WC1’ which was printed on the bottom corner of their log sheets. A Microsoft excel version of the log was also made available for those who preferred to fill in digitally (3/11 teachers). This version was well-received by all teachers and so it was agreed that this version would be used for the remainder of the evaluation in school A and rolled out across all intervention schools (n=5) in the expanded study the following year (2015/16).
# Spraoi in your classroom!

Please fill in the duration of each category for each day of the week.

<table>
<thead>
<tr>
<th>Class:</th>
<th>Dates:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fitness i.e. Huff n’ Puff</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Notes/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td>Physical Education</td>
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</tr>
<tr>
<td>Other (please specify)</td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fitness i.e. Huff n’ Puff</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Notes/Comments</th>
</tr>
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<td>Physical Education</td>
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<tr>
<td>Other (please specify)</td>
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<td></td>
</tr>
</tbody>
</table>
C.1.2 PA log template 2

### ‘Spraoi in your classroom’

**Teacher Name:** ________________________________

**Class:** ____________________ **Date:** ________________

Enter duration in minutes of daily physical activity (PA) delivered in the relevant box below.

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Monday PA (mins)</th>
<th>Tuesday PA (mins)</th>
<th>Wednesday PA (mins)</th>
<th>Thursday PA (mins)</th>
<th>Friday PA (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sport/Games</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes/Comments:**

__________________________________________________________________________________________
### Weekly Physical Activity Log Sheet

**Week Ending: ____________**

<table>
<thead>
<tr>
<th></th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration (mins)</strong></td>
<td>5 10 15 20</td>
<td>5 10 15 20</td>
<td>5 10 15 20</td>
<td>5 10 15 20</td>
<td>5 10 15 20</td>
</tr>
<tr>
<td>Huff and Puff</td>
<td>Tick the box</td>
<td>Tick the box</td>
<td>Tick the box</td>
<td>Tick the box</td>
<td>Tick the box</td>
</tr>
<tr>
<td>Learning Games</td>
<td>am pm</td>
<td>am pm</td>
<td>am pm</td>
<td>am pm</td>
<td>am pm</td>
</tr>
<tr>
<td>Activity Breaks</td>
<td>yes mins</td>
<td>yes mins</td>
<td>yes mins</td>
<td>yes mins</td>
<td>yes mins</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

_Yard_  
am pm am pm am pm am pm

_Parental Education_  
Comments

---

*Huff and Puff = Project Spraoi Games*  
*Activity Breaks = 5min brain breaks e.g. Just Dance/Bizzy Breaks/Go Noodle*

*Learning Games = Cross Curricular Physical Activities*  
*Other = GAA practice, cross country, external activity coordinator*

WC 1
C.2 Draw and write
During the pilot study, the current researcher also acted as the Energizer in school A and so it was deemed a conflict of interest for the Energizer to conduct the draw and write data collection as their presence might unintentionally influence children to respond favourably. As a solution, it was decided that it would be more convenient for each class teacher to deliver the activity as a classroom task at a time that was suitable. To prepare, teachers were each briefed individually on how to deliver the task (C.2.1) and were supplied with a clear set of instructions (C.2.2).

When the study was expanded in the following year (2015/16), the current researcher administered the task to all evaluation classes across five different schools to ensure consistency. As the researcher did not have any role within these schools (S1-S5), she was not familiar to the student’s participating, and so was not perceived in this circumstance to pose any potential for bias in children’s reporting.
Draw and Write - Teacher Information

Visual methods place children at the centre of the research process (Clark, 2011) as research moves away from being collect on children to a consideration of research being collected with children (Ryan, 2008).

Draw and write is an inclusive tool for classroom-based research in health education, enabling even the youngest children to participate and contribute their views and unique perspective on Project Spraoi. Its resemblance to a classroom activity makes it most useful in a primary school setting.

The draw and write technique invites participants to draw and then write about a given statement/topic. Children should be reassured that this is not a test and that there are no right or wrong answers. If children are not confident in their ability to write or draw, they can be reassured that these drawings will not be put up for display nor will they be made available for anyone else in their class to see and a “spelling holiday” can be granted for the duration of this task.

It is important that children do not feel coerced into participation. Children should be given the freedom to choose whether or not they wish to consent to take part in the task and reassurance that there will be no punishment for non-participation. An alternative task should be set for those that do not wish to participate.

The draw and write method gives children a platform to express their own unique perspective on the world that they live in. Their views and feedback are of the upmost importance to the Project Spraoi research cluster.

If you are happy for your class to participate in this task, please sign the attached class teacher consent form.
C.2.2 Protocol for administering the Draw & Write

Directions for Administering the Draw and Write task

For the purpose of controlled data collection, it is important that the task is implemented in the same way in every classroom setting, without leading or unintended prompting. The task should be administered in the following order:

1. **Introduce the task** – “Today we are going to draw about Project Spraoi. I want everyone to take a minute now to think about what Project Spraoi means to you.”

2. **Reassure that this is not a test** – “There are no right or wrong answers. You can draw anything you like, and you can be as creative as you want.”

3. **This is an individual task** - When you’re drawing, I want you to work on your own and think about what you would like to draw. Keep your work private from your desk partner and work by yourself. I want you to draw what Project Spraoi means to you in the box on the page provided. You can use any colours/pens/crayons that you like.”

4. **Don’t worry about your ability level** – “These drawings are not going to be put up on display and nobody else in the class will see your drawing so don’t be too worried about what your drawing looks like. Just try your best.”

5. **Write about what you’ve drawn** – “When you have finished your drawing, you can write a sentence or two about it on the lines at the end of the page. Don’t worry about your spelling, we are going to have a “spelling holiday” for this activity so again just try your best but don’t worry if you can’t spell everything right.”

6. **Consent** – “This is an optional activity. You don’t have to participate if you do not want to. It is up to you to decide. If you do not want to participate you can do another activity instead.” Assign a different activity that will be seen as neither a punishment (extra maths) nor a reward (playtime/start their homework early). “Raise your hand if you want to participate in the Project Spraoi drawing activity.

7. **Hand out activity sheets to all with raised hands.**

8. **Name** – When you have finished your drawing. I would like you to write your name on the back of the page.

9. **Collection** – Collect all sheets. Randomly select two sheets from the pile, until you have one girl’s drawing and one boy’s drawing in your hands. These two children will take part in the focus group with a Project Spraoi “Energizer” from another school. Give these two students a parental consent form to take home and sign if they wish to participate. If the parents do not consent, randomly select a third drawing, select a girl’s drawing to replace a girl, etc.

Place all drawings and completed consent forms back into the supplied envelope.

Thank you
Project Spraoi – Process Evaluation: Draw and Write

Teacher Informed Consent

(Complete if you are a class teacher and you consent to (a) your class participating in this evaluation and (b) administering this activity to your class).

As a class teacher of ____________________________________________ (class),

I hereby consent to my class taking part in this evaluation.

Signed: _______________________________________________________

(Please circle the appropriate answer)

I have fully read the attached teacher information sheet                               yes               no
I understand my role in administering this activity to my class                     yes               no
I have closely read and followed the directions given to me                          yes               no
I have not consciously influenced or prompted any child’s drawing             yes               no
I have not coerced participation from any student who did not want
or was hesitant to participate in this activity                                                      yes               no

Teacher Signature:

Sign: _________________________________________ Date: __________________________

Please fill in the following after administering the draw and write activity to your class:

Number of children in your class: _____________
Number of absentees: _____________
Number of students that refused consent: __________
Total number of drawings collected: _____________
C.2.4 Draw and write activity sheet

What Project Spraoi means to me

...
### C.3 Child interview questions

#### Focus Group Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>Process evaluation dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Draw &amp; Write Questions</strong></td>
<td></td>
</tr>
<tr>
<td>1. Last week you drew a picture about Project Spraoi. Can you tell me about your picture?</td>
<td>• Visual aid to encourage talk and break down any power-imbalance</td>
</tr>
<tr>
<td>2. Who are the people in your drawing? (If there are people in the drawing)</td>
<td></td>
</tr>
<tr>
<td>3. In the drawing, how do you and/or the people in the drawing feel? (If there are people in the drawing)</td>
<td></td>
</tr>
<tr>
<td>4. When do you take part in this activity? (If it is an activity)</td>
<td></td>
</tr>
<tr>
<td>5. Why did you choose to draw this activity?</td>
<td></td>
</tr>
<tr>
<td><strong>Spraoi Games &amp; Nutrition lessons</strong></td>
<td></td>
</tr>
<tr>
<td>6. How do you feel when it is time for Project Spraoi games and healthy eating lessons with your teacher and/or (Energizer name)?</td>
<td>• Interactions</td>
</tr>
<tr>
<td>7. How do you feel after Project Spraoi games?</td>
<td>• Interactions</td>
</tr>
<tr>
<td>8. How do you feel after Project Spraoi healthy eating lessons?</td>
<td>• Interactions</td>
</tr>
<tr>
<td>What activities/games does (Energiser) do with you? What do you think of these?</td>
<td>• Activities</td>
</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
| 9. | **What nutrition lessons does (Energizer) do with you?**  
What do you think of these? |
| 10. | **Do you think you eat and drink healthier because of Project Spraoi?** (Yes – what sort of things do you do now to eat/drink healthier? No – why?) |
| 11. | **Do you enjoy the learning games? E.g. maths games. Would you like if you were able to learn more (English/Irish/History/etc.) while being active and playing games?** (Yes –Why?) |
| **School environment & Project Spraoi feedback** |   |
| 12. | **What opportunities do you have at school to be physically active?** |
| 13. | **Do you think you get enough exercise during school?** |
| 14. | **Does your teacher do Project Spraoi games or other games on the days that (Energiser) isn’t there?** (why do you think this is?) |
| 15. | **Would you like if your teacher did Spraoi games with your class more often?** How often do you think you should do activities? |
| 16. | **What activities/games does your teacher do with you?** What do you think of these? |
| 17. | **What is your favourite thing about Project Spraoi?** |
| 18. | **What do you think could be better about Project Spraoi?** |
| 19. | **How would you feel if you couldn’t do Project Spraoi anymore?** |

- **Activities**
- **Interactions**
- **Context**
- **Dose**
- **Fidelity**
- **Barriers/Facilitators**
- **Dose**
- **Interactions**
- **Activities**
- **Interactions**
- **Adaptations**
- **Facilitators**
- **Interactions**
Project Spraoi Questionnaire

Name: _________________________________ Class: ________________

Please indicate your level of agreement with the following statements:

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
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<td>14</td>
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</tr>
</tbody>
</table>

2. Please note any positive comments you have with regards to Project Spraoi.
__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

3. Please note any improvements that you suggest could be made to Project Spraoi.
__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________
Project Spraoi – End of Year Review 2015

Please indicate your level of agreement with the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I enjoyed taking part in Project Spraoi this year.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. I found the workload involved with Project Spraoi this year manageable.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I would like for Project Spraoi to continue in Scoil Bhailenóra next year.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I think that Project Spraoi can continue in Scoil Bhailenóra next year without the presence of an Energiser.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Rate the quality of delivery of Project Spraoi this year by circling the appropriate answer below:

<table>
<thead>
<tr>
<th>Category</th>
<th>Very Good</th>
<th>Good</th>
<th>OK</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energiser Quality</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Physical activity content</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Nutrition content</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Please note any comments on or suggested improvements to the delivery of Project Spraoi? (Energiser quality, Physical activity/nutrition content, anything else that you think Project Spraoi could offer School A)

Please note your favourite part of Project Spraoi this year, (e.g. favourite memory, activity,
Please note the biggest barriers you faced this year with Project Spraoi?

_________________________________________
_________________________________________

Any other comments/suggestions in relation to Project Spraoi?

________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________

Thank you for taking the time to complete this review
C.6 End of Year Review survey (revised version)

Project Spraoi – End of Year Review 2016

Please indicate your role in the school environment by ticking the appropriate box below:

Principal □ Class teacher □ Resource Teacher □ S.N.A. □ Administration □ Auxiliary □

Please indicate your level of agreement with the following statements;

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I enjoyed taking part in Project Spraoi this year.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. I found the workload involved with Project Spraoi this year manageable.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I would like Project Spraoi to continue in (School name) next year.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I think that Project Spraoi can continue in (School name) next year without the presence of an Energiser.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. I will continue to implement Project Spraoi next year after the intervention has finished.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Rate the quality of delivery of Project Spraoi this year by circling the appropriate answer below:

<table>
<thead>
<tr>
<th></th>
<th>Very Good</th>
<th>Good</th>
<th>OK</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition content</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Physical activity content</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Energiser Capability</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Please note any comments on or suggested improvements to the delivery of Project Spraoi?
(Energiser enthusiasm/capability; Physical activity/nutrition content; inclusion of stakeholders, e.g. school staff, parents, children; anything else that you think Project Spraoi could have offered your school)

Please note your favourite part of Project Spraoi this year? (e.g. favourite memory, activity, etc.)
Please note the barriers you faced this year when implementing Project Spraoi? *

*Barriers are defined as problems external to the intervention itself encountered when implementing intervention components and reaching participants.

Please note the facilitators you faced this year when implementing Project Spraoi? **

**Facilitators are defined as elements that promoted the successful implementation of intervention components and reaching participants.

Any other comments/suggestions in relation to Project Spraoi?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Thank you for taking the time to complete this review & for your participation in Project Spraoi this year.
C.7 Physical Activity and Nutrition Profile

A. Class Physical Activity (PA) & Physical Education

1. How many sessions and average time/session do you spend on PE each week?

   No. sessions: ________ Average time / session: ________ mins   Total time: ___ mins

2. How many sessions and average time/session do you spend on Physical Activities outside of P.E each week? (e.g. learning games, Bizzy Breaks, etc)

   No. sessions: ________ Average time / session: ________ mins   Total time: ___ mins

3. Do you use PE, PA or games as a reward in the classroom? YES/NO

   a. If yes, how often? ________________________________

4. What written/electronic resources do you use to plan for PE or PA? (P.E. Curriculum, Irish Heart Foundation Bizzy Breaks, Go Noodle (Online Resource), Get Ireland Active, etc)

B. School Physical Activity

1. Are your class involved in any of the following activities/inter school competitions outside of PE and if so how many children from your class?

   Sciath Na Scoil (Football): YES/NO ________ Number of Boys: ________
   Sciath Na Scoil (Football): YES/NO ________ Number of Girls: ________
   Sciath Na Scoil (Hurling): YES/NO ________ Number of Boys: ________
   Sciath Na Scoil (Camogie): YES/NO ________ Number of Girls: ________
   Cork City Sports: (Athletics) YES/NO ________ Number of Children: ________
   Cork Schools Orienteering: YES/NO ________ Number of Children: ________
   Dance (Irish, folk, etc): YES/NO ________ Number of Children: ________
   Number of Children: ________________________________

2. Does your class attend yard at break times? AM Yes/No PM Yes/No

   Do your class participate in activities at yard time? Yes/No (please specify below)

3. Is your school or class currently under-taking or taking part in any other physical activity initiatives: (please give details) e.g. Walk/Cycle to school, Pedometer Challenge, National Bike Week, Active Flag Award, Cork Sports Partnership Initiatives, etc...
C. Class Healthy Eating

1. How many sessions a year would you teach healthy eating (include full units, incidental learning activities, one off planned sessions)?

   No. of sessions: ______________

   Topics covered: ______________________________________________________________

2. Do you use food as a reward in the classroom? YES/NO

   If so, what food and how often? _____________________________________________

4. Do you allow water in the classroom? YES/NO

5. What written/electronic resources do you use to plan for healthy eating? Primary School Curriculum, Safe Foods etc

D. School Healthy Eating

1. Is your school or class currently involved in any of the following programmes/initiatives:

   Food Dudes: YES/NO _______
   School Milk Scheme: YES/NO _______
   School Lunch Scheme: YES/NO _______
   National Dairy Week: YES/NO _______
   Breakfast Club: YES/NO _______

   Other: ________________________________________________________________

2. Is your school or class currently involved in any initiatives in relation to healthy eating?

   e.g. Fruit & Veg Friday, No Junk Food Policy, Healthy Eating Day for Pupils & Parents, Vegetable Garden, etc.
C.8 Energizer Questionnaire

Energizer Questionnaire

*Barriers – anything external to the intervention itself that make delivering the intervention more difficult.
**Facilitators – anything external to the intervention itself that encourage better delivery of the intervention.

1. What is your perception of the barriers* to extra physical activity for teachers in your school?

2. What is your perception of the barriers to extra physical activity for you in your school?

3. What is your perception of the facilitators** to extra physical activity for teachers in your school?

4. What is your perception of the facilitators to extra physical activity for teachers in your school?
C.9 Energizer Questionnaire (ranking)

Energizer Questionnaire

Please rank what you think the following facilitators to extra physical activity are for teachers from 1 – 4. (1=most important; 4=least important):

Breaking 20 minutes down into multiple PA breaks throughout the day: ______
Classroom Games: ______
PA challenges e.g. Stride for Five: ______
PA Resources e.g. 12 days of fitness, games manual, etc: ______

Please rank what you think the following barriers to extra physical activity for teachers are from 1 – 4. (1=most important; 4=least important):

Curriculum constraints: ______
Class Management: ______
Lack of Space: ______
Teacher Confidence: ______

Any other comments:
C.10 Energizer Reflective Journal

**Energiser's Reflective Journal - (Enter School)**

**Date:** ________________  **Intervention week:** ________________

**Section 1a: Environmental & Self Evaluation:**

(Scale : 1=very positive; 2=positive; 3=just above acceptable; 4=just below acceptable; 5=negative; 6=very negative)

Energy Levels: 1 2 3 4 5 6  
Will to Energise: 1 2 3 4 5 6

Weather (am)  
Weather (pm)  

**Section 1b: Activity & Facility**

Junior ___________________________________________________________ Yard [ ] Hall [ ] Classroom [ ]
Senior ___________________________________________________________ Yard [ ] Hall [ ] Classroom [ ]

**Section 2: Dose** (Record testing groups only)

Estimate in minutes how much of your 20min Huff & Puff lesson is MVPA and the percentage of children that received the MVPA dose delivered i.e. what percentage of children moved moderate/vigorously when given the opportunity?

<table>
<thead>
<tr>
<th></th>
<th>Junior</th>
<th>Senior</th>
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</thead>
<tbody>
<tr>
<td>Dose Planned (mins)</td>
<td></td>
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<tr>
<td>Dose Delivered (mins)</td>
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<tr>
<td>Dose Received (%children)</td>
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**Section 3a: Reach/Effectiveness**

**Level of student participation?** (Number of students participating in activity e.g. 27/30)

<table>
<thead>
<tr>
<th>Class</th>
<th>J1</th>
<th>S1</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
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</thead>
<tbody>
<tr>
<td>A</td>
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</table>

**Reasons for non-participation?** (Rate: A=absent; I=injured; S=sick; R=refused; O=other e.g. 1A 2S)

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<thead>
<tr>
<th>Class</th>
<th>J1</th>
<th>S1</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
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<td>A</td>
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**Level of teacher engagement?** (Rate: P/D/I/M/O/T)

<table>
<thead>
<tr>
<th>Class</th>
<th>J1</th>
<th>S1</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
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</tbody>
</table>
Level of student enjoyment? (Record testing groups only: Number of students with thumbs up/middle/down)

<table>
<thead>
<tr>
<th>Class</th>
<th>Very Enjoyable - Fun</th>
<th>Not Sure - OK</th>
<th>Not Enjoyable - Boring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td></td>
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</tr>
</tbody>
</table>

Section 4: End of school day reflection

positive = ✓, negative = ✗, teacher = T, student = S, energiser = E, male = M, female = F
junior infants = JI, senior infants = SI, rang 1 = R1, etc.

What went well today?

What problems/barriers were faced today? (e.g. why planned Huff & Puff dose was not delivered?/Class unavailable due to match/church/musical?)

What was learned? (State whether learned by E/T/S e.g. rules for game need to be adapted)

Positive/Negative comments about Project Spraoi: (State who? positive/negative?)
Appendix D: Impact Evaluation Results
The secondary aim of this study was to assess the impact of Project Spraoi on a number of pre-defined health outcomes in children which are detailed in Chapter 3. Over the course of the three-year data collection, a step-back approach to implementation, described in Chapter 3 and Chapter 5, was applied. This longitudinal data set which was collected between 2013 and 2016 with the same child cohort enabled an analysis of the sustainability of Project Spraoi as the step-back approach enabled implementation to be gradually transitioned into the schools’ full control.

For the purpose of evaluation, a junior and senior intervention and comparable control child cohort, both from medium-sized rural mixed gender schools were recruited. Unfortunately, due to the delayed treatment approach agreed with control schools, the comparable control cohort were only valid for the first two years of this evaluation. In the third year (2015/16), the control cohort were offered the opportunity to receive the full Project Spraoi intervention.

D.1 Impact evaluation sample
The impact evaluation sample was divided into a junior (n=40) and senior (n=45) cohort for the purpose of analysis. The junior cohort included males (n=20) and females (n=20) aged 6.03 ± 0.33 years at induction. The senior cohort included males (n=25) and females (n=20) aged 10.15 ± 0.35 years. Measures were taken pre and post intervention with the same junior (n=40) and senior cohort (n=45) in year one and two. In year three, a one-year post intervention impact evaluation was conducted with the same cohort, allowing for longitudinal comparisons.

D.2 Impact evaluation: intervention versus control cohort
Dependent on whether the conditions of normality were met, differences between measures taken pre and post intervention for each subgroup were calculated using a paired sample t-test or Wilcoxon test. Effect size was calculated using G Power version 3.1 and interpreted using Cohen’s classification of effect size (small 0.2≤d<0.5, medium 0.5≥d<0.8, large ≥0.8). Table 1 reports the appropriate scores for centrality and variance for all physical measures, as well as the statistical difference between measures taken pre and post intervention.
Table 1: Descriptive statistics of physical measures and mean difference pre and post intervention

<table>
<thead>
<tr>
<th>Physical Measures</th>
<th>Junior Cohort</th>
<th>Difference (Nov ’13 - May ’15)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nov ’13</td>
<td>May ’15</td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>Control</td>
</tr>
<tr>
<td></td>
<td>n = 39</td>
<td>n = 36</td>
</tr>
<tr>
<td></td>
<td>May ’15</td>
<td>p value (effect size)</td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>Control</td>
</tr>
<tr>
<td></td>
<td>n = 40</td>
<td>n = 41</td>
</tr>
<tr>
<td>Age (years)</td>
<td>6.02 ± 0.33</td>
<td>6.03 ± 0.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>117.85 ± 6.78</td>
<td>117.06 ± 5.14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass (kg)</td>
<td>22.34 ± 2.7</td>
<td>22.46 ± 2.73</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>16.1 ± 1.3</td>
<td>16.34 ± 1.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (z score)</td>
<td>0.35 ± 0.8</td>
<td>0.55 ± 0.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WCHt Ratio</td>
<td>0.47 ± 0.03</td>
<td>0.47 ± 0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>550m walk/run (secs)</td>
<td>205 ± 27</td>
<td>216 ± 32</td>
</tr>
<tr>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Senior Cohort</th>
<th>Difference (Nov ’13 – May ’15)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nov ’13</td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>n = 43</td>
</tr>
<tr>
<td></td>
<td>May ’15</td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>n = 45</td>
</tr>
<tr>
<td>Age (years)</td>
<td>9.93 ± 0.62</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>140 ± 8.1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass (kg)</td>
<td>33.7 ± 5.5</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>17.44 ± 2.12</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (z score)</td>
<td>0.24 ± 0.94</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>WCHt Ratio</td>
<td>0.43 ± 0.04</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>550m walk/run (secs)</td>
<td>153.5 ± 22</td>
</tr>
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</tbody>
</table>

*p ≤ 0.05

D.2.1 Body Mass Index
A statistically significant increase in BMI with a small effect size was reported across all four subgroups between November 2013 and May 2015 (Figure 1). The BMI of the junior intervention cohort increased from 16.1 to 16.42 (p<0.0005, ES=0.48), while the comparable control cohorts BMI increased from 16.34 to 16.55 (p=0.037, ES=0.34). Similarly, the BMI of the senior intervention cohort increased from 17.44 to 18.29 (p=0.018, ES=0.38) and the senior control cohort’s BMI increased from 17.3 to 17.91 (p=0.001, ES=0.4). Descriptors of anthropometric variables such as height (cm) and mass (kg) revealed a statistically significant
increase in their values in parallel with increasing age, suggesting a growth spurt amongst the children (Table 1). It would appear that both the junior and senior intervention cohorts BMI increased more than the control cohort over the two-year intervention (Figure 1), however this difference was not found to be statistically significant (p=0.102).

Based on the IOTF cut offs, results from this study showed that the majority of children from each subgroup were of a normal weight, with between 75.7 % and 87.8 % of children in each group classified as normal weight (Table 2). The prevalence of overweight and obese children in the junior cohort in Nov ’13 was lower amongst the intervention (15.4%) than the control group (18.6%). In contrast, the prevalence of overweight and obesity amongst the senior cohort increased from Nov ’13 (INT=14%, CON=13.6%) to May ’15 (INT=18.9%, CON=16.2%) (Table 3).
Table 2: BMI classifications for junior cohort

<table>
<thead>
<tr>
<th>BMI category</th>
<th>Junior Cohort</th>
<th></th>
<th></th>
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<tr>
<td></td>
<td>Intervention</td>
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<td>May '15</td>
<td>Control</td>
<td>Nov '13</td>
<td>May '15</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
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<td>1</td>
<td>2.6</td>
<td>1</td>
<td>2.3</td>
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<tr>
<td>Overweight/Obese</td>
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<td>15.4</td>
<td>5</td>
<td>12.9</td>
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Table 3: BMI classifications for senior cohort

<table>
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<th>BMI category</th>
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<td>May '15</td>
<td>Control</td>
<td>Nov '13</td>
<td>May '15</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
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<td>%</td>
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<td>0</td>
<td>2</td>
<td>5.4</td>
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<td>0</td>
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<tr>
<td>Overweight/Obese</td>
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<td>14</td>
<td>7</td>
<td>18.9</td>
<td>6</td>
<td>13.6</td>
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D.2.2. Waist circumference to height ratio

Waist circumference to height (WCHt) ratio was calculated by dividing participant’s mean waist circumference (cm) by their mean height (cm). A similar trend to BMI was noted in the WCHt ratio scores for the senior cohort with both intervention and control subgroups WCHt ratio increasing between Nov ‘13 and May ’15 (Figure 2). However, this increase was not found to be statistically significant in either of the senior subgroups (p>0.05). In contrast to BMI, a statistically significant decrease in WCHt ratio scores with a small effect size was reported for both the junior intervention (p=0.012, ES=0.287) and junior control subgroups (p=0.001, ES=0.365) between Nov ‘13 and May ‘15.
D.2.3 Cardiorespiratory fitness
Given that the condition of normality was not met, the change in time taken to complete the 550m walk/run test (secs) was analysed using a Wilcoxon test (Table 1). An ANOVA was used to explore potential differences and interaction effects between subgroups. Over the two-year intervention period, the time taken for all groups to complete the 550m walk/run test significantly decreased (p<0.0005), indicating that all groups CRF significantly increased. The intervention sample exhibited a statistically significant higher level of CRF than the control sample (p=0.001, n²=0.075) as they recorded significantly faster times at baseline and follow up.

D.3 Impact evaluation – 3-year evaluation
Significant increases in height (cm) and mass (kg) in parallel with increasing age, suggested significant linear growth amongst the children in both subgroups (Table 4). For this reason, change in height between year 1 and year 3 also acted as a covariate in analysis of variables with which height was deemed to be an influencing factor. Pairwise comparisons were used to further examine significant interaction and main effects. Results of the ANOVA are presented in Table 4 and 5.
D.3.1 Anthropometric measures

A statistically significant decrease in both BMI (p<0.05, ES=0.27) and BMI (SDS) (p<0.05, ES=0.42) with a small effect size was observed over time in the junior cohort. In contrast, a significant increase in BMI with small effect was observed in the senior cohort over the same time period (p<0.05, ES=0.42).

In order to control for the effect of increased stride length of children over the three-year evaluation period due to significantly increased height, change in height was used as a covariate during analysis of cardio-respiratory fitness (CRF). The time taken to complete the 550m walk/run test decreased in both subgroups over time (Table 4), indicating increased CRF. Despite both subgroups recording faster times, a significant increase in CRF was only observed in the senior cohort (p=0.03, ES=0.13) (Table 5). Analysis of CRF revealed statistically significant age effects on 550m run/walk time as the senior cohort recorded significantly faster times than the junior cohort with a large effect size (p<0.0005, n²=0.573).

Table 4: Summary of markers of health and analysis of variance – junior cohort

<table>
<thead>
<tr>
<th></th>
<th>Junior Cohort (n=40)</th>
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<th></th>
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<th>P value</th>
<th>Effect size</th>
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<tr>
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<td>Year 1</td>
<td>Year 2</td>
<td>Year 3</td>
<td>Mean difference</td>
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<td></td>
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<tr>
<td>Age (years)</td>
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<td>7.54</td>
<td>8.54</td>
<td>1.97</td>
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<tr>
<td>Height (cm)</td>
<td>120.68</td>
<td>126.68</td>
<td>136.54</td>
<td>-15.86</td>
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<td>0.99</td>
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<tr>
<td>Mass (kg)</td>
<td>24.34</td>
<td>27.02</td>
<td>30.92</td>
<td>-6.58</td>
<td>0.02*</td>
<td>0.14</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>16.66</td>
<td>16.76</td>
<td>16.49</td>
<td>0.17</td>
<td>0.00*</td>
<td>0.27</td>
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<tr>
<td>BMI (SDS)</td>
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<td>0.45</td>
<td>0.09</td>
<td>0.5</td>
<td>0.02*</td>
<td>0.2</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>56.1</td>
<td>57.87</td>
<td>57.24</td>
<td>-1.14</td>
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<td>0.05</td>
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<td>WCHt Ratio</td>
<td>0.47</td>
<td>0.46</td>
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<td>0.07</td>
<td>0.08</td>
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<td>550m run (secs)</td>
<td>195.19</td>
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<td>164.39</td>
<td>-30.81</td>
<td>0.55</td>
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</table>

*p≤0.05
Table 5: Summary of markers of health and analysis of variance – senior cohort

<table>
<thead>
<tr>
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<th>Senior Cohort (n=45)</th>
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<td>Year 1</td>
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<tr>
<td>Height (cm)</td>
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<tr>
<td>Mass (kg)</td>
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<td>BMI (kg/m2)</td>
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<tr>
<td>BMI (SDS)</td>
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<tr>
<td>Waist circumference (cm)</td>
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<tr>
<td>WCHt Ratio</td>
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<tr>
<td>550m run (secs)</td>
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</table>

*p≤0.05

D.3.2 Physical Activity
At baseline, 68 students (junior, n=32; senior, n=36) met the required accelerometer wear time to be included in analysis. The introduction of the PS intervention saw a significant increase in the mean daily MVPA of both subgroups at the end of year 1 when compared to their baseline measures (mean difference = 22.83 mins, p=0.00; senior mean difference = 31.16 mins, p=0.00) (Figure 1). In the junior cohort only, the mean daily minutes of MVPA accumulated by participants between year 1 and year 3 significantly decreased (p=0.034, n² =0.107). No significant changes in mean daily minutes of MVPA was noted amongst the senior cohort over the course of the intervention. Despite both subgroups PA levels decreasing as the intervention was stepped back in year two and three, the children in both subgroups were significantly more active at intervention end in year three compared to at baseline, prior to the introduction of PS (p<0.05) (Figure 3).
Figure 3: Change in mean daily MVPA over time

Figure 4 outlines the proportion of children meeting the recommended PA guidelines at each time point. The proportion of children meeting the MVPA guidelines decreased in both subgroups over the course of the three years with the greatest drop off occurring between year 2 and year 3. No significant differences were found to exist between the junior and senior cohorts in year 1 and year 2. However, in year 3, the senior cohort of sixth class children were significantly less likely to meet the recommended MVPA guidelines than their junior counterparts in second class (p=0.00, ES=0.64).

Figure 4: Percentage of children meeting the World Health Organisation MVPA guideline
A repeat measure between and within subject’s ANOVA revealed no significant difference in the mean daily sedentary time accumulated by children over the course of the intervention (p>0.05). However, the junior cohort was found to accumulate significantly less daily sedentary time than the senior cohort (p=0.000, $n^2=0.245$; mean difference 47.659 minutes) (Figure 5). No interaction effects for time and class were identified.

Figure 5: Change in mean daily sedentary time
Appendix E: ‘Huff & Puff’ Resources
E.1 Maths games
In response to teachers’ feedback during the preliminary study in school A, a number of cross-curricular games resources were provided to teachers to facilitate the delivery of ‘Huff & Puff’ without impacting on available learning time. A set of maths game cards were created by the researcher and disseminated to all class teachers. On the front of the card, was the name of the game with an accompanying picture. On the back of the card was a set of instructions on how to set up, deliver and progress the difficulty of the game described. An example of some of the maths game cards created as part of this study are provided below.

Figure 1: ‘Add it Up’ – front side of game card
Equipment required: None
Organisation: Students work in pairs
Safety: Ensure all bags and chairs are pushed in under desks

Instructions:

1. Ask students to pair with their desk partner and stand facing each other.
2. Both students make a fist with 1 hand and pump the fist into the air three times, calling “1, 2, 3!”
3. On the fourth fist pump, both students reveal a number, 1-5, by holding up a number of fingers.
4. The first student in each pair to shout out the correct answer by adding the two numbers together gets to pick an activity for his/her pair to do for 10 repetitions.
5. Students complete 10 repetitions of the chosen activity and repeat.

Examples of activities include:

- Jumping Jacks
- Star Jumps
- Sit Ups
- Press Ups
- Run on spot
- Frog Hops
- Burpees
- Single leg hops

*encourage creativity in a limited space*

Progressions:

1. Ask each pair to join with another pair to make a group of 4. Each group is now trying to add 4 numbers together.
2. Subtraction - Must take the bigger number from the smaller one.
3. Change to multiplication working in pairs. The number which each child holds up is now a factor and they must multiply the 2 factors to find the product.
4. Fractions – place one hand above the other, the number shown on the top hand is the numerator and the bottom hand is the denominator.
Figure 3: ‘The Right Combination’ – front side of game card
**Equipment required:** None

**Safety:** Ensure all bags and chairs are pushed in under desks

**Instructions:**

1. Allocate each student a number 1, 2, 3 or 4.
2. Ask each student to communicate his/her number by holding up an equivalent number of fingers, e.g. number 1 will hold up 1 finger.
3. Explain to students that this is a **silent** game and that they are required to communicate using visual cues only, i.e. holding up fingers.
4. Teacher calls out an activity for students to do moving around the space as quickly and quietly as possible.
5. Teacher calls out a number e.g. 10, and students must silently get into groups with the right combination of numbers to sum to the answer 10 e.g. 4,3,2,1 or 4,4,2, etc.
6. When a group has the right combination, they squat down to signal the teacher to check their result.
7. Repeat using a different activity to move around the space.

Examples of activities include:

- Single leg hop
- 2 foot Jump
- Sideways Crab Crawl
- Gallop
- Skip
- Ballerina Walk on tip toes

*emphasis* on a soft quiet landing, light on the ball of the foot*

**Progressions:**

1. Change the number 1's to 5's so now you have 2,3,4,5. Each person is now a factor. If the teacher calls out 20, students form a group with the factors to give the product 20 e.g. 2,2,5, or 5,4. Anyone who is not a factor forms a separate group e.g. 3's.

---

Figure 4: ‘The Right Combination’ – back side of game card
E.2 Learning Games

In addition to the maths games cards, teachers were also provided with a set of learning games which could be adapted to a wide selection of subjects. In addition to providing a printed lesson plan, the Energizer modelled these games for the teachers to ensure they knew how to implement the instructions. The Energizer also engaged in discussion with each class teacher about how the games could be adapted to include topics that suited their class level. An example of the learning game lesson plan, created by the researcher as part of this study, can be found below.

**Figure 5: ‘Nouns & Adjectives’ – learning games resource**

**Nouns & Adjectives**

*Curriculum links: English; Irish; Geography*

*Equipment Needed: cones or use the lines in the yard*

*Organisation: Two groups, in two straight lines facing each other.*

<table>
<thead>
<tr>
<th>Safe zone</th>
<th>Nouns</th>
<th>Adjectives</th>
<th>Safe zone</th>
</tr>
</thead>
</table>

**Instructions:**

1. Label 1 group nouns and the opposite group adjectives
2. Teacher calls out a word, if the word is a noun the ‘nouns’ chase the adjectives. Once in the safe zone they cannot be caught.
3. If the word is an adjective, the ‘adjectives’ chase the nouns.
4. Anyone who is caught must join the opposite team before the next round.
5. The team with the most members at the end of the game wins.

**Progression:** Allow a student to pick the word each time.

Can be applied to any subject using two different topics e.g. rivers & mountains; éadaí (clothes) & dathanna (colours)
E.3 Twelve days of fitness
In addition to cross-curricular games, the Energizer also provided classroom game resources for teachers to use on days when the weather was poor. One such resource designed as a power point presentation to be used on a smart whiteboard in the classroom was the ‘12 Days of Fitness’. Each day included a new exercise which added to the previous and was designed to be sung along with to the tune of the song, ‘The 12 Days of Christmas’.

On the 1st day of Fitness my trainer gave to me.............
A balance with a foot on one knee

On the 2nd day of Fitness my trainer gave to me...........
2 Muscle Poses

On the 3rd day of Fitness my trainer gave to me...........
3 Touch the Sky Jumps

On the 4th day of Fitness my trainer gave to me.............
4 Forward Lunges

On the 5th day of Fitness my trainer gave to me.............
5 Frog Leaps
On the 6th day of Fitness my trainer gave to me................
6 Seconds Running

On the 7th day of Fitness my trainer gave to me.................
7 Santa Squats

On the 8th day of Fitness my trainer gave to me............
8 Overhead Punches

On the 9th day of Fitness my trainer gave to me.................
9 Single Foot Hops

On the 10th day of Fitness my trainer gave to me............... 
10 Jumping Jacks

On the 11th day of Fitness my trainer gave to me............... 
11 High Knees

On the 12th day of Fitness my trainer gave to me............... 
12 Desk Press Ups
Stride for 5

Get everyone in your class to run for 1 minute without stopping. Once your class masters one minute, place your class star on 1 minute. Keep building up your time and moving your star up the board until everyone in your class can run for 5 minutes without stopping!
Appendix F: Healthy eating resources
F.1 Tip sheet example

**Kickstart Your Day with Breakfast!**

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!

- **Mouse Traps**: toast + marmite + cheese
- **Porridge**: rolled oats + yoghurt + dried fruit
- **Weetbix**: weetbix + banana + milk
- **Fruit Smoothie**: banana + canned fruit + milk
- **Toast & Milk**: toast + spread + milk
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 H₂O is the way to go!

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.
kick start your day with BREAKFAST

Any breakfast is better than none but some choices are better than others!

Great choices: Porridge, Weetbix and wholegrain toast are low in sugar and have plenty of goodness so are a great start to the day.

Sugar Swaps – remember sugar is not good for your teeth and has no goodness.

Instead of putting sugar on your breakfast cereal, try naturally sweetening it with one of these:
- Yoghurt
- Dried fruit (apricots, sultanas, raisins)
- Fruit (banana, kiwi, canned fruit, berries)

Breakfast helps ‘kick-start’ your brain and gets you ready for the day!