Moving in School: Physical Activity Promotion in the Primary School Setting

A thesis submitted for the award of Doctor of Philosophy (PhD)

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June 2016

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Publications and Presentations

Reviewed conference proceedings

D Hegarty, EM Murtagh, D Ní Chróinín (2013) An Evaluation of Irish Primary School Children's Physical Activity during the Segmented School Day. Physical Eduction, Physical Activity and Youth Sport Conference Proceedings; Dublin, 13-14th June: 103-109.

W O'Brien, **D Hegarty** (2012) Current Directions in Physical Activity Research in Ireland. Physical Education, Physical Activity and Youth Sport Forum Conference Proceedings; Limerick, 14th-15th June: 39-40.

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D Hegarty, EM Murtagh, D Ní Chróinín (2016) A mixed method study of girls' physical activity in a peer-led lunch-time intervention. Physical Education, Physical Activity and Youth Sport Forum; Tralee, 30th May.

D Hegarty, EM Murtagh, D Ní Chróinín (2016) A mixed-method evaluation of a peer-led lunch-time physical activity intervention for primary school girls. All Ireland Postgraduate Conference in Sports Sciences, Physical Activity and Physical Education; Waterford, 29th April.

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DM Harrington, **D Hegarty**, EM Murtagh, D Ní Chróinín (2014) Contribution of After-School MVPA to Overall MVPA in a Sample of Irish School-Children. Global Summit on the Physical Activity of Children; Toronto, 19th-22nd May.

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D Hegarty, EM Murtagh, D Ní Chróinín (2013) Children's Physical Activity during Structured and Unstructured Periods of the Primary School Day. Physical Education, Physical Activity and Youth Sport Forum; Dublin, 13-14th June.

D Hegarty, EM Murtagh, D Ní Chróinín (2013) Physical Activity Research in the Primary School Setting: Identifying a Suitable Context for Physical Activity Promotion. Limerick Postgraduate Conference; Limerick, 6th June.

D Hegarty, EM Murtagh, D Ní Chróinín (2013) An Evaluation of Irish Primary School Children's Moderate to Vigorous Physical Activity during the Segmented School Day: A Pilot Study. International Society of Behavioural Nutrition and Physical Activity; Ghent, Belgium, 22nd-25th May.

D Hegarty, EM Murtagh, D Ní Chróinín (2012) An Evaluation of Irish Primary School Children's Moderate to Vigorous Physical Activity during the Segmented School Day. Physical Education, Physical Activity and Youth Sport Forum; Limerick, 14th-15th June.

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Abstract

Moving in School: Physical Activity Promotion in the Primary School Setting

Introduction: Childhood physical activity is associated with numerous health benefits. However, many children worldwide are not sufficiently active to meet the 60 minutes of moderate to vigorous physical activity (MVPA) daily target. The school is a popular location to encourage physical activity participation among children, thus this thesis focuses on the promotion of physical activity in primary schools.

Purpose: To evaluate the impact of physical activity promotion initiatives on primary school children's physical activity. Three studies were undertaken to 1) examine children's MVPA during the segmented school day; 2) evaluate the impact of the Active School Flag (ASF), a whole-school initiative, on children's daily MVPA and 3) determine the impact of a peer-led lunch-time intervention on primary school girls' daily MVPA.

Methods: ***Study 1:*** A convenience sample of boys and girls aged 11.2 ± 1.2 years (n=98), attending four non-DEIS (Delivering Equality of Opportunity in Schools) mixed urban primary schools in Co. Kerry, wore accelerometers for five consecutive days during school hours in March, September or October 2012. ***Study 2:*** Boys and girls aged 9.2 ± 1.7 years, attending one DEIS and one non-DEIS mixed rural primary schools undertaking the ASF process acted as the intervention group (n=31) and two schools matched for school type, DEIS status and location acted as the control group (n=30). Participants wore accelerometers for seven consecutive days at baseline (November 2012) and at six (June 2013) or twelve-month (November 2013) follow-up. ***Study 3:*** Girls aged 7.6 ± 0.5 years, attending eight randomly selected girl-only primary schools in Munster, acted as the intervention (n=32) or control (n=24) group. One intervention and two control schools were of DEIS status. The intervention group participated in lunch-time activities led by student leaders aged 10.8 ± 0.4 years over eight weeks from March to June or September to December 2014. The intervention and control groups wore accelerometers for five consecutive days during weeks 0, 4 and 8. On weeks 4 and 8, the intervention group produced individual drawings and writings and three participants from each intervention class participated in focus group discussions describing their experience of the intervention.

Findings*: Study 1:* Break-time was the segment of the school day in which boys undertook the highest percentage of MVPA; that is 30.8% of 15-20 minute break-times were spent in MVPA compared to 26.4% of 30 minute lunch-times and 23.5% of 30-60 minute physical education lessons spent in MVPA. Girls carried out the highest percentage of school day MVPA during physical education by engaging in MVPA for 17.4% of 30-60 minute physical education lessons, 13.8% of 30 minute lunch-times and 12.9% of 15-20 minute break-times. Both boys and girls spent the lowest percentage of time in MVPA during class-time: 3% and 2.3% of 225-290 minutes respectively. Mann Whitney U tests showed girls were significantly less active than boys throughout the segmented school day ($P < .05$). ***Study 2:*** Daily MVPA for the ASF group at baseline and follow-up were 55.2(15) and 65.3(20.5). Corresponding values for the control group were 50.5(18) and 64.3(23.6). A mixed ANOVA revealed participation in the ASF did not significantly alter children's daily MVPA from baseline to follow-up in comparison to the control group ($P > .05$). ***Study 3:*** Daily MVPA for the intervention group on weeks 0, 4 and 8 were 49.6(15), 55.6 (17.1) and 50.5(19.1).

Corresponding values for the control group were 61.4(25.1), 54.9(23.5) and 54.1(25.6). A mixed ANOVA showed the peer-led lunch-time intervention significantly increased girls' daily MVPA in comparison to the control group from weeks 0 to 4 and weeks 0 to 8 ($P < .05$). Through a thematic analysis, three main themes were identified: friendships with participants enhanced the physical activity experience; involvement of players in decision-making; and leaders were challenged to manage play and players.

Conclusion: This thesis contributes to the literature on children's physical activity by outlining the development and evaluation of a peer-led lunch-time intervention that successfully increased primary school girls' daily MVPA. Objective measurements of Irish children's MVPA levels are provided that can be used for the tracking and surveillance of national physical activity levels. Opportunities for physical activity promotion in the school setting are identified and an evaluation of the impact of a whole-school initiative on primary school children's daily MVPA is provided.

Declaration

Moving in School: Physical Activity Promotion in the Primary School Setting

I hereby certify that this material, which I now submit for assessment leading to the award of Doctor of Philosophy is entirely my own work and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed: ……

Date: ……

Acknowledgements

Firstly to my supervisors Dr. Elaine Murtagh and Dr. Déirdre Ní Chróinín, thank you for your continued guidance, support and wisdom. You provided me with a deep insight into the research on physical activity and I could not have completed this PhD without your help and support. It was a privilege to be your student and learn from your expertise.

I am sincerely grateful to Mary Immaculate College for funding this research. Without this bursary I could not have undertaken this PhD.

I thank my fellow postgraduate students and staff in the Department of Arts Education and Physical Education for welcoming me to Mary Immaculate College and encouraging me throughout my PhD studies. I particularly thank Niall Quinn for allowing me to use the photocopier to print task cards for my research.

I particularly thank Dr. Wesley O'Brien for encouraging me to pursue a PhD and continuing to provide guidance and support.

To the staff in the Research and Graduate School, thank you for responding to my queries and providing workshops and information that detailed the process of completing the PhD.

To the librarian Norma O'Neill, thank you for helping me source the Health Behaviour Questionnaire.

I especially thank all the staff at the School of Health and Human Performance in Dublin City University for giving me a solid foundation from which to undertake this research.

I thank Dublin City University and Cork Institute of Technology for providing research equipment for my studies.

Thank you to the staff at the Institute of Technology Tralee for allowing me access to their library. I also thank Tadhg O'Shea immensely for assisting me with my statistical calculations and giving me a copy of his statistics book.

To all of the principals, teachers and students of the participating schools, I thank you for your enthusiasm and taking part in my research. Without your involvement, this PhD would not have been possible.

To Debbie, thank you for expanding my experience of dance and gymnastics - I always wanted to continue my passion for this type of exercise and you provided a fun, supportive and imaginative space to do this. To all the members at Kerry Dance and Fitness Centre, thank you for all the laughs and fun we had together, it was always the part of my day I looked forward to.

Carly, thank you for becoming my "gymnastics buddy"! All of the crazy idea stunts we shared and tried kept me amused on my study breaks!

Thank you Claire-Marie for introducing me to the aerial hoop world and welcoming me into the supportive group at your studio even though I lived miles away!

I thank Theresa and John Murphy for helping to build my aerial hoop 'playground' at the Tralee Gymnastics Centre. All the coaches and gymnasts at your club have been so welcoming and it has been a pleasure to work with them.

To my childhood friends Orla, Sarah, Sinéad, Amber and Sarah and my college friends Laura, Brian, Patrick and Glenn, thank you for your endless support, encouragement and being a source of many fun distractions from my work over the years. I particularly thank Sarah Kelliher for becoming my "aerial hoop buddy" and joining me on this circus arts journey - long may it continue!

To the Comiskey family, thank you for your continued hospitality on my numerous visits to your home. To Helen in particular, thank you for always being so welcoming and making me feel at home.

To Anne-Marie, Siobhán and Aoife, you are amazing sisters! Thank you for your numerous prep talks and advice over the years. I especially thank you for hosting our many girlie nights!

Mom and Dad, as you know it has always been a dream of mine to achieve a PhD. Thank you for enabling me to accomplish this dream. Mom, thank you for being a pillar of support and always having the "we can do it" attitude. Dad, thank you for talking with me about my research ideas and volunteering to read countless drafts of my thesis - you were always very encouraging in your feedback.

Stephen, you were there from the beginning and continued to be there for me throughout my PhD journey. You were always there to listen to my worries, joyous moments and the mundane daily updates on my work progress. You always remained positive about my PhD work for which I am extremely grateful. I couldn't have asked for better support from you - you went above and beyond! Thank you.

Chapter 1. General Introduction

This thesis is about the promotion of physical activity in primary schools. Physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (World Health Organisation, 2004). A mixed methods social inquiry is used to examine physical activity in this thesis. In the present chapter I will outline the problem under investigation including the argumentative thread that runs through the thesis. This chapter concludes with a formal statement of the problem this mixed methods social inquiry addresses with accompanying research questions and hypotheses.

1.1 Background of the problem

Childhood physical activity is positively associated with physical and mental function (Gu et al., 2016). Numerous health benefits are linked to physical activity participation during childhood such as the development of muscular strength, bone health and cardiorespiratory fitness (U.S. Department of Health and Human Services, 2008). Research has shown physical activity can reduce levels of depression, give children an opportunity to have fun (U.S. Department of Health and Human Services, 2008) and is associated with academic achievement, cognitive functioning and concentration (Chalkley et al., 2015). The World Health Organisation (2010) recommends children engage in 60 minutes of moderate to vigorous physical activity (MVPA) each day to attain the benefits associated with physical activity. Activities of a moderate to vigorous intensity means that breathing is harder than normal and the heart is beating faster than when at rest (Department of Health and Children, 2009). Examples of physical activities that children undertake at a moderate to vigorous intensity include skipping rope activities, cycling, swimming, dancing, skating and games like basketball and tag (Department of Health and Children, 2009).

Despite the known benefits of physical activity, there is an epidemic of physical inactivity among children (Designed to Move, 2012). Physical inactivity refers to undertaking insufficient amounts of MVPA to meet specified physical activity guidelines like the World Health Organisation (2010) daily physical activity guideline (Sedentary Behaviour Research Network, 2012) whereas sedentary behaviour is any waking behaviour performed in the sitting or lying position with an energy expenditure of ≤ 1.5 Metabolic equivalents (METs) (Biddle and the Sedentary Behaviour and Obesity Expert Working Group, 2010, Sedentary Behaviour Research Network, 2012). It has become the norm for children in many countries to be physically inactive (Troiano et al., 2008, Colley et al., 2011, Verloigne et al., 2012, Griffiths et al., 2013b, Woods et al., 2010) with one study finding MVPA levels decreasing by approximately 38 minutes per day per year from the age of nine years (Bradley et al., 2011). In Ireland, the physical activity levels of children and adolescents were awarded a D minus grade (Harrington et al., 2014b) based on the findings that only 12-43% of 7-18 year old children met the daily physical activity guideline between the years 2009 and 2013 (Woods

et al., 2010, Griffiths et al., 2013b, Williams et al., 2009, Central Survey Unit, 2011, Kelly et al., 2012). Inactivity threatens children's health, wellbeing and quality of life due to the increased prevalence of non-communicable diseases such as cardiovascular disease, diabetes and cancer, their risk factors such as raised blood pressure, raised blood sugar and overweight (World Health Organisation, 2010). Furthermore, research shows that less active children have a lower academic achievement than their more active counterparts (Kwak et al., 2009, Carlson et al., 2008). As adults, research suggests a physically inactive lifestyle may lead to lower earnings (Stevenson, 2010) and less productivity at work than physically active adults due to absenteeism for at least a week each year (Proper et al., 2006). Physical inactivity is also the fourth leading risk factor for global mortality (World Health Organisation, 2010) and was the cause of 5.3 million of the 57 million global premature deaths in 2008 (Lee et al., 2012). The poor health and wellbeing associated with inactivity during childhood and adulthood will continue and may potentially worsen unless interventions are designed to address this issue. The National Physical Activity Plan in Ireland aims to increase the proportion of children aged 0-18 years participating in at least 60 minutes of MVPA daily by 1% each year (Department of Health & Department of Transport Tourism and Sport, 2016). Implementation of physical activity initiatives and interventions in Ireland is essential to reach this national target.

Another issue of concern is that girls are generally less active than boys worldwide. An evidence-based multidisciplinary report on girls' physical activity outlined that this gender difference in physical activity participation may be explained by the fact that girls normally list more perceived barriers to physical activity participation than boys (Wiese-Bjornstal and LaVoi, 2007). The four perceived barriers girls typically cite for not being physically active, as identified in this report, include: time (e.g. too much homework), access and opportunity (e.g. transport limitations), interpersonal (e.g. parental belief that sport is not as important for girls as for boys) and psychological barriers (e.g. limited confidence in their physical abilities) (Wiese-Bjornstal and LaVoi, 2007). Other research suggests that a lower participation in organised sport (Vella et al., 2014), lower perceived social support in physical activity (Edwardson et al., 2013) and lower levels of enjoyment in physical education (Cairney et al., 2012) compared to their male counterparts may contribute to the disparity between boys' and girls' physical activity levels. Furthermore, a multilevel cross-sectional and longitudinal study suggested that the reason 19% of the 8 year old Australian girls were less active than boys may have been due to less participation in extracurricular sports, lower levels of cardio-respiratory fitness, lower eye-hand coordination, higher body fat percentage and lower perceived competence in physical education (Telford et al., 2016). Despite the knowledge that there is a pronounced difference between boys' and girls' physical activity, only a few interventions have specifically addressed the issue of girls' inactivity (Biddle et al., 2014). The majority of physical activity interventions target both boys and girls together (Biddle et al., 2014), yet previous research shows girls prefer an

environment that is free from the scrutiny of boys and comparison to boys (Camacho-Minano et al., 2011). A meta-analysis of interventions to increase girls' physical activity found girl-only interventions were more effective at increasing girls' physical activity than the interventions that included both boys and girls (Biddle et al., 2014). Furthermore, many intervention studies do not report the findings of boys' and girls' physical activity separately, thus limiting the evidence base on strategies that increase or do not increase girls' physical activity. Collectively this evidence suggests that girls' physical activity warrants particular attention due to their low levels of physical activity and the lack of tailored interventions that address this issue.

The school is one of the best locations for promoting physical activity as it can reach large audiences of children from many different backgrounds (Peterson and Fox, 2007). Furthermore, children attend school for at least a decade of their lives and the majority of their waking hours during these years are spent in this location (Story et al., 2006). Traditionally, much of school time is spent seated, with opportunities for physical activity limited to physical education, break- and lunch-times (Kobel et al., 2015). Many school-based physical activity interventions targeted a specific time of the school day such as physical education, class-, break- or lunch-times, however several of these interventions are limited to improving physical activity during these specific time periods only (Burns et al., 2015). A whole-school approach to physical activity promotion involves a multi-component approach that addresses the provision of physical activity in the school curriculum, policy and environment (Timperio et al. 2004). Numerous researchers have endorsed this approach to physical activity promotion due to its' greater potential for promoting physical activity among children than single component interventions (Carson et al., 2014a, Institute of Medicine, 2013, Public Health England, 2015, Naylor and McKay, 2009, Fox et al., 2004b, Sebelius et al., 2010). Surprisingly, few studies have examined the impact of the whole-school intervention design on children's physical activity and most of the studies that have targeted adolescents' physical activity (Naylor et al., 2008). One study in this thesis will examine primary school children's physical activity in a whole-school intervention design to determine whether the continued endorsement of this intervention design is justified.

Many school-based physical activity interventions contain methodological and reporting flaws. A randomised controlled design represents the gold standard for evaluating interventions (Schulz et al., 2010), however there is a lack of high quality evaluations on children's physical activity in interventions with randomised controlled designs (van Sluijs et al., 2007). One methodological issue of many physical activity interventions is the use of self-report for evaluation purposes (van Sluijs et al., 2007, Dobbins et al., 2013). Evaluations using self-report lacks the precision of measuring physical activity compared to accelerometers (van Sluijs et al., 2007). Furthermore, many assessments of school-based

interventions do not measure children's physical activity in the entire day or during segments of the day. The lack of daily and segmented day physical activity analysis within interventions means the potential of behavioural compensation at other times of the day may not be accounted for (Metcalf et al., 2012). Additionally, many studies do not examine the interacting elements of interventions (Van Sluijs and Kriemler, 2016). Without examination of the interacting components of an intervention, there is no knowledge regarding the elements of the intervention that are or are not effective at altering physical activity (Van Sluijs and Kriemler, 2016). Another methodological limitation of many interventions is the lack of student voice in the development stages of physical activity interventions (O' Cathain et al., 2013). It is highly recommended that participants are asked for their input on the intervention design during the developmental stages so that they will be keen on adopting the ideas of the intervention (Van Sluijs and Kriemler, 2016). Lastly, the reporting of interventions is generally poor which means there is insufficient detail for other researchers to replicate or improve the design (Corder et al., 2015). The limitations to implementing and reporting school-based interventions outlined above will be addressed in this thesis so that strong conclusions regarding the impact of school-based interventions on children's physical activity can be made.

1.2 Statement of the problem

Three studies were conducted in this thesis to examine children's physical activity in the segmented school day, a whole-school initiative and a peer-led lunch-time intervention. The gaps in the evidence base that informed the design of these studies are outlined below.

Previous studies examined 8-14 year old children's physical activity within segments of the school day using pedometers and accelerometers to determine the opportunities to promote physical activity within this setting (Brusseau et al., 2011, Tudor-Locke et al., 2006, Nettlefold et al., 2011, Bailey et al., 2012). Pedometers measure activity in terms of step count whereas accelerometers provide information on the intensity of the activity performed (Dollman et al., 2009). The measurement of children's physical activity using accelerometers is valuable as the data can be compared to the physical activity intensity guidelines. Only one previous study exclusively measured primary school-aged children's physical activity during the segmented school day using accelerometers. The findings of their study showed these children exceeded or almost reached the daily recommendation of 60 minutes of MVPA during school time only (Nettlefold et al., 2011). Many children do not meet the daily MVPA guideline in the entire day (Verloigne et al., 2012, Troiano et al., 2008, NHS Information Centre, 2010, Riddoch et al., 2007b, Griffiths et al., 2013b, Colley et al., 2011, Woods et al., 2010). Researchers using the Report Card on Physical Activity model to compile and assess the national evidence on physical activity among children and adolescents awarded a B grade to New Zealand (Maddison et al., 2014) and Mozambique (Prista et al., 2014), a C grade to England (Standage et al., 2014), Nigeria (Akinroye et al.,

2014), Kenya (Wachira et al., 2014) and Mexico (Rodriguez et al., 2014), a D grade to Ireland (Harrington et al., 2014a), Finland (Liukkonen et al., 2014), South Africa (Draper et al., 2014), Ghana (Ocansey et al., 2014), Canada (Gray et al., 2014), the US (Dentro et al., 2014), Colombia (Gonzalez et al., 2014) and Australia (Schranz et al., 2014) and an F grade to Scotland (Reilly et al., 2014) for physical activity participation, which further indicates the low physical activity levels among children globally. Therefore, the participants' school day activity levels in Nettlefold et al. (2011) are not representative of children's physical activity worldwide. An examination of primary school children's physical activity using accelerometers during the segmented school day is thus warranted to provide details that can help identify a suitable setting and cohort for a primary school-based physical activity intervention.

A whole-school approach to physical activity promotion is recommended as one of the seven best areas of investment to increase physical activity (Global Advocacy for Physical Activity the Advocacy Council of ISPAH, 2011) as it continues to be identified as having great potential to promote physical activity among children (Carson et al., 2014a, Institute of Medicine, 2013, Public Health England, 2015, Naylor and McKay, 2009). A national whole-school self-evaluation physical activity initiative called the Active School Flag (ASF) was established in Ireland in 2009. This initiative requires schools to review, plan, implement improvements and create community links to enhance physical education and physical activity for all students. To achieve the ASF, five of the six physical education strands (aquatics, athletics, dance, gymnastics, games and outdoor and adventure activities) must be taught to all class groups and held for at least 60 minutes weekly as per the Department of Education and Science (1999b) guideline. Teachers must be encouraged to attend training courses in physical education, physical activity and sport. Physical activity is to be celebrated, inclusive and promoted during discretionary, break- and lunch-times and in the journey to and from school. Students are to be involved in the decision making regarding the provision and promotion of physical activity. Links with parents, the local community, National Governing Bodies, Local Sports Partnerships and the Health Service Executive are to be created to promote physical activity. An Active School Week is to be organised each year that encourages the whole school community to become more active. The National ASF screening committee awards the ASF by viewing the evidence which confirms that each of the improvements stated in the application form have been completed or implemented. The ASF was awarded to at least 634 primary schools (Naughton, 2016), however the impact of this initiative on primary school children's physical activity has not yet been examined. Although previous studies have examined Canadian, American, English and Australian children's physical activity in whole-school interventions, an evaluation of children's physical activity in the ASF whole-school initiative is warranted as the findings of physical activity interventions in other countries may vary due to basing the results on a unique mix of students, teaching styles, curriculums and differently resourced education systems

(McKenna, 2009). An examination of children's MVPA in the ASF initiative will add to the limited evidence base on primary school children's activity levels in whole-school approaches to physical activity.

Girl-only interventions that are tailored to meet the unique needs of girls are recommended (Wiese-Bjornstal and LaVoi, 2007) to provide girls with more enjoyment, more attention from instructors, a greater opportunity to develop skills and relationships, lessen concerns about body image, scrutiny from boys and constant comparison to boys (Camacho-Minano et al., 2011). Social support from peers is the primary influence of girls' physical activity from childhood to adolescence, therefore peer-based interventions targeted at girls are recommended for future study (Camacho-Minano et al., 2011). Three previously implemented interventions contained a peer-led lunch-time activity component and measured participants' physical activity by pedometers (Eather et al., 2013a, Lubans et al., 2011) and accelerometers (Peralta et al., 2009). These interventions were multicomponent and tailored for primary school children (Eather et al., 2013a) or secondary school boys (Peralta et al., 2009, Lubans et al., 2011). To date, there has been no physical activity evaluation of a primary school girl-only lunch-time intervention. There has also been no examination of girls' physical activity in a single-component peer-led lunch-time intervention. Therefore, an evaluation of a peer-led lunch-time intervention is warranted to determine the impact of this type of intervention of primary school girls' MVPA.

1.3 Purpose and significance of the study

The first study of this thesis addressed the gap in the knowledge regarding children's physical activity levels during the segmented school day. A convenience sample of children aged 8-12 years participated in the study. Analysis of children's physical activity during segments of the school day highlighted physical activity opportunities for children, trends in school day physical activity and times where there was low physical activity. This information provides school personnel and researchers with details on times further physical activity is warranted for improving primary school-aged children's school day activity.

The second study of this thesis is the only research to examine the impact of a whole-school initiative on the accelerometer-measured physical activity levels of exclusively primary school-aged children. A purposive sample of children aged 6-12 years attending schools that were and were not engaged in the ASF initiative participated in the study. Policy makers, school personnel and the ASF Awarding Body may find the results of this study of particular interest, as an in-depth analysis of primary school children's MVPA in the ASF initiative was undertaken to determine the impact of this initiative on children's daily MVPA

and identify whether aspects of the ASF initiative were successful at increasing children's daily MVPA or warranted improvement.

The third study of this thesis addressed the gap in identifying a school-based physical activity intervention specifically to increase primary school girls' daily MVPA. A peer-led lunch-time intervention for primary school girls was designed based on previous published research of girls' physical activity and feedback from a representative sample of the target cohort who took part in a pilot study. A cluster randomised controlled sample of girls aged 7-8 years and 10-11 years participated in this intervention. Researchers, policy makers and school personnel may find this study of particular interest as it presented the findings of a school-based strategy targeted at primary school girls' physical activity.

1.4 Aims, research questions and hypotheses

The overall aim of this research is to evaluate the impact of physical activity promotion initiatives on the provision of physical activity in primary schools.

The first study of this thesis examines children's MVPA during segments of the school day and investigates the following research questions: 1) How long do children spend in MVPA during physical education, class-, break- and lunch-times? 2) Is there a difference between the time boys and girls spend in MVPA during physical education, class-, break- and lunch-times? It is hypothesised that children will spend a short amount of time in MVPA during physical education, class-, break- and lunch-times and that there will be a significant difference between the time boys and girls spend in MVPA during these segments of the school day.

The second study investigates children's MVPA in a whole-school physical activity initiative and examines the following research questions: 1) Does the whole-school physical activity initiative have an impact on children's daily, physical education, break- or lunch-time MVPA in comparison to the control group? 2) Is there a difference between boys' and girls' physical activity as a result of participation in a whole-school physical activity initiative? 3) Is there a correlation between children's self-efficacy, perceived barriers or benefits of physical activity and daily MVPA after participating in a whole school initiative? It is hypothesised that participation in the whole-school physical activity initiative will significantly increase children's daily, physical education, break- and lunch-time MVPA in comparison to the control group, maintain the significant difference between boys' and girls' physical activity and demonstrate a correlation between children's self-efficacy, perceived barriers or benefits of physical activity and daily MVPA.

Based on the lunch-time MVPA findings from the first and second studies, the third study examines girls' MVPA in a school-based physical activity intervention. The research questions in this study are: 1) What impact does this intervention have on primary school girls' daily, physical education, break- or lunch-time MVPA in comparison to the control group? 2) What impact does this intervention have on girls' perceived social support and enjoyment of physical activity? 3) What are the participants' experiences of the intervention? It is hypothesised that the intervention will significantly increase primary school girls' daily and lunch-time MVPA but not alter their physical education and break-time MVPA in comparison to the control group. It is also predicted that the girls will have a significantly higher perceived social support and enjoyment of physical activity after participating in the intervention in comparison to the control group.

1.5 Thesis structure

This thesis is arranged into seven chapters. Following this introduction, **chapter two** contains an analysis of the relevant literature. Within the literature review chapter, a rationale for physical activity participation is provided. In addition, an outline of children's physical activity guidelines, patterns and school-based interventions is described.

Chapter three presents the findings from the first study. This study evaluated primary school children's MVPA patterns during segments of the school day. These findings provide an account of children's MVPA during the entire school day as well as during physical education, class-, break- and lunch-times. Opportunities for physical activity promotion among boys and girls are also identified through the specific analysis of boys' and girls' MVPA during segments of the school day. **Chapter four** presents the findings of the second study. This study examines the impact of a whole-school activity promoting initiative on primary school children's daily MVPA. Children's MVPA during physical education, break and lunch-times are also analysed to determine whether the school physical activities implemented during these times of the day influence their MVPA levels. To provide further insights into the participants' physical activity response to the initiative, an analysis of their self-efficacy and perceived benefits and barriers to physical activity is detailed.

Based on the findings of the studies described in chapters three and four, the development of a physical activity intervention for primary school girls is described in **chapter five**. The implementation and evaluation of this peer-led lunch-time intervention is then outlined in **chapter six**. Girls' daily, school day and segmented school day MVPA patterns are examined to determine whether the girls altered their MVPA levels in response to the intervention. The two targeted correlates of physical activity within the intervention, perceived social

support and enjoyment levels, are analysed to gain insights into the girls' physical activity response to the intervention. To provide a comprehensive evaluation of the intervention, the participants' experience of the intervention is described. The strengths and limitations of each study are described within chapters 3-6. **Chapter seven**, the final chapter, examines the overall conclusions of this thesis and makes recommendations for future research.

Chapter 2. Literature Review

2.1 Introduction

The following literature review, of studies worldwide, describes the benefits children attain when physically active and implications of inactivity. This link will be considered as a rationale for promoting physical activity among children. The recommended physical activity targets for children during the entire day, school day, physical education and break-/lunch-times are outlined. Children's physical activity patterns are also considered. School-based physical activity interventions based in the school setting are detailed at the end of this chapter.

2.2 Rationale for physical activity

Physical activity enhances the quality of life (Haskell et al., 2007) of healthy people, people at risk of developing chronic disease and people with current chronic conditions or disabilities (U.S. Department of Health and Human Services, 2008). Engagement in physical activity benefits every aspect of health including the physiological, psychological and social wellbeing (Chalkley et al., 2015, Department of Health and Children, 2009) of children, adolescents, young, middle-aged and older adults, and those in every studied racial and ethnic groups (U.S. Department of Health and Human Services, 2008). Physiological and psychological health benefits associated with physical activity engagement include improved cardiovascular and metabolic health, enhanced cardio-respiratory and muscular fitness, stronger bones, weight maintenance after weight loss and reduced levels of depression (Department of Health and Children, 2009, U.S. Department of Health and Human Services, 2008). In terms of social wellbeing, physical activity can provide people with an opportunity to have fun, be with friends and family and enjoy the outdoors (U.S. Department of Health and Human Services, 2008). It is important for society to be physically active in order to attain the physiological, psychological and social outcomes of physical activity engagement.

There is strong evidence of physiological, psychological and social health outcomes associated with physical activity among children aged 5-11 years (Chalkley et al., 2015). Physiological health outcomes associated with children's physical activity include cardio-metabolic health (Krekoukia et al., 2007, Ondrak et al., 2007, Raitakari et al., 1997), muscular strength (Malina, 2006, Blimkie and Bar-Or, 1996), bone health (Bradney et al., 1998, Macdonald et al., 2007, MacKelvie et al., 2004, MacKelvie et al., 2002) and cardiorespiratory fitness (Physical Activity Guidelines Advisory Committee, 2008). Self-esteem (Ekeland et al., 2005, Biddle and Asare, 2011, Findlay and Coplan, 2008, Tirlea et al., 2015), anxiety (Biddle and Asare, 2011, Dimech and Seiler, 2011), academic achievement (Singh et al., 2012, Wittberg et al., 2012, Hillman et al., 2014, Tremblay et al., 2000, Booth et al., 2013, Haapala, 2012), cognitive functioning (Biddle and Asare, 2011, Sibley and Etnier, 2003) and attention/concentration (Erwin et al., 2012, Trudeau and Shephard, 2008) are psychological health outcomes associated with physical activity during childhood. There is

also a positive association between children's physical activity and confidence (Tirlea et al., 2015, Zarrett et al., 2009, Holt et al., 2011, Wiersma and Fifer, 2008) and peer acceptance (Fitzgerald et al., 2012). Evidence also shows there is a trend that physical activity during childhood generally leads to a physically active adulthood (Telama et al., 2014, Telama, 2009). This physical activity trend is explained by Blair et al.'s (1989) model of the health consequences of childhood physical activity. This model (Blair et al., 1989) illustrates that physical activity during childhood is directly related to the quality of life and health during childhood, can improve the adult health status by delaying the onset of chronic diseases and can indirectly improve adult health as childhood physical activity generally leads to a physically active adulthood (Blair et al., 1989). There is also a linear relation between physical activity and health status, in that increases in physical activity during childhood and adulthood leads to additional improvements in health status (Warburton et al., 2006). The importance of childhood physical activity is clear due to the caridiometabolic, muscular, cardiorespiratory and bone health benefits plus higher levels of self-esteem, academic achievement, cognitive functioning, concentration, confidence and peer acceptance attained during childhood and the likelihood of a positive health status during adulthood.

In contrast to physical activity engagement, an inactive lifestyle is linked to poor health (World Health Organisation, 2010) and academic performance (Kwak et al., 2009, Carlson et al., 2008). Inactivity increases the prevalence of osteoporosis (Gunter et al., 2012) and non-communicable diseases such as cardiovascular disease, diabetes and cancer and their risk factors such as raised blood pressure, raised blood sugar and overweight (World Health Organisation, 2010). Physical inactivity among children is associated with lower academic achievement than their physically active counterparts (Kwak et al., 2009, Carlson et al., 2008). Physical inactivity is the fourth leading risk factor for global mortality (World Health Organisation, 2010) and was the cause of 5.3 million of the 57 million global premature deaths in 2008 (Lee et al., 2012). The non-communicable diseases associated with physical inactivity places a large financial burden on countries due to direct health care costs, earnings lost due to sickness absence and premature death (World Health Organisation, 2006). A review of 11 published national estimates on the cost of physical inactivity in the US, Holland, the UK, Australia, Canada and Switzerland reported that physical inactivity contributed to 1% to 2.6% of total healthcare costs (Pratt et al., 2014). One study that provided a quantification of the economic cost of physical inactivity worldwide reported that physical inactivity in 2013 cost health-care systems $53.8 billion (Ding et al., 2016). Other studies conducted in England (Department for Culture, 2002) and Switzerland (Martin et al., 2001) found that inactivity cost the country about €3-12 billion and €1.1-1.5 billion per year respectively. Based on these reports, it was estimated that inactivity costs countries about €150-200 per citizen annually (World Health Organisation, 2006). These estimates exclude the contribution of physical inactivity to overweight and obesity, which is estimated to cost between €9.6 billion and €10.8 billion yearly (Report by the Comptroller

and Auditor General, 2001). The number of youth that are classified as overweight and obese has increased in recent decades (Sturm, 2005). In Ireland, obesity is a major public health concern (The Report of the National Taskforce on Obesity, 2005) as one in every four children are classified as overweight or obese (Woods et al., 2010, Williams et al., 2009). Evidence shows that regular physical activity is effective in the primary and secondary prevention of many chronic diseases such as obesity, cardiovascular disease, diabetes, cancer and osteoporosis (Warburton et al., 2006). The promotion of physical activity is thus warranted to reduce the non-communicable diseases and financial burden associated with physical inactivity.

2.3 Daily physical activity guidelines

Physical activity guidelines were developed to help people achieve the health benefits associated with physical activity participation. The original physical activity guidelines for children and adolescents, proposed by the American College of Sports Medicine (1988), included the recommendation that youth should take part in 20-30 minutes of vigorous exercise daily. In the early 1990s, the physical activity guideline was refined for adolescents however, the expert committee consisting of researchers from the US, Canada, Australia, and Europe did not formulate guidelines specifically for children at that time due to a lack of scientific evidence surrounding childhood physical activity (Twisk, 2001). In 1998, two recommendations for physical activity were made for young people aged 5-18 years: 1) young people should take part in at least 60 minutes of moderate intensity physical activity daily, and children that do only a little amount of activity should participate in at least 30 minutes of moderate intensity physical activity daily and 2) activities focused on developing bone density, muscular strength and flexibility should be carried out twice a week (Biddle et al., 1998). Sixty minutes was the recommended time for physical activity daily as the prevalence of childhood overweight and obesity was increasing while the majority of young people were accumulating 30 minutes of physical activity each day (Biddle et al., 1998).

At present, researchers have provided recommendations for the amount of physical activity and sedentary behaviour to undertake each day. There are physical activity guidelines for the early years aged 0-4/5 years (Okely and Janssen, 2015), children aged 5-17 years, adults aged 18-64 years and older adults aged 65 years and above (World Health Organisation, 2010). Australia (Australian Government, 2010), Canada (Canadian Society for Exercise Physiology, 2012) and the UK (Department of Health, 2011) recommend the early years (aged 0-4/5 years) accumulate at least three hours of any intensity physical activity throughout the day, while the US advocate at least 90 or 120 minutes of daily physical activity among this age group (National Association for Sport and Physical Education, 2009). Adults (aged 18-64 years) and older adults (aged 65+ years) are recommended to accumulate at least 150 minutes of moderate activity or 75 minutes of vigorous activity or a MVPA equivalent (World Health Organisation, 2010). This thesis specifically focuses on

primary school-aged children's physical activity and the guideline for 5-17 year olds is to accumulate a minimum of 60 minutes of different developmentally appropriate physical activities daily at a moderate to vigorous intensity (World Health Organisation, 2010). Activities of a moderate to vigorous intensity means that the heart is beating faster and the child is breathing harder (Department of Health and Children, 2009). Examples of activities performed at a moderate to vigorous intensity for children includes active games with running like tag, jumping rope, bicycle riding, brisk walking, jogging, stair climbing, basketball, racquet sports, soccer, dance, swimming laps and skating (Department of Health and Children, 2009). Aerobic activity is suggested to be the primary component of 5-17 year olds' physical activity with an addition of bone strengthening activities incorporated at least three times a week (World Health Organisation, 2010). Physical inactivity refers to undertaking insufficient amounts of MVPA to meet this daily physical activity guideline (Sedentary Behaviour Research Network, 2012) whereas sedentary behaviour is any waking behaviour performed in the sitting or lying position with an energy expenditure of ≤ 1.5 METs (Biddle and the Sedentary Behaviour and Obesity Expert Working Group, 2010, Sedentary Behaviour Research Network, 2012). The guideline regarding sedentary behaviour for children is to minimise the amount of time spent in extended periods of sedentary behaviour (Department of Health, 2011, Department of Health, 2014, Tremblay et al., 2011).

Many children worldwide are inactive i.e. not sufficiently active to meet the 60 minutes MVPA daily guideline. Across the globe, researchers compiled and assessed the national evidence on physical activity among children and adolescents based on meeting the 60 minutes of MVPA daily guideline using the Report Card on Physical Activity model. The child and adolescent physical activity grades awarded include a B grade to New Zealand (Maddison et al., 2014) and Mozambique (Prista et al., 2014), a C grade to England (Standage et al., 2014), Nigeria (Akinroye et al., 2014), Kenya (Wachira et al., 2014) and Mexico (Rodriguez et al., 2014), a D grade to Ireland (Harrington et al., 2014a), Finland (Liukkonen et al., 2014), South Africa (Draper et al., 2014), Ghana (Ocansey et al., 2014), Canada (Gray et al., 2014), the US (Dentro et al., 2014), Colombia (Gonzalez et al., 2014) and Australia (Schranz et al., 2014) and an F grade to Scotland (Reilly et al., 2014). These country specific physical activity grades indicate the low physical activity levels among children globally. Furthermore, only 48% of boys and 35% of girls aged 6-11 years in the US (Troiano et al., 2008), 14% of boys and 1.7% of girls aged 10-12 years in Belgium (Verloigne et al., 2012), 9.5% of boys and 0% of girls aged 10-12 years in Greece (Verloigne et al., 2012), 13.9% of boys and 1.5% of girls aged 10-12 years in Hungary (Verloigne et al., 2012), 15.8% of boys and 2.1% of girls aged 10-12 years in the Netherlands (Verloigne et al., 2012), 27.8% of boys and 12.5% of girls aged 10-12 years in Switzerland (Verloigne et al., 2012), 50.9% of children aged 7-8 years in England (Griffiths et al., 2013b), 33% of boys and 21% of girls aged 4-15 years in England (NHS Information Centre, 2010), 51.7% of children aged 7-8 years in

Wales (Griffiths et al., 2013b), 52.5% of children aged 7-8 years in Scotland (Griffiths et al., 2013b) and 43.4% of children aged 7-8 years in Northern Ireland (Griffiths et al., 2013b) reached the 60 minutes of MVPA daily guideline as measured by accelerometers. Similarly, a low percentage (19%) of Irish children aged 10-12 years met the daily MVPA guideline as measured by accelerometers (Woods et al., 2010). In light of the findings that the majority of children do not meet the daily MVPA guideline worldwide, it is clear that childhood physical activity is a public health concern that warrants attention.

2.4 School day physical activity guideline

School-time may provide the greatest opportunity for children to be physically active as a large amount of their waking hours is spent in this setting (Guinhouya et al., 2009, Dobbins et al., 2009, Naylor et al., 2006a). There is no consensus on a school day physical activity guideline; however two targets have been proposed (Rush et al., 2012, Pate et al., 2006). The Energize Project suggests that 20 minutes of MVPA should be accumulated at school (Rush et al., 2012), whereas a minimum of 30 minutes MVPA at school is the most common cited school day target (Fox et al., 2004a, Pate et al., 2006, Howells et al., 2010, The Report of the National Taskforce on Obesity, 2005). The latter guideline is based on the amount of waking hours spent at school and how much of this time can contribute to their overall daily physical activity. Children spend half their waking hours at school (Owen et al., 2000, Naylor et al., 2006a), therefore researchers suggested that 30 minutes (50%) of the recommended 60 minutes of MVPA should be accumulated at school (Fox et al., 2004a, Pate et al., 2006, Howells et al., 2010, The Report of the National Taskforce on Obesity, 2005). Two studies examined whether children reached the 30 minutes of school day MVPA target using accelerometers (Walter, 2011, Nettlefold et al., 2011). More than 90% of 8-11 year old Canadian children (Nettlefold et al., 2011) and 54.5% of 8-12 year old South African children (Walter, 2011) achieved the 30 minutes of MVPA school day target. The findings of the Canadian study are not representative of children's physical activity worldwide as these boys and girls accumulated a total of 63.5 and 52.9 minutes of MVPA at school which meant they exceeded or almost reached the daily recommendation of 60 minutes of MVPA during school hours (Nettlefold et al., 2011). Most children do not meet the daily physical activity guideline during the entire day (Riddoch et al., 2007b, Woods et al., 2010, Centers for Disease Control and Prevention, 2005). Further research is warranted to determine an appropriate school day guideline for children as there is limited data to verify whether 20 or 30 minutes of MVPA at school is an achievable target.

2.5 Physical education physical activity guideline

Physical education provides a framework in which to be regularly active in a structured manner (Fairclough and Stratton, 2005) and is a source of a minimum amount of activity for children (Public Health Service, 1991, US Department of Health and Human Services, 2000). Spending a minimum of 50% of physical education lessons in MVPA was proposed as a national objective in the US Healthy People 2010 report (US Department of Health and Human Services, 2000) and recommended by the UK's Association for Physical Education in

their 2008 Health Position Paper (Association for Physical Education, 2008). This physical activity target was deemed ambitious but feasible to achieve (US Department of Health and Human Services, 2000). One review of 44 studies that were published up to 2005 and examined primary school-aged children's physical activity in physical education lessons using accelerometers, pedometers, observational methods and heart rate monitors found an average of 34.2% of physical education time was spent in MVPA (Fairclough and Stratton, 2006). A second review of the 13 studies published between 2005 and 2014 that analysed primary school-aged children's physical activity during physical education through accelerometry and direct observation noted a higher percentage of physical education was spent in MVPA, that is an average of 44% of physical education lessons was spent in MVPA (Hollis et al., 2015). These reviews (Hollis et al., 2015, Fairclough and Stratton, 2006) indicate that on average primary school-aged children spend less time in MVPA during physical education than the US Department of Health and Human Services (2000) and Association for Physical Education (2008) recommended target.

This physical activity target in physical education has most commonly been attained during intervention studies that intentionally aimed to increase children's MVPA (Lonsdale et al., 2013, McKenzie et al., 1996, McKenzie et al., 1997). According to Stratton (1996) and Fairclough (2003) this physical activity target is too ambitious due to the broad aims of physical education (Fairclough and Stratton, 2005) such as the teaching of motor skills to becoming aware of the benefits of physical activity and developing social and affective competencies (Meyer et al., 2011). To strive to meet the guideline, Fairclough and Stratton (2005) state that physical educators would need to structure their lessons with a MVPA goal in mind in order to reach these activity levels within their lesson. However, three non-intervention studies showed children met or exceeded the 50% of physical education in MVPA target (Chow et al., 2008, Cardon et al., 2004b, Verstraete et al., 2007). One potential reason the Chinese and Belgian participants met the physical activity target in physical education was that the lessons were led by specialist PE teachers (Chow et al., 2008, Verstraete et al., 2007). The National Institute of Child Health and Human Development Study of Early Child Care and Youth Development Network (2003) found that children taught by physical education specialists expended more energy and accumulate more active minutes as they provided longer lessons than the classroom teachers. Furthermore, the Chinese children who were inactive during physical education were frequently disciplined (Chow et al., 2008). One other potential reason the Chinese and Belgian children met the physical education target was that physical activity was measured by direct observation (Chow et al., 2008, Cardon et al., 2004b) where student reactivity is a concern (Armstrong and Welsman, 2006, Trost, 2007). Overall, many children worldwide do not meet the physical activity target in physical education, however further studies are required to determine whether MVPA as the primary goal of physical education lessons is beneficial to the long-term health of children.

2.6 Break and lunch time physical activity guideline

Break- and lunch-times provide an opportunity for children to engage in unstructured physical activity. Prior to 2003, physical education was the only segment of the school day in which researchers recommended a physical activity target (Ridgers et al., 2005). Stratton and Mullan (2003) suggested that the physical activity target for physical education is applied to break- and lunch-times, that is for children to be physically active at a moderate to vigorous intensity for at least 50% of break-/lunch-times. Ridgers et al. (2005) examined whether this target was achievable and realistic for break-/lunch-times among 228 English children. The findings indicated that this break-/lunch-time guideline may be too ambitious for children to achieve as only 5.8% of boys and 0.5% of girls aged 5-10 years participated in MVPA for 50% of break-/lunch-times. On reflection of this result and the 60 minutes of MVPA daily target (World Health Organisation, 2010), Ridgers et al. (2005) proposed that the physical activity target was lowered from 50% (Stratton and Mullan, 2003) to 40% of break-/lunch-times in MVPA. More children in Ridgers et al. (2005) reached the 40% of break-/lunch-time in MVPA guideline than the previous proposed break-/lunch-time target (+9.1% of boys, +3.8% of girls). The number of children that attained the 40% of break-/lunch-time in MVPA guideline in Ridgers et al. (2005) was low. Therefore break-/lunch-time interventions are warranted to help children attain the 40% of break-/lunch-times in MVPA target. Six accelerometer-measured studies reported the percentage of break- and lunch-time 5-14 year old North American, European and African children spent in MVPA (Nettlefold et al., 2011, Ridgers et al., 2005, Walter, 2011, Bailey et al., 2012, Verstraete et al., 2006, Ridgers et al., 2007b). Two studies reported that Belgian children aged 9-11 years (Verstraete et al., 2006) and English children aged 10-14 years (Bailey et al., 2012) spent more than 40% of break- and lunch-times in MVPA. In contrast the children aged 5-12 years from Canada, England and South Africa spent between 19.6% and 33.7% of break-time and between 21.9% and 34.7% of lunch-time in MVPA, thus did not meet the MVPA target during these segments of the day (Nettlefold et al., 2011, Ridgers et al., 2005, Walter, 2011, Ridgers et al., 2007b). Bailey et al. (2012) suggests that the variances between these studies that examined the number of children who met the break-/lunch-time physical activity guideline may be due to the differences in accelerometer devices, MVPA cut-points applied, school policy or duration of break- and lunch-times. Overall, these findings suggest many children are not active enough during break- and lunch-times to meet the physical activity target, thus break-/lunch-time interventions are warranted.

2.7 Class-time physical activity

There is no specified guideline on the amount of MVPA that is to be included during class-time. Most of the school day is spent in class-time where children are generally required to sit quietly for academic instruction (Belton et al., 2010, Tudor-Locke et al., 2006, Donnelly et al., 2009, Goh et al., 2014, Sturm, 2005). To date, children's activity within the class-time has only been detailed in a few studies (Martin and Murtagh, 2015, Brusseau et al., 2011, Tudor-Locke et al., 2006, Nettlefold et al., 2011, Rush et al., 2012). In one study, American

children aged 9-11 years accumulated less than 400 steps during class-time which equated to less than 9% of their school day steps (Brusseau et al., 2011). Similarly, 8-9 year old Irish children (Martin and Murtagh, 2015) and 8-11 year old New Zealander children accumulated a low amount of school day MVPA during class-time (Rush et al., 2012). The 8-9 year old Irish children accumulated 0.3 minutes of their 24.8 minutes of school day MVPA during class time which represents 1.2% of their school day MVPA (Martin and Murtagh, 2015). The New Zealander children aged 8-11 years accumulated a low amount of their school day MVPA during class-time, which equates to 13.2 minutes of class-time MVPA and 19.6% of their school day MVPA (Rush et al., 2012). In contrast to these studies, 8-11 year old Canadian children accumulated approximately 60% of their school day MVPA during class-time, that is 33.8 to 39.9 minutes of their 52.9 to 63.5 minutes of school day MVPA were accumulated during class-time (Nettlefold et al., 2011). The findings in Nettlefold et al. (2011) are unusual as it was found that the children accumulated most of their school day MVPA during class-time. This contradicts the findings in Brusseau et al. (2011), Rush et al. (2012) and Martin and Murtagh (2015) who found that class-time represented the lowest accumulation of MVPA in the school day. These studies indicate the potential to improve physical activity during class-time (Rush et al., 2012, Brusseau et al., 2011, Martin and Murtagh, 2015). Overall, there is a dearth of research on children's physical activity during class-time, therefore further research is warranted.

2.8 Boys' and girls' physical activity patterns

A consistent finding in the literature shows that there is a disparity between boys' and girls' daily physical activity, with the trend generally showing that boys accumulate more activity than girls each day (Hallal et al., 2012, Pearce et al., 2012, Trost et al., 2002). There is a similar finding among boys' and girls' objectively measured school day physical activity in that boys are typically more physically active than girls during school hours (Nettlefold et al., 2011, Morgan et al., 2003, Tudor-Locke et al., 2006, Brusseau et al., 2011, Belton et al., 2010, Guinhouya et al., 2009, Walter, 2011). Within the school day, research has also shown that boys tend to take more steps (Sarkin et al., 1997, Brusseau et al., 2011, Tudor-Locke et al., 2006, Beighle et al., 2006) or spend more time in accelerometer-measured MVPA (Nettlefold et al., 2011, Ridgers et al., 2005, Walter, 2011, Bailey et al., 2012, Dessing et al., 2013, Ridgers et al., 2011, Blaes et al., 2013) during break- and lunch-times than girls. From examining this literature, it is clear that the promotion of girls' physical activity is particularly warranted.

An evidence-based multidisciplinary report on girls' physical activity (Wiese-Bjornstal and LaVoi, 2007), a multilevel cross-sectional and longitudinal study (Telford et al., 2016) and cross-sectional studies on children's physical activity and psychological correlates of physical activity (Vella et al., 2014, Edwardson et al., 2013, Cairney et al., 2012) provide some insights into the disparity between boys' and girls' activity levels. Firstly, Wiese-Bjornstal

and LaVoi (2007) found that girls tend to list more perceived barriers to physical activity participation than boys. Time (e.g. too much homework), access and opportunity (e.g. transport limitations), interpersonal (e.g. parental belief that sport is not as important for girls as for boys) and psychological barriers (e.g. limited confidence in their physical abilities) were the top four perceived barriers to physical activity participation listed by girls in this report (Wiese-Bjornstal and LaVoi, 2007). Cross-sectional studies found lower participation in organised sport (Vella et al., 2014), lower perceived social support in physical activity (Edwardson et al., 2013) and lower levels of enjoyment in physical education (Cairney et al., 2012) compared to their male counterparts may have contributed to the differences between boys' and girls' physical activity levels in these studies. The multilevel cross-sectional and longitudinal study suggested that the reason 19% of the 8 year old Australian girls were less active than boys may be due to less participation in extracurricular sports, lower levels of cardio-respiratory fitness, lower eye-hand coordination, higher body fat percentage and lower perceived competence in physical education (Telford et al., 2016). This literature highlights that different approaches to physical activity promotion are likely to differ among boys and girls, therefore should be considered in future intervention designs.

Physical education is a segment of the school day where both genders are generally instructed to engage in the same activities (Tudor-Locke et al., 2006). As expected of activity levels during physical education, four studies found no significant difference between boys' and girls' steps (Sarkin et al., 1997, Brusseau et al., 2011, Tudor-Locke et al., 2006) and accelerometer-measured MVPA levels (Nettlefold et al., 2011) during physical education. However, one study found boys engaged in significantly more observed MVPA than girls during physical education (The National Institute of Child Health and Human Development Study of Early Child Care and Youth Development Network, 2003). Perhaps this contrasting result may be due to the different tools used to measure activity levels in these studies (use of direct observation versus motion sensors). Limited data exists on the activity levels of boys and girls during class-time. One study of 8-11 year old Canadian children found boys spent a significantly higher amount of class-time in accelerometer-measured MVPA than girls (Nettlefold et al., 2011) whereas another study found no significant difference between 8-11 year old New Zealander boys' and girls' class-time step counts (Rush et al., 2012). Further research is warranted on the class-time activity levels of boys and girls to identify potential gender trends during this segment of the school day.

Overall, this literature has consistently shown that boys accumulate more physical activity than girls in the entire day, school day and break- and lunch-times. As boys are generally more physically active than girls during these times of the day, research suggests that the promotion of physical activity is approached differently for each gender. This review also

indicates that there is insufficient data to determine a physical education and class-time activity trend among boys and girls.

2.9 Effect of age on physical activity

Studies suggest that age is a determining factor for activity levels. Studies conducted in the US (Hovell et al., 1999, Goran et al., 1998) and England (Ridgers et al., 2011, Waring et al., 2007) have shown that physical activity levels decrease as children age. Hovell et al. (1999) examined the activity of Californian children over a 2 year period (from fourth to sixth grade) with a self-report survey data collection method. The findings support the general trend between age and physical activity in that as the children aged, their activity levels decrease. Goran et al. (1998) also reported similar results of decreases in physical activity over time among children aged between 4.5-6.3 years in the US. There was a 50% reduction in physical activity over the 5 years of measurements. Waring et al. (2007) summarised findings of studies suggesting that activity declined with increasing age. Contrary to these results, Cox et al. (2006) explained that as the New Zealander children increased in age (5-11 years), so did their pedometer-measured daily activity levels. The authors suggested a reason for this contrast in findings was that the younger children may have less of an opportunity to be unsupervised by parents outside the home due to the fears of traffic and strangers. Furthermore, younger children engage in more short, intermittent bouts of activity than older children (Welk et al., 2000) and the pedometers used in Cox et al. (2006) may not have recorded these bouts of activity in the younger children compared to the prolonged activities of the older children. The results of Vincent and Pangrazi (2002), recorded via pedometers, suggest that the activity levels of American children between the ages of 6 and 12 years remained stable. The study stated that there was no significant decrease in step count among participants aged 6 to 12 years. Possibilities for this unusual report on activity levels, illustrated by the authors, may be due to the good weather allowing children to be active outdoors, strong community programmes that encourage physical activity among families and schools which implemented a physical education programme that encourages physical activity. According to Sallis (2000a), the period in which a rapid decline in physical activity is most evident is during the teenage years (13-18 years old). In summary, there is conflicting evidence regarding the physical activity patterns as children age. Several studies have identified that as children increase in age their physical activity levels decrease. However, one study found no change in the children's activity levels as they aged while another study reported an increase in children's activity as they became older.

2.10 Review of school based physical activity interventions

The school provides an unparalleled opportunity to reach the vast majority of children (Peterson and Fox, 2007) as most children attend school from the ages of 5 to 17 years, for 180 days per year and for 6 or more hours per day (Peterson and Fox, 2007). Along with spending a significant amount of their waking hours at this location (Dobbins et al., 2009, Naylor et al., 2006a), children from different socioeconomic backgrounds attend school

(Naylor et al., 2006a, Cale, 2000). Furthermore, the school has the most continuous and intensive contact with children than any other institution in the first 20 years of their lives (Story et al., 2006). Additionally, inclusive interventions conducted within this setting avoid stigmatisation of overweight or obese children (Dobbins et al., 2009). For these reasons, school was identified as an ideal setting to promote children's physical activity.

The school setting has several unique venues for physical activity promotion such as before school, after school, physical education, class-, break- and lunch-times. Previous interventions targeted singular and multiple segments of the school day in an attempt to increase children's physical activity. A review of school-based physical activity interventions for students aged 6-18 years found these type of interventions can increase the duration of physical activity from five to 45 more minutes per day (Dobbins et al., 2013). Furthermore, school-based physical activity interventions increase the likelihood of children participating in about three times more MVPA during the school day compared to their non-participating counterparts (Dobbins et al., 2013). The subsequent sections outline the impact of single component physical education, class-, break- and lunch-time interventions as well as whole-school interventions that contain multiple components on children's physical activity.

2.10.1 Compensation after school in response to school physical activity interventions?

Many school-based intervention studies only examine children's physical activity during school hours (Lanningham-Foster et al., 2008, Murtagh et al., 2013, Goh et al., 2014, Mahar et al., 2006, Erwin et al., 2011, Martin and Murtagh, 2015, Bartholomew and Jowers, 2011, Verstraete et al., 2007, Donnelly et al., 1996, Sallis et al., 1997, McKenzie et al., 1996, Luepker et al., 1996, Stratton and Mullan, 2005, Blaes et al., 2013, Ridgers et al., 2007b, Ridgers et al., 2007a, Ridgers et al., 2010, Huberty et al., 2011, Verstraete et al., 2006, Lopes et al., 2009, Scruggs et al., 2003, Howe et al., 2012, Larson et al., 2014) which leaves the debate open to whether children would compensate or sustain the increased school day activity after school (Kriemler et al., 2011, Pate et al., 2006). Morgan et al. (2007) suggests that if children compensate after school in response to low school day activity there may be less need for school-based physical activity interventions, whereas if children do not compensate after inactive school days, the promotion of physical activity during the school day, such as during physical education, break- and lunch-times, becomes even more important. Studies investigated this potential compensation of physical activity after school by examining children's physical activity on days with and without physical education (Pate et al., 2011, Meyer et al., 2011, Murtagh and McKee, 2013, Morgan et al., 2003, Tudor-Locke et al., 2006, Dale et al., 2000, Myers et al., 1996, Mallam et al., 2003). Most studies found primary school-aged children attained higher amounts of physical activity on days with physical education versus days without physical education (Pate et al., 2011, Meyer et al., 2011, Murtagh and McKee, 2013, Morgan et al., 2003, Tudor-Locke et al., 2006, Dale et al., 2000, Myers et al., 1996). This finding suggests that children do not compensate their

physical activity after school in response to the provision or absence of physical education during the school day. On the contrary, one study found children that took part in physical education for 1.8 to 2.2 hours per week increased their after school physical activity to a greater extent than those who participated in nine hours of physical education weekly (Mallam et al., 2003). This finding suggests that children increased their after school activity in response to lower levels of school day activity. As the majority of studies showed children increased their after school activity on days with physical education, these findings suggest the physical activity opportunities during this segment of the school day is important and school-based interventions are a potential source of increasing children's daily physical activity. Furthermore, children's physical activity in school-based interventions should be measured in the entire day to determine whether compensation occurs after school.

2.10.2 Break- and lunch-time physical activity interventions

Ideally, physical education would be scheduled for longer periods and more frequently within the school day, however academic pressures often take precedence (Dobbins et al., 2009). Although physical education interventions were somewhat successful at increasing children's physical activity, the available physical education time has been limited (Cardon et al., 2012) and reduced due to academic pressures (Jago and Baranowski, 2004). Therefore, other avenues towards physical activity promotion were sought. Lunch-times are scheduled each day and may provide the greatest opportunity to increase children's physical activity during the school day (Robert Wood Johnson Foundation, 2007). Providing loose game equipment (Lopes et al., 2009, Verstraete et al., 2006), playground markings with and without physical structures (Stratton and Mullan, 2005, Blaes et al., 2013, Ridgers et al., 2007a, Ridgers et al., 2007b, Ridgers et al., 2010) and structured or semi-structured activities during lunch-times (Scruggs et al., 2003, Howe et al., 2012, Huberty et al., 2011, Stellino et al., 2010, Larson et al., 2014) were the types of single component lunch-time interventions that were implemented with the intention of increasing primary school-aged children's physical activity.

Painting school playgrounds with markings was a low-cost intervention implemented in the UK to increase children's physical activity (Stratton and Mullan, 2005, Ridgers et al., 2007a, Ridgers et al., 2007b, Ridgers et al., 2010). One study examined the impact of this type of intervention on French children's physical activity as school policies regarding frequency and duration vary by country (Blaes et al., 2013). Playground markings such as castles, clock faces, mazes, dens, hopscotch and letter squares were painted on the yard in no particular order in one study (Stratton and Mullan, 2005) and contained within three coloured zones in the other four studies (Blaes et al., 2013, Ridgers et al., 2007a, Ridgers et al., 2007b, Ridgers et al., 2010). The three coloured zones were designed to encourage a certain level of activity i.e. yellow was the chill out zone, red was the sports area and blue was the fitness and skills area (Blaes et al., 2013, Ridgers et al., 2007a, Ridgers et al., 2007b, Ridgers et al.,

2010). In three studies, physical structures such as soccer goal posts, basketball hoops, fencing around red sports area and a seating in yellow quiet area were placed within the colour coded zones (Ridgers et al., 2007a, Ridgers et al., 2007b, Ridgers et al., 2010). The findings of these studies showed painting playground markings and/or providing physical structures increased 6-11 year old French and English children's lunch-time physical activity in comparison to the control group when implemented for four (Stratton and Mullan, 2005, Blaes et al., 2013) to six weeks (Ridgers et al., 2007a) or six months (Ridgers et al., 2007b). Although the findings of these studies were encouraging, one year-long study found the strongest effect of the intervention on eight year old children's morning and lunch-time MVPA was during the first six months and decreased between the six and 12 month period (Ridgers et al., 2010). It appears from these findings that playground markings have a positive effect on children's lunch-time physical activity in the short term but that a further stimulus may be required to promote activity after six months.

Two studies investigated the impact of the provision of game equipment during lunch-time on Portuguese and Belgian children's physical activity (Lopes et al., 2009, Verstraete et al., 2006). Both studies provided loose game equipment such as skipping ropes and balls during lunch-times. Only Verstraete et al. (2006) gave the children instructions on games that could be played with the equipment provided. The findings of this study showed Belgian children aged 9-11 years significantly increased their lunch-time MVPA in comparison to the control group (Verstraete et al., 2006). Similarly, the Portuguese children aged 6-12 years spent a significantly higher percentage of lunch-time in physical activity when they had game equipment at lunch-time compared to when they did not have access to this equipment (Lopes et al., 2009). These findings suggest the provision of game equipment even without instructions on games to play with the equipment can help increase primary school-aged children's physical activity during lunch-time. Measurements of children's school day and daily physical activity is warranted to determine how children respond to this type of intervention outside lunch-times. Furthermore, the long term effects and sustainability of this initiative is unknown and warrants further investigation.

Five studies examined the impact of structured and semi-structured lunch-times on children's physical activity (Scruggs et al., 2003, Howe et al., 2012, Huberty et al., 2011, Stellino et al., 2010, Larson et al., 2014). One study implemented 15-20 minute additional structured fitness breaks on three schools days and were supervised by a physical education specialist (Scruggs et al., 2003). This study found the 11 year old American children were significantly more active in the fitness breaks compared to the traditional unstructured break- and lunch-times (Scruggs et al., 2003). In another structured lunch-time intervention, the trained research team delivering 22 games to American children aged 8-10 years during lunch-times over nine weeks (Howe et al., 2012). The children participating in this

intervention significantly increased their lunch-time and school day MVPA compared to the control group (Howe et al., 2012). Two studies implemented semi-structured lunch-times (Larson et al., 2014, Huberty et al., 2011). These intervention designs were semi-structured as the children were allowed to switch to different activity stations during lunch-times. The activities in Larson et al. (2014) that lasted only four days were provided by the research teams whereas the semi-structured activities in Huberty et al. (2011) that were implemented over seven months were planned by the physical education and lunch-time staff and modified when they did not attract children. American children aged 8-11 years spent significantly more MVPA during the semi-structured lunch-times than during unstructured lunch-times (Larson et al., 2014). Similarly, the 8-11 year old American children's participation in the semi-structured activities increased their lunch-time and school day MVPA in comparison to baseline measures (Huberty et al., 2011). These findings suggest that semi-structured or structured lunch-times can help increase primary school-aged children's physical activity. The impact of this type of intervention on children's daily MVPA is unknown and warrants investigation.

Overall, there is some evidence to show that playground markings, game equipment and structured or semi-structured activities can successfully increase primary school-aged children's lunch-time and school day MVPA. Further investigations of children's physical activity in lunch-time interventions are warranted to build the evidence base. An examination of children's daily MVPA as they participate in lunch-time interventions is warranted to determine how they respond after school to these types of interventions.

2.10.3 Class-time physical activity interventions

Due to academic pressures, time allocated to physical education, break- and lunch-times have been reduced and children are spending more of their school day inactive during class-time (Holt et al., 2013). Studies suggest physical activity participation can improve children's academic performance (Centers for Disease Control Prevention, 2010), concentration (Caterino and Polak, 1999), classroom behaviour (Mahar et al., 2006) and attentiveness (Azrin et al., 2006). Children's physical activity within three types of class-time interventions were examined that involved 1) changes to the classroom environment (Lanningham-Foster et al., 2008, Cardon et al., 2004a), 2) physical activity breaks during class-time (Murtagh et al., 2013, Drummy et al., 2016) and 3) integrated physical activity into academic content (Stewart et al., 2004, Liu et al., 2008, Mahar et al., 2006, Erwin et al., 2011, Gibson et al., 2008, Martin and Murtagh, 2015, Bartholomew and Jowers, 2011, Oliver et al., 2006). Efficient class-time interventions would increase children's physical activity but not interrupt teaching. The impact of these types of class-time interventions on children's physical activity is outlined in the following sections.

2.10.3.1 Changes to the classroom environment

Two interventions structurally altered the furniture in two classrooms with the aim of increasing primary school-aged children's physical activity (Lanningham-Foster et al., 2008, Cardon et al., 2004a). One 1.5 year intervention promoted physical activity during class-time through work organisation (removing the association between work and place of work), circumstantial influence (providing standing tables) and behavioural influence (highlighting good examples of being physically active in the classroom) (Cardon et al., 2004a). The findings of this study showed the eight year old German children attending this active classroom were more physically active during class-time than the comparative Belgian control group who completed their lessons using standard chairs and desks (Cardon et al., 2004a). A second US study structurally changed the furniture of two classrooms (Lanningham-Foster et al., 2008). The "standing" classroom had adjustable vertical desks and anti-fatigue floor-mats and the "neighbourhood" classroom contained standing desks, vertical mobile whiteboards, miniature golf, basketball hoops, indoor soccer and climbing mazes. Ten year old children's physical activity was measured with accelerometers in these classrooms were compared to children's physical activity in classrooms with standard desks and chairs and children on their summer holidays. Findings indicate the "neighbourhood" classroom significantly increased children's school day physical activity by 50% which was comparable to the physical activity of children on summer holidays. However, the "standing classroom" did not significantly alter children's physical activity in comparison to the control group. Although the "neighbourhood" classroom successfully increased children's school day physical activity, this approach may not be feasible for schools due to the cost and structural changes involved in replicating this classroom design. Overall, these studies show structural changes to the classroom furniture, especially the large and costly changes to the classroom furniture, appear to be promising at increasing children's physical activity.

2.10.3.2 Physical activity breaks during class-time

Two interventions promoted physical activity during class-time by providing activity breaks from academic studies (Murtagh et al., 2013, Drummy et al., 2016). Bizzy Breaks, one of the class-time activity break interventions, required Irish children to engage in physical activities when taking a ten minute break from academic studies (Murtagh et al., 2013). The activities consisted of mobility, stretching and pulse-raising exercises and were performed to music. A music CD, poster that summarised the activities and teacher notes that detailed information on the activities were provided to the teachers in the intervention group. Children aged 7-12 years significantly increased their school day steps by participating in the Bizzy Breaks class-time intervention when compared to the control group. The second class-time activity break intervention was trialled in Northern Ireland among children aged nine and ten years (Drummy et al., 2016). Class teachers were provided with information packs detailing approximately 40 exercises to enable the implementation of the activity breaks. These teachers were asked to lead activity breaks of their own choosing that began with a one minute gentle jog and four minute activities consisting of exercises such as hopping,

jumping and running on the spot. The intervention group significantly increased their weekday daily MVPA after participating in the class-time activity breaks for 12 weeks when compared to the control group. The findings of these two studies suggest that five and ten minute activity breaks during class-time can help children increase their school day and weekday physical activity. Further research is warranted to build the evidence base on the impact of class-time activity breaks on children's daily MVPA.

2.10.3.3 Integrated physical activity into academic content

The third and most popular approach to promoting physical activity during class-time is the integration of physical activity into the academic curriculum (Goh et al., 2014, Mahar et al., 2006, Erwin et al., 2011, Donnelly et al., 2009, Martin and Murtagh, 2015, Bartholomew and Jowers, 2011). Two systematic reviews of class-time integrated physical activity interventions found primary school-aged children's physical activity improved after participating in these types of interventions (Norris et al., 2015, Webster et al., 2015). These intervention instructed teachers to incorporate physical activity into at least one ten minute academic lesson per school day (Goh et al., 2014, Mahar et al., 2006, Donnelly et al., 2009, Martin and Murtagh, 2015, Bartholomew and Jowers, 2011) or part of the 60 and 90 minute 4^{th} and 5^{th} grade US maths lessons (Erwin et al., 2011) or to meet the US physical activity policy of providing 20 minutes of daily physical activity outside physical education, break- and lunch-times (Holt et al., 2013). American children aged 8-11 years participating in the Take 10 class-time intervention significantly increased their school day steps by 672 from baseline to mid-intervention and significantly increased their accelerometer-measured school day MVPA by approximately 2 minutes from baseline to end-intervention (Goh et al., 2014). American children aged 8-11 years that engaged in the Energizers class-time intervention took significantly more school day steps than the control group (Mahar et al., 2006). The Physical Activity Across the Curriculum (PAAC) class-time intervention significantly increased 7-9 year old American children's school day and daily MVPA in comparison to the control group (Donnelly et al., 2009). American children aged 8-12 years spent significantly more steps during the physical activity integration maths lessons and school day than baseline measures (Erwin et al., 2011). American children aged 8.7 years significantly increased their school day MVPA when engaged in class-time integrated physical activity that attempted to reach the 20 minutes of extra school day activity target (Holt et al., 2013). Irish children aged 8-9 years that engaged in the Active Classrooms class-time intervention spent 7.7 more minutes in MVPA during the integrated academic physical activity lessons than the regular academic lessons (Martin and Murtagh, 2015). American children aged 8-9 years that participated in the Texas-ICAN class-time intervention spent approximately 20% of the intervention lessons in MVPA and took significantly more steps during these lessons than the control group (Bartholomew and Jowers, 2011). Overall, these studies show the integration of physical activity into the academic curriculum is effective at increasing children's school day physical activity. Further research is warranted

to determine whether children compensate after school in response to higher school day physical activity.

In summary, studies show that changing the classroom environment, providing physical activity breaks during class-time and integrated physical activity into academic content are effective strategies at increasing primary school-aged children's physical activity. While the changes to the classroom environment were effective at increasing children's physical activity, the structural changes were vast and costly thus not feasible for schools generally. The positive effect of activity breaks during class-time on children's physical activity is promising, however further research is warranted to build the evidence base regarding the impact of this type of class-time intervention on children's physical activity. Integrating physical activity into academic content consistently increased children's class-time and school day physical activity. While one study reported the impact of physical activity integrating into academic lessons on children's daily MVPA (Donnelly et al., 2009), further research is warranted to determine children's after school physical activity response to this type of class-time intervention. Overall, these studies suggest schools should incorporate physical activity into academic lessons or provide physical activity breaks during class-time.

2.10.4 Whole-school physical activity interventions

The time allocated to physical education is generally not sufficient to make a large impact on children's daily and weekly energy expenditure (Fox et al., 2004a). Therefore, it has been suggested that the promotion of physical activity within the school context is shifted from the traditional focus on the promotion of sport and physical education exclusively to a whole-school approach in which the culture and policy of the school is child centred and health and activity driven (Fox et al., 2004a). A whole-school approach deals with the single health issue of promoting physical activity (Naylor et al., 2008, Naylor et al., 2006b). This approach is inclusive of all children and addresses the provision of physical activity within the school curriculum, policy and environment (Timperio *et al.* 2004). Under this approach, highly active physical education lessons are scheduled regularly (Cardon et al., 2012), the school ethos promotes active travel, informal and formal participation in physical activity (Cale, 2000) and the family and community are involved in the promotion of physical activity (Naylor et al., 2006c). The whole-school approach broadens children's opportunities to be physically active at school (Fox et al., 2004b). Physical activity is promoted throughout the school day for example with the provision of active break-/lunch-times, active travel, sports clubs or teams and a broad range of non-competitive activities such as gardening and theatre designed to entice pupils to be active that are usually inactive at school (Fox et al., 2004b).

A whole-school approach is recommended as one of the seven best areas of investment to increase physical activity when applied at a sufficient scale (Global Advocacy for Physical Activity the Advocacy Council of ISPAH, 2011). This strategy is also endorsed by many researchers and organisations due to its' great potential to promote physical activity among children (Carson et al., 2014a, Institute of Medicine, 2013, Public Health England, 2015, Naylor and McKay, 2009, Fox et al., 2004b, Sebelius et al., 2010). However, there is only limited evidence that shows the effectiveness of this approach at improving physical activity (Fox et al., 2004b, Timperio et al., 2004, Naylor et al., 2015, Heath et al., 2012) with the majority of findings based on older children within middle and high schools (Naylor et al., 2008, Cale, 2000). One study examining physical activity levels in whole-school interventions versus single component interventions found the three reviewed whole-school interventions were more successful at increasing children, adolescents' and young adults' physical activity than the modified teaching strategies during physical education with an MVPA focus, changes in school policy, the painting of playground markings, offering a curriculum-based physical activity unit as a credit subject and the teaching of units on preventing unhealthy weight gain or the promotion of physical activity (Timperio et al., 2004). In total, primary school-aged children's physical activity has been examined in five types of whole-school interventions: Comprehensive School-based Physical Activity Programme (CSPAP), APPLES Schools model of Comprehensive School Health (CSH), Move It Groove It, Action Schools BC and Active Programme Promoting Lifestyle Education in School (APPLES). The outcome of these whole-school interventions on primary school-aged children's physical activity are outlined below.

Three whole-school interventions for primary school-aged children were not evaluated using objective measures. One of these whole-school interventions, called APPLES (Sahota et al., 2001a) was developed in the UK primarily to reduce risk factors for obesity among primary school-aged children. This intervention altered the curriculum, physical education lessons, and playground activities in primary schools. Children aged 7-11 years participated in the evaluation of this intervention over one academic year which revealed no significant difference in the self-reported physical activity scores between the intervention and control groups. A second whole-school intervention was trialled with South African children aged 10-15 years over 18 months (Naidoo and Coopoo, 2012). Principals and educators were trained to implement the intervention activities during class-time, lunch-time and after school. After participating in this intervention for 18 months, the participants self-reported engaging in 45-125 minutes of MVPA weekly. The Australian Move It Groove It whole school intervention (NSW Health Physical Activity Demonstration Project, 2003) targeted children's physical activity during physical education, break- and lunch-times. In an attempt to increase children's physical activity by 10%, a range of strategies were used including buddy systems, professional development, project teams and the provision of resources in the form of a website and equipment. While this year-long intervention did not increase

children's physical activity by 10%, there was an observed increase of 3% in vigorous physical activity during physical education. The main limitation of these evaluations was that physical activity was not measured objectively. Children's physical activity was measured by self-report in APPLES and the South African intervention while Move It Groove It was assessed by direct observation. Self-report is not recommended for research among children under the age of ten due to limited recall skills (Dollman et al., 2009) and student reactivity is a concern of direct observation (Armstrong and Welsman, 2006, Trost, 2007). Further research on whole-school interventions using objective measurements is warranted to provide a more accurate assessment of children's physical activity in this type of intervention.

Previous studies measured children's physical activity in the Canadian Action Schools! BC whole school intervention (Naylor et al., 2006a) using pedometers (Naylor et al., 2008) and accelerometers (Tomlin et al., 2012). This intervention promotes physical activity through the school environment, physical education, class-time, family, community, extra-curricular activities and school spirit. The aim is for schools to provide children with 150 minutes of physical activity per week that includes two 40 minute physical education lessons weekly and 15 minutes of additional physical activity during class-time each day or 75 more minutes of physical activity per week (Naylor et al., 2008). Two different approaches to implementing this whole school intervention were examined in each study. One approach entitled Liaison meant that all teachers received regular support from a School Facilitator. The second approach called Champion meant that one teacher became a leader in promoting physical activity within the school by receiving information from the School Facilitator and sharing this knowledge with the other teachers. One study compared 9-11 year old Canadian children's physical activity that participated in this intervention over one year to a control group using pedometers and found a significant difference of 1175 steps between the boys in the Liaison schools and the control group (Naylor et al., 2008). However, there was no statistically significant difference between the girls' step count in all types of schools or boys' step count in the Champion and control schools. Another study measured 12.5 year old Canadian Aboriginal children's physical activity within this whole-school intervention using accelerometers (Tomlin et al., 2012). This study found no significant difference in the Aboriginal children's daily MVPA from baseline to follow-up (Tomlin et al., 2012). The main limitation of this study was that the findings cannot be generalised to the population as only Aboriginal children were included in the study and there was no comparison group (Tomlin et al., 2012). While the findings of both studies provide objective measures of children's physical activity in whole-school interventions, the accelerometer findings are context specific to Aboriginal children and the pedometer findings cannot be compared to the daily physical activity intensity guideline. Further research is warranted that examines the general population of primary school children's physical activity in whole school intervention using accelerometers.

Children's physical activity in another Canadian whole-school intervention called APPLES Schools model of CSH was measured using pedometers (Ploeg et al., 2014). The key component of this intervention was the placement of a full-time school health facilitator in each school. These school health facilitators were hired as new staff in each school and received six weeks of training to assist in the implementation of the intervention. Parents, communities and school stakeholders were involved to ensure policies, programmes and environments in the whole school community were supportive of physical activity. Children aged 10-11 years that participated in this whole-school intervention took significantly more steps per day than those in the control group. It appears the employment of a full time health facilitator in this type of intervention is effective at increasing primary school children's physical activity. Measurements of children's physical activity in this whole-school intervention using accelerometers is warranted to determine the contribution this approach makes to meeting the daily physical activity intensity guideline.

The American CSPAP whole-school intervention was evaluated in two studies (Burns et al., 2015, Carson et al., 2014b). This whole-school intervention promoted physical activity before school, after school and during physical education, class-, break- and lunch-times. The physical activity target during physical education was to be active for at least 50% of the lesson. Teachers were provided with training monthly that focused on the delivery of physical education. During break- and lunch-times, staff encouraged students to play in the semi-structured activity stations or "walk and talk" with their friends along the walking trails. "No parking zones" were also established to prevent children from sitting or standing in certain areas of the yard. Teachers were encouraged to hold a minimum of 2-3 five minute activity breaks during class-time. The study conducted by Burns et al. (2015) found children aged 9-11 years significantly increased their school day step count from baseline to post-intervention. The main limitation of this study was that there was no control group to compare the intervention group's physical activity. In contrast, Carson et al. (2014b) found the 9-14 year old children that participated in this whole school intervention spent significantly less time in accelerometer-measured MVPA daily compared to the control group. This study did not exclusively examine primary school-aged children's physical activity thus further research on whole-school interventions using accelerometers is warranted.

Overall, there is limited data that shows the impact of whole-school interventions on children's physical activity and further research is warranted to build this evidence base. The available data provides mixed findings on the effectiveness of this intervention at increasing primary school children's physical activity. One study found children in a whole-

school intervention significantly increase their school day steps from baseline to post-intervention (Burns et al., 2015). Two studies found significant increases in children's or boys-only steps after participating in whole-school interventions compared to control groups (Naylor et al., 2008, Ploeg et al., 2014) and one study found children that participated in a whole-school intervention spent significantly less time in MVPA daily compared to the control group (Carson et al., 2014b). There is still data to be acquired on the impact of primary school-aged children's physical activity in a whole school intervention using accelerometers that is compared to a control group.

2.10.5 Are existing physical activity interventions effective?

Systematic reviews of school-based physical activity interventions for children find multi-component interventions are the most effective at increasing children's physical activity (Public Health England, 2015, Naylor and McKay, 2009, U.S. Department of Health and Human Services, 2012, Riso et al., 2014, Kriemler et al., 2011). A multi-component intervention implies two or more intervention strategies are implemented simultaneously (U.S. Department of Health and Human Services, 2012). The effective strategies of multi-component interventions included support from families (Kriemler et al., 2011, Naylor and McKay, 2009, Public Health England, 2015), the delivery of physical education by specialists (Kriemler et al., 2011, U.S. Department of Health and Human Services, 2012), a focus on increasing MVPA during physical education (U.S. Department of Health and Human Services, 2012, Naylor and McKay, 2009), additional or longer physical education lessons (Riso et al., 2014, U.S. Department of Health and Human Services, 2012, Naylor and McKay, 2009), classroom activity breaks (Riso et al., 2014, U.S. Department of Health and Human Services, 2012, Naylor and McKay, 2009), curricular learning (Public Health England, 2015), active lunch-times (Riso et al., 2014, Naylor and McKay, 2009), changes to the school environments (Riso et al., 2014, Public Health England, 2015) and activity sessions before and after school including active travel (U.S. Department of Health and Human Services, 2012). Generally, interventions that target physical activity during physical education and incorporate curriculum and/or environmental changes were found to be more effective at increasing children's physical activity than curriculum only interventions (van Sluijs et al., 2007, Kriemler et al., 2011). This evidence suggests a multi-component approach to promoting physical activity should be adopted by schools to increase children's physical activity.

There is limited objective data available that indicates the impact of a whole-school approach to physical activity promotion among primary school-aged children (Naylor et al., 2008, Ploeg et al., 2014, NSW Health Physical Activity Demonstration Project, 2003, Carson et al., 2014b, Burns et al., 2015, Sahota et al., 2001a). This type of intervention addresses the provision of physical activity in the school curriculum, policy and environment (Timperio *et al.* 2004). Regardless of the limited data available, this strategy is recommended as one

of the seven best investments for physical activity (Global Advocacy for Physical Activity the Advocacy Council of ISPAH, 2011) and is endorsed by many researchers and organisations due to its' great potential to promote physical activity among children (Carson et al., 2014a, Institute of Medicine, 2013, Public Health England, 2015, Naylor and McKay, 2009). Further research on children's physical activity in whole-school interventions is warranted to build the evidence base for determining the effectiveness of this type of approach to physical activity promotion.

There is sufficient, emerging and suggestive evidence that single component physical education, active travel and activity break interventions can increase children's physical activity respectively (U.S. Department of Health and Human Services, 2012). Physical education interventions that develop and implement a well-designed physical education curriculum, enhance instructional practices to provide substantial MVPA or provide teachers with appropriate training has shown to successfully increase children's overall physical activity and physical activity during physical education (U.S. Department of Health and Human Services, 2012). Evidence is suggestive that active travel strategies can increase children's physical activity (U.S. Department of Health and Human Services, 2012). One systematic review found active travel interventions consistently increased children's physical activity in their targeted setting (McDonald et al., 2015), however further studies and reviews are required to strengthen the evidence base on the effectiveness of this strategy to increase children's physical activity. There is emerging evidence that activity breaks during class-, break- and lunch-times can increase children's physical activity (U.S. Department of Health and Human Services, 2012). However, it was difficult for reviews to draw conclusions regarding the impact of activity breaks on children's physical activity as many of these studies were part of multi-component interventions (U.S. Department of Health and Human Services, 2012, Naylor and McKay, 2009). Therefore, further studies of single component activity breaks are warranted to enable conclusions to be made on the impact of single component interventions on children's overall daily physical activity levels. Overall, these reviews suggest the physical education strategies to promote physical activity are worth promoting but further research is warranted to make definitive conclusions regarding the effectiveness of active travel and activity breaks on increasing children's physical activity.

In summary, the multi-component approach is the most effective at increasing children's physical activity. There is also sufficient evidence that children's physical activity can be improved through physical education strategies. A whole-school approach to physical activity promotion is widely recommended however only a few studies examine children's physical activity in this type of intervention. Further research on children's physical activity

in whole school, active travel and activity break approaches are warranted to determine the effectiveness of these strategies.

2.10.6 Considerations for future intervention designs

It is good practice to provide sufficient information of the intervention to enable other researchers to replicate or improve the design (Corder et al., 2015, Schulz et al., 2010). Checklists such as the Consolidated Standards of Reporting Trials (CONSORT) (Schulz et al., 2010) and the Transparent Reporting of Evaluations with Nonrandomised Designs (Des Jarlais et al., 2004) were developed to guide researchers to report transparent and replicable studies. However, many physical activity intervention studies do not follow these guidelines thus contain methodological flaws such as the use of physical activity measures of unknown reliability and validity (Salmon et al., 2007). Self-report is the most commonly used tool to evaluate the impact of interventions on physical activity (Dobbins et al., 2013), however this form of measurement is not recommended for research among children under the age of ten due to limited recall skills (Dollman et al., 2009). Accelerometers are highly recommended for evaluating physical activity interventions as they provide objective and dynamic information on the duration and intensity of the activity performed (Dollman et al., 2009). This measurement tool also allows comparisons to be made to the daily physical activity intensity guideline (Dollman et al., 2009), however only a few intervention studies use accelerometers for their physical activity evaluations (Dobbins et al., 2013). Furthermore, many school-based physical activity interventions only measure children's physical activity during the targeted setting or school hours only which is problematic as it may overestimate the total daily changes in physical activity (Metcalf et al., 2012). For example, the effect of the KISS intervention (Kriemler et al., 2010) during school was more than four times greater than the entire day intervention effect (Metcalf et al., 2012). It is recommended that future interventions capture participants' physical activity in the entire day as well as during the specific intervention periods to determine whether children compensate after school in response to higher school day activity (Metcalf et al., 2012, Van Sluijs and Kriemler, 2016). Overall, future school-based physical activity interventions should follow guidelines, such as CONSORT, when reporting the study findings, measure participants' physical activity for the entire day using accelerometers and examine MVPA levels during the targeted setting.

2.10.6.1 Theoretical models

It is becoming more common for physical activity interventions to use theoretical models, such as the Theory of Planned Behaviour (Ajzen, 1985), the Ecological Model (Sallis et al., 2008), Behavioural Change Wheel framework (Michie et al., 2011), Behavioural Choice Theory (Rachlin, 1989), the Ecological Systems Theory (Bronfenbrenner, 1986) and Social Cognitive Theory (Bandura, 1986), to guide the intervention development (Van Sluijs and Kriemler, 2016, Dobbins et al., 2009). The three most frequently used theories to develop physical activity interventions are Skinner's PRECEDE model 1953, Social Cognitive Theory, and Rosenstock's Health Belief Model 1966 (Dobbins et al., 2009). Since 2008, the

comprehensive school physical activity programme (CSPAP) has been a widely endorsed whole-school physical-activity focused theoretical model (Carson et al., 2014a, American Alliance for Health Physical Education and Dance, 2013, Control and Prevention, 2013) that proposes 60 minutes of physical activity may be achieved daily through the multi-component CSPAP implementation (Centers for Disease Control and Prevention, 2011, Control and Prevention, 2013). The use of theoretical models are deemed imperative when developing interventions for children (Eather et al., 2013b) as it leads to more successful, stronger and longer lasting changes (Michie and Abraham, 2004, Lai et al., 2014). Theoretical models also help interventions to be developed based on the best available and most recent evidence (Van Sluijs and Kriemler, 2016), ensures it is acceptable to those delivering and participating in it (Van Sluijs and Kriemler, 2016), identifies gaps to be addressed prior to undertaking large evaluations (Van Sluijs and Kriemler, 2016) and helps in the understanding of how the intervention worked and how interventions can be improved in the future (Van Sluijs and Kriemler, 2016, Michie and Abraham, 2004, King et al., 2002). It is clear the use of theoretical models is beneficial in the development and evaluations of interventions, thus continues to be warranted to guide future physical activity interventions.

2.10.6.2 Student views/voice/perspectives

A relatively novel idea is the inclusion of participants' views during the developmental stages of physical activity interventions (Naylor and McKay, 2009, O' Cathain et al., 2013). Engaging student voice early in the process helps develop an acceptable and attractive intervention for participants and increases the likelihood of a successful trial, effectiveness and intervention sustainability (Van Sluijs and Kriemler, 2016). Children's perspectives can also reveal their understandings, interpretations, negotiations and feelings about their daily lives (Greene and Hogan, 2005, Loveridge and Hetherington, 2010). This strategy has been listed as one of the eight principles for practice that works to increase children's physical activity at school as it ensures activities are tailored to their needs thus supports participation in the intervention (Public Health England, 2015). The importance of including children's perspectives in research is highlighted in article 12 of the United Nations Convention on the Rights of the Child (United Nations, 1989), the UK Children's Act (Department of Health, 1989) and the Irish National Children's Strategy (Department of Children and Youth Affairs, 2000). The National Physical Activity Plan and the ASF national whole-school initiative also stress the importance of incorporating student voice in the provision and promotion of physical activity (Department of Health & Department of Transport Tourism and Sport, 2016). One target of the National Physical Activity Plan is to include children in the development and implementation of programmes in which they are involved (Department of Health & Department of Transport Tourism and Sport, 2016) and one of the requirements of the national ASF initiative is to involve the children in the decision making process regarding the provision and promotion of physical activity by including them in the ASF school committee. There is a paucity of research that involves student voice in the design of health interventions (O' Cathain et al., 2013). To date, only a

few studies were found that incorporate student voice in the design of physical activity interventions for adolescents (Jago et al., 2011, Edwardson et al., 2015, Corder et al., 2013). No published research consulted with a representative sample of participants prior to the main trial of an intervention for primary school-aged children. The development of interventions in light of primary school-aged children's perspectives is warranted to help create successful physical activity interventions in the future.

In summary, the evidence outlined in this section suggests future school-based physical activity interventions are guided by a theoretical model, include student voice in the research process particularly during the developmental stages, use accelerometers to measure physical activity for the entire day and intervention specific periods and follow the recommended checklists such as CONSORT when reporting the study findings.

2.11 Conclusion

The literature highlights the numerous health benefits associated with physical activity engagement among primary school-aged children. However, studies show the majority of children accumulate low levels of physical activity. Research suggests that increasing children's school day activity can lead to higher amounts of daily physical activity, therefore school-based interventions designed to increase children's physical activity are warranted. Whole-school interventions are the most promising strategy to increase children's physical activity, however further research is warranted due to the limited data available. Further analysis of children's physical activity in single component interventions would be beneficial as it would indicate the impact of specific strategies on children's overall physical activity levels.

Chapter 3. An evaluation of primary school children's physical activity during the segmented school day.

3.1 Introduction

Despite evidence that physical activity provides fundamental health benefits for children (Strong et al., 2005), many Irish (Woods et al., 2010), other European (Riddoch et al., 2007b) and American children (Centers for Disease Control and Prevention, 2005) do not meet the physical activity guideline of 60 minutes of MVPA daily (World Health Organisation, 2010), rendering physical activity promotion essential. School is a popular location to promote physical activity as it has an unparalleled opportunity to reach the vast majority of children of different ethnic and socio-economic backgrounds (Peterson and Fox, 2007). This setting also has more continuous and intensive contact with children than any other institution in the first 20 years of their lives (Story et al., 2006). Most children attend school from the ages of 5-17 years (Peterson and Fox, 2007) and in Ireland full-time education is compulsory for children aged 6-16 years (Halbert and MacPhail, 2005). Children also spend a significant amount of their waking hours in school (Dobbins et al., 2009, Naylor et al., 2006a, Guinhouya et al., 2009). For example American elementary school children attend school for 180 days per year and for 6 or more hours each school day (Peterson and Fox, 2007). In Ireland, primary school children attend school for 183 days and for 5 hours and 40 minutes per school day (Department of Education and Science, 1995). Overall, the school provides an opportunity to reach many children from different backgrounds and for a large proportion of their waking hours, thus is an ideal setting to promote physical activity.

A typical day at primary school consists of three main segments: class-, break- and lunch-times. In Ireland, physical education is recommended to be scheduled for one hour each week (Irish National Teacher's Organisation, 2007) and break- and lunch-times held for 10 and 30 minutes each school day (Department of Education and Science, 1999b). Physical education, break- and lunch-times are often the only segments during the school day which children can be regularly physically active (Kobel et al., 2015, Belton et al., 2010). An analysis of the segmented school day highlights physical activity opportunities for children, trends in school day physical activity and times where physical activity may be beneficial. Four studies assessed primary school children's physical activity within the segmented school day (Nettlefold et al., 2011, Tudor-Locke et al., 2006, Brusseau et al., 2011, Bailey et al., 2012). Two American studies assessed the school day activity of elementary school children (Brusseau et al., 2011, Tudor-Locke et al., 2006). They reported that lunch-time provides the largest source of step counts during the school day for boys and girls aged 9-11 years (Brusseau et al., 2011), and boys and girls aged 11-12 years accumulated the highest steps during lunch-time and physical education respectively (Tudor-Locke et al., 2006). As pedometers were used to measure physical activity in these studies the findings do not

show the contribution of school time activity towards meeting the daily physical activity intensity guideline.

A study of 10-14 year old British children utilised accelerometers for physical activity analysis, thus were able to explore physical activity intensity levels during the segmented school day (Bailey et al., 2012). The findings of this study showed that girls spent significantly more time in sedentary behaviour and light physical activity during break- and lunch-times than boys. Boys engaged in more vigorous physical activity at break-time and moderate physical activity and vigorous physical activity at lunch-time than girls. Although this study identified gender physical activity differences during the segmented school day, the age range of the sample is not representative of primary level only. It is imperative to identify primary school children's physical activity alone to detect this age group's physical activity for future initiatives that will attempt to delay the age-related decline in physical activity (Waring et al., 2007).

A further Canadian study examined elementary school children's physical activity during the segmented school day using accelerometers (Nettlefold et al., 2011). The findings of this study showed that 8-11 year old boys and girls accumulated the following minutes of MVPA at school: 5.3 and 3.8 at break-time, 15.6 and 12.5 at lunch-time, 4.6 and 5.2 minutes during physical education and 39.9 and 33.8 during class-time. Overall these boys and girls accumulated a total of 63.5 and 52.9 minutes of MVPA at school, indicating that the children's average school day minutes of MVPA exceeded or almost reached the daily recommendation of 60 minutes of MVPA. This finding is unusual as studies conducted worldwide indicate that the majority of children do not meet the daily physical activity guideline (Riddoch et al., 2007b, Woods et al., 2010, Centers for Disease Control and Prevention, 2005). Furthermore, the range of school day accelerometer-measured minutes of MVPA among 6-11 year old Swiss (Kriemler et al., 2010), 10 year old English (Van Sluijs et al., 2011), 8-11 year old French (Guinhouya et al., 2009) and 5-7 year old Australian children (Engelen et al., 2013a) was only 17.7 to 43.6, indicating the participants' school day activity levels in Nettlefold et al. (2011) is not representative of children's physical activity worldwide. Therefore an investigation into primary school children's segmented school day accelerometer-measured physical activity is warranted in a location where school day physical activity is low.

In summary, previous studies of children's physical activity during the segmented school day did not use accelerometers to identify primary school children's physical activity exclusively where low daily physical activity levels were previously identified. It is important to identify

children's physical activity levels during the segmented school day in locations that previously reported low daily physical activity to determine usual school day physical activity behaviours. Thus, the primary purpose of the present study is to determine the amount of minutes children spend in MVPA during the segmented school day. As boys and girls generally have different physical activity patterns (World Health Organisation, 2008, Sallis, 2000b, Woods et al., 2010), the secondary objective of the present study is to identify whether gender differences are evident in the school day MVPA.

3.2 Methods

3.2.1 Study Design

The design of the present study is cross-sectional as physical activity measurements were conducted at one time point over a short period (Levin, 2006). A convenience sampling method was used to select the schools for the study. Four mixed primary schools situated in one town in Co. Kerry agreed to participate in the study. Within these schools, pupils of third to sixth class whose teachers expressed an interest in the study were invited to participate. Ethical approval was granted by the Research Ethics Committee at Mary Immaculate College (MIREC) in February 2012 (see Appendix 1).

3.2.2 Participants

A priori power analysis was performed using the G*Power 3 software package (Faul et al., 2007) to determine the appropriate sample size to detect the statistical significance between boys' and girls' physical activity that is of practical importance (O' Shea, 2013). Given 80% power, .05 alpha and the difference between two independent means statistical test, 102 participants were required to detect a medium (t=.50) standardised effect (Cohen, 1988). Additional participants were recruited to account for possible noncompliance issues. 184 children in third to sixth class from four mixed urban primary schools were invited to participate in the study. The children and parents were informed of the nature of the study before participating in the research. Informed consent of both children and their guardians was obtained and participants were free to withdraw from the research at any stage. 22 children (4^{th} class n=10, 5^{th} class n=4, 6^{th} class n=8) did not give parental or child consent to participate, thus were excluded from the study. The target age group was eight to twelve years. One participant was older than 12 years, thus was excluded from the study. Participants with disabilities were not excluded from the study.

3.2.3 Anthropometric characteristics

Participants' anthropometric measurements were taken the day before physical activity monitoring began according to standardised procedures (Lohman et al., 1988) as outlined in the following sections.

3.2.3.1 Height

Participants' height was measured using a portable stadiometer (Seca Corp, Model #214 Road Rod, Hanover, MD). The height protocol used was based on Lohman's (1988)

Anthropometric Standardization Reference Manual (see Appendix 2). The participants were measured in their school uniform excluding shoes and accessories. Participants stood on the footprints of the base of the stadiometer with their heels together and touching the backstop. Participants aligned themselves to touch the uprights with their buttocks and shoulder blades and hung their arms freely by their side with palms facing their thighs. When the participant's head was positioned in the Frankfurt Plane, the measuring arm was lowered and placed firmly against their head, with enough pressure to compress the hair down to touch the head. Height measurements were recorded to the nearest millimetre. This procedure was repeated immediately after the first recording of the participant's height. A third measurement was taken when there was over a 1cm inconsistency between the first and second measurements (Yildirim et al., 2013). When three measurements were taken, the closest two were averaged to calculate BMI (Yildirim et al., 2013).

3.2.3.2 Body Mass

Participants' body mass was measured using an electronic personal scale (Seca Corp, Model #899, Germany). The weight protocol used was based on Lohman's (1988) Anthropometric Standardization Reference Manual (see Appendix 2). Participants wore their school uniform and were instructed to remove their shoes and accessories. Participants were instructed to stand on the scale with both feet fully on the weighing platform and weight equally distributed between their feet. Participants were told to hang their arms freely by their side with palms facing the thighs, look straight ahead and stand as still as possible. Body mass measurements were recorded to the nearest 0.1kg. This procedure was repeated immediately after the first recording of the participant's body mass. A third measurement was taken when there was over a 1kg inconsistency between the first and second measurements (Yildirim et al., 2013). When three measurements were taken, the closest two were used to calculate BMI (Yildirim et al., 2013).

3.2.3.3 Body Mass Index

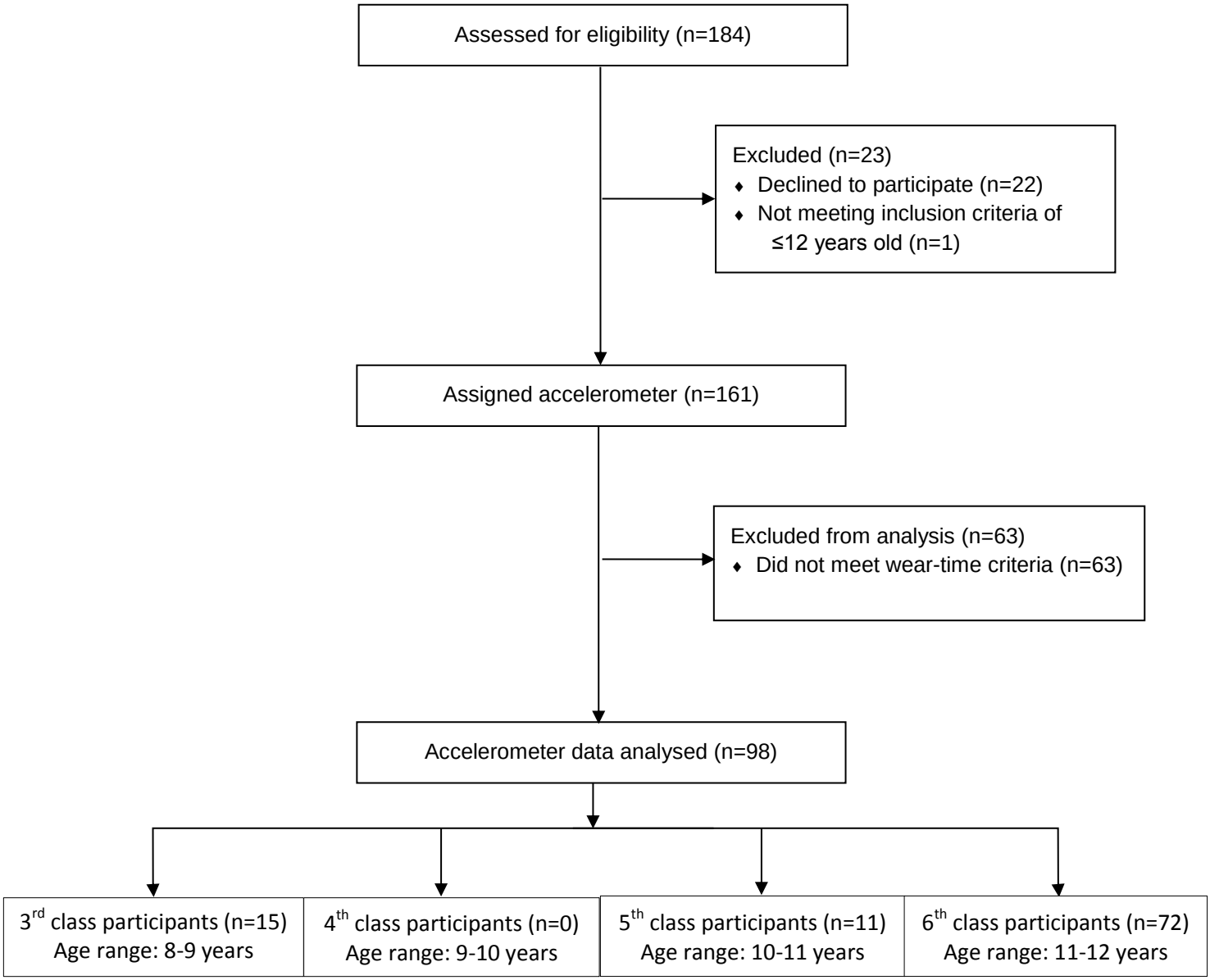
Height and body mass measurements were averaged for each participant. BMI was calculated as weight divided by height squared (kg/m^2). Decimal age was calculated using participants' date of birth and the date of height and body mass measurements. Participants were assigned to underweight, normal weight, overweight and obese categories according to the cut off BMI values specific to their age and sex, derived by Cole et al. (2007) and Cole et al. (2000).

3.2.4 Physical activity

Physical activity was measured using two types of Actigraph accelerometers (Models GT1M and GT3X, Pensacola, FL32502). The uniaxial GT1M and triaxial GT3X accelerometers utilised in the present study both have the same dimensions (1.5" x 1.44" x 0.70") and weight (27g) (Exercise and Physical Activity Resource Center). The vertical axis output of both types of accelerometers are also comparable (Sasaki et al., 2011). All participants with informed consent were assigned an accelerometer (n=161). The accelerometers were

calibrated through the ActiLife software (Version 6.6.3, Pensacola, FL32502) to measure in 5-second epochs (the user-specified time interval in which a filtered digitalised acceleration signal from the accelerometer is combined (Trost et al., 2005)) as this has been shown to provide the best estimate of the intermittent and sporadic nature of children's physical activity (Edwardson and Gorely, 2010, Mc Clain et al., 2008, Trost et al., 2005). To distinguish between non-wear time (occasions when the participant is not wearing the device e.g. while sleeping or participating in water-based activities) and sedentary behaviour, patterns of physical activity reading more than 20 minutes of consecutive zero counts were excluded from the analysis. This duration was selected as a study found the longest recorded bout of motionless data among children aged 8-13 years was on average 17 minutes, suggesting 20 minutes of consecutive zeros is behaviourally implausible in school aged-children (Esliger et al., 2005). A previous study on children's school day physical activity required participants to wear the physical activity monitor for a minimum of 300 minutes per school day to be included in the analysis (Murtagh et al., 2013). Most recent research suggests that a minimum of three days wear time is the most commonly used criteria for children (Rich et al., 2013). Therefore, participants that did not wear the accelerometer for at least 300 minutes on three days out of five were excluded. 63 participants did not meet this criterion and were excluded. Therefore, 60.9% of participants had valid accelerometer data and were included in the final analysis (n=98). Figure 3.1 illustrates the flow of participants through the trial.

Figure 3.1. Diagram showing the flow of participants



3.2.5 Data collection

Participants' height and weight measurements were conducted and recorded once by the principal researcher the day before the physical activity monitoring period. Height and weight were measured in single sex groups of four in a private room in the school to ensure confidentiality. Participants waiting to be measured were instructed to stand with their backs touching the wall so that they could not view other participant's height and weight measurements. The electronic personal scale (Seca Corp, Model #899, Germany) has a two metre-long cable that connects the display to the scales. This display was placed on a table facing the researcher and away from all participants' view. Height and weight measurements were recorded using participant identification numbers (PID) rather than participants' names. Participants' were not told their height and weight measurements. Only neutral comments such as "thank you" and "you can step off the scale" were made by the researcher (Kudat et al., 1996).

The principal investigator measured participants' physical activity at one school during spring (March) and three schools during autumn (September and October). The physical activity data was collected on school days from Monday to Friday at one school in March 2012, Thursday to Wednesday at two schools in September and Monday to Friday at another school in October 2012. Data, forms and accelerometers were identified only by a PID to maintain confidentiality. Labels containing PIDs were stuck on the accelerometers for organisation and confidentiality purposes. The accelerometers were fully charged through a standard USB port. These devices were initialised through the ActiLife software (Version 6.6.3, Pensacola, FL32502) to record in 5-second epochs (Edwardson and Gorely, 2010, Mc Clain et al., 2008, Trost et al., 2005) from 9am on the first day of monitoring (ActiGraph Software Department, 2012) and stop at the end of the school day (2.30/2.40pm) on the fifth day of monitoring.

The researcher fitted the participants with an accelerometer on an elastic belt at the centre of the right hip due to the greater energy expenditure associated with whole-body movements compared with upper-body movements among children older than five years (Cliff et al., 2009). Participants were instructed to wear the accelerometer during school hours only for five consecutive school days over or under their shirt so that it is worn as close as possible to the hip region. The researcher also prompted the participants to follow their normal daily routine, remove the accelerometer for water-based activities and leave it beside the bed while sleeping (e.g. on their bedside locker). Participants wore the accelerometer during school time the day before the physical activity testing period to minimise the influence of possible behaviour change (Dossegger et al., 2014). Each morning of the physical activity monitoring week, the participants placed the accelerometers on their hip using the elastic belt. The researcher visited each school on the first day of physical

activity monitoring to check the position of the accelerometers and address any issues participants had with these devices. Class teachers were shown the position the participants were to wear the accelerometers and were asked to correct the placement of the accelerometer if worn incorrectly throughout the physical activity monitoring week. Class teachers were provided with the researcher's telephone number if they had any further queries regarding the accelerometers. A container was provided to store the accelerometers at the end of each school day.

The researcher collected the accelerometers at the end of the last school day monitored and asked the class teachers to provide details on the times for the start and end of school day and the times when participants took part in physical education, break- and lunch-times during the physical activity monitored week. The accelerometer data was downloaded through the ActiLife software (Version 6.6.3, Pensacola, FL32502) (ActiGraph Software Department, 2012) the day after the last day of monitoring. The Evenson et al. (2008) cut-point of ≥2296 counts per minute (cpm), derived from a laboratory based study of 33 children aged between 5 and 8 years old, was used to determine MVPA. This cut-point was chosen as an evaluation of five independently developed ActiGraph cut-points (Evenson et al., 2008, Freedson et al., 2005, Mattocks et al., 2007, Puyau et al., 2002, Treuth et al., 2004) on 206 participants aged 5-15 years revealed the Evenson et al. (2008) cut-point misclassified the least amount of sedentary and light intensity activity as MVPA among children aged ≥ 10 years (Trost et al., 2011). Time filters within the ActiLife data analysis software (Version 6.6.3, Pensacola, FL32502) were applied to extract the mean minutes of MVPA accumulated during the school day, physical education, class-, break- and lunch-times (ActiGraph Software Department, 2012). For confidentiality purposes, records were kept in a locked file cabinet, computer entry and networking programmes were completed using PIDs only, data was stored on a password protected computer and access to data was limited to the principal investigator.

3.2.6 Statistical Analysis

Data manipulation was conducted in Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA) and statistical analysis was conducted with the statistical package for the social sciences (IBM SPSS Statistics version 21, US). Descriptive statistics were used to summarise subject characteristics, minutes of MVPA and proportion of time spent in MVPA. Three assumptions were checked to determine whether parametric tests could be performed on the accelerometer data. The three parametric assumptions require the dependent variable to be measured on interval or ratio scales, to be normally distributed and have homogeneity of variance and covariance between samples being compared (O' Donoghue, 2013). MVPA, the dependent variable, is measured on the ratio scale as the numerical values measure quantities and zero represents an absence of the concept being measured (O' Donoghue, 2013). To determine whether MVPA was normally distributed, the

Kolmogorov-Smirnov test was used as there were more than 50 cases of MVPA data (Field, 2013). The results of this test indicate that MVPA data was normally distributed (p>0.05) as the distribution of the sample was not significantly different from a normal distribution (Field, 2013) (p=.150). Levene's test was conducted to determine whether there was homogeneity of variance (Field, 2013). The results of this test indicate that MVPA does not have homogeneity of variance (p=.015). This analysis indicates the MVPA did not come from a normally distributed population, therefore non-parametric tests were used. Mann Whitney U tests were used to identify any significant gender differences in terms of age, weight, height, BMI, school day MVPA, physical education MVPA, class-time MVPA, break-time MVPA and lunch-time MVPA. Significance was accepted at $p<.05$

3.3 Findings

3.3.1 Descriptive characteristics

Descriptive characteristics of participants attending four urban mixed primary schools are presented in Table 3.1. When the Cole et al. (2007) and Cole et al. (2000) age and gender specific cut-points for underweight, overweight and obesity were applied, three participants were identified as underweight, four participants were classified as obese, 22 participants were identified as overweight and 69 participants were of normal weight (see Figure 3.2). There was no significant gender difference for age, weight, height or BMI ($P > .05$). In total, 70.4% of the sample was of normal weight, 3.1% was classified as underweight, 22.4% as overweight and 4.1% as obese.

Table 3.1. Mean (SD) measurements of participants' characteristics

	Boys (n=49)	Girls (n=49)	All (n=98)
Age (years)	11.2 (1.1)	11.1 (1.3)	11.2 (1.2)
Weight (kg)	41.1 (9.6)	42.0 (9.7)	41.5 (9.6)
Height (m)	1.5 (0.1)	1.5 (0.1)	1.5 (0.1)
BMI (kg/m^2)	19.2 (2.9)	19.1 (3.0)	19.1 (2.9)

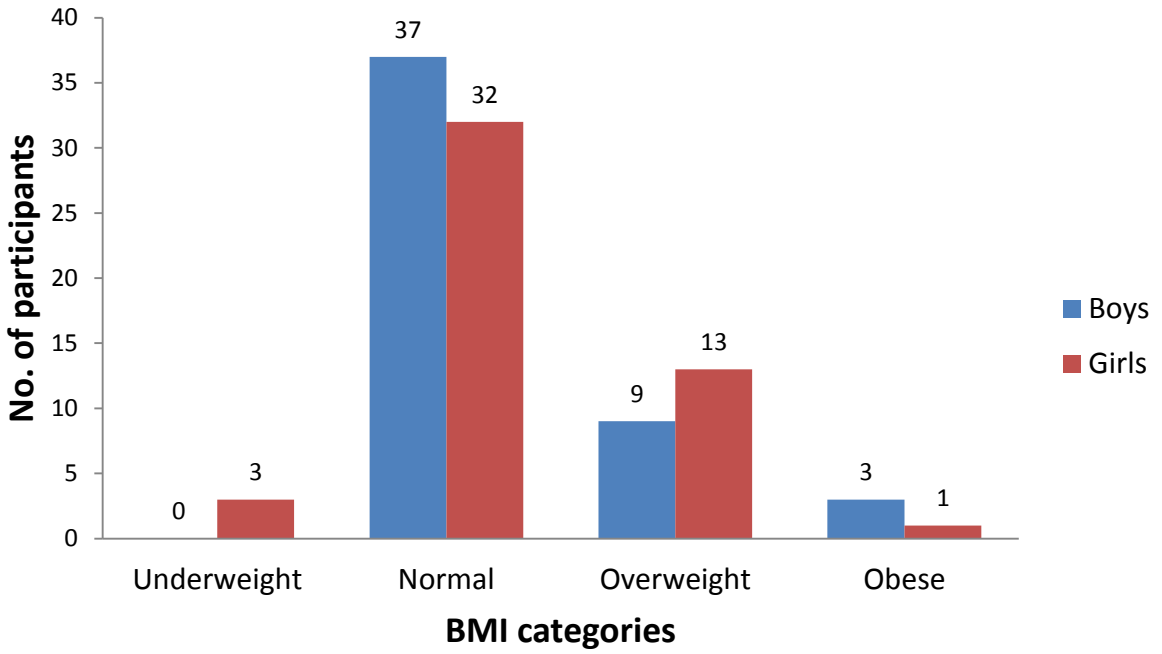


Figure 3.2. BMI profile of participants

3.3.2 School environmental factors and practices

All schools had a hall for physical education lessons. School playgrounds were 300m^2, 640m^2, 1144m^2 and 5200m^2 in size. The break- and lunch-time play area in two schools consisted of a tarmacadam surface. The other two schools had both a tarmacadam surface and grass area for break- and lunch-times. Playground markings such as hopscotch, mazes and clocks were available in all school yards for break- and lunch-times. Two school yards contained a basketball playground marking and one school had an artificial grass surface for soccer games for use during break- and lunch-times. Children in all schools were permitted to bring their own personal game equipment to school such as balls and skipping ropes and use during break- and lunch-times. All schools permitted students to use the bathroom during yard time. Three schools designated time to eat before the scheduled yard time. One school used half of the scheduled break- and lunch-times for eating. Weather during the physical activity monitoring period was not recorded which is a limitation of this study.

3.3.3 Segmented school day MVPA

The school day consisted of 330-340 minutes with 15-20 minutes for break-time, 30 minutes for lunch-time, 30-60 minutes for physical education scheduled once weekly, 285-290 minutes for class-time on days without physical education and 225-255 minutes for class-time on days with scheduled physical education. Physical education MVPA measurements of four children (one boy and three girls) are unavailable as they were absent from school on the day when physical education was scheduled. Boys spent significantly more time than girls in MVPA in the entire school day ($P < .001$), physical education ($P = .014$), class-time ($P = .019$), break-time ($P < .001$) and lunch-time ($P < .001$) (see Table 3.2).

Table 3.2. Mean (SD) minutes of MVPA during the entire school day, physical education, class-, break- and lunch-time.

Minutes of MVPA	All (n=98)	Boys (n=49)	Girls (n=49)	p-Value
School day	18.5 (7.2)	22.8 (6.9)	14.2 (4.3)	.000*
Break-time	3.5 (2.1)	4.7 (2.2)	2.2 (1)	.000*
Lunch-time	6 (3.4)	7.9 (3.3)	4.1 (2.3)	.000*
Class-time	7.3 (3.1)	8.1 (3.6)	6.4 (2.1)	.019*
Physical education	10.4 (5)	11.7 (4.3)	9 (5.4)	.014*

*Significant difference between boys' and girls' MVPA

Figure 3.3 illustrates the percentage of time boys and girls spent in MVPA during each school day segment. Boys spent a significantly higher percentage of physical education, class-, break- and lunch-times in MVPA than girls ($P < .05$). The segment of the school day in which boys undertook the highest percentage of MVPA was break-time (30.8% of 15-20 minutes) whereas physical education was the segment of the school day in which girls carried out the highest percentage of MVPA (17.4% of 30-60 minutes). Both genders spent the lowest percentage of time in MVPA during class-time.

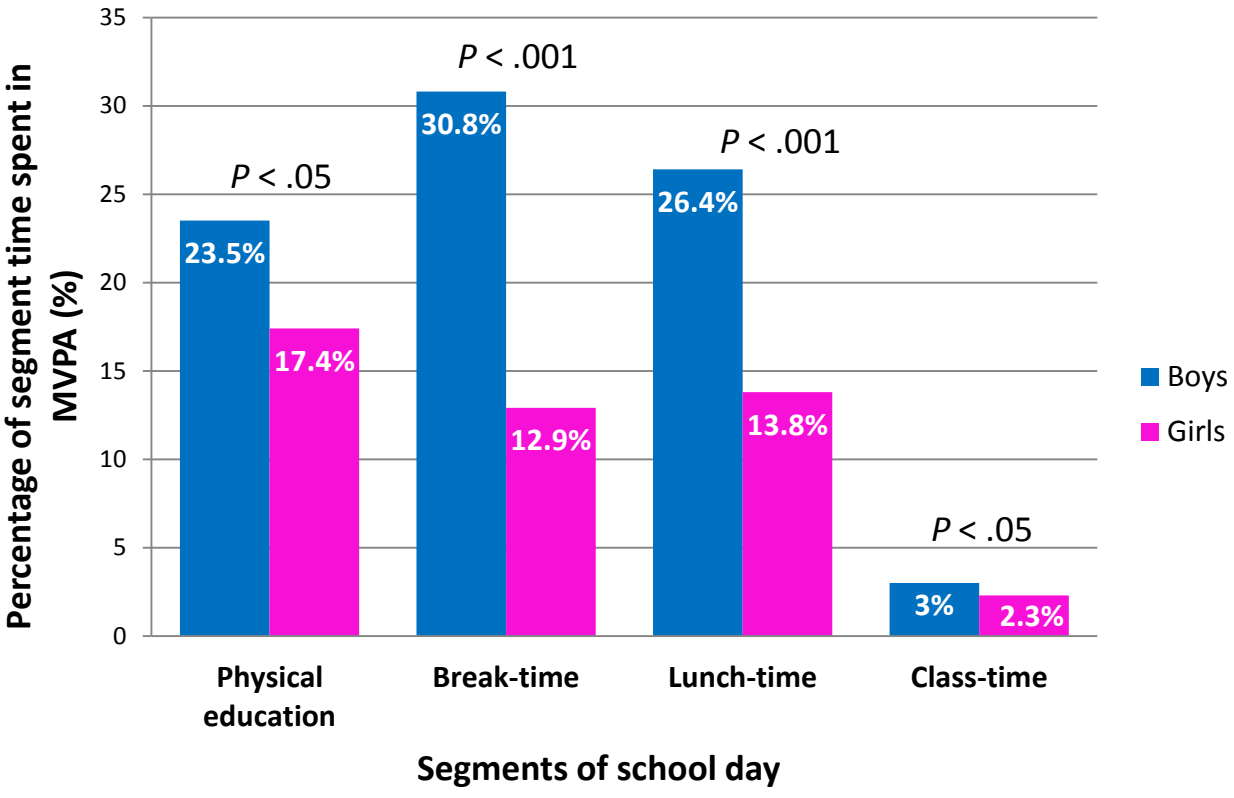


Figure 3.3. Percentage of time boys and girls spent in MVPA during each segment of the school day

*Statistical significant difference between boys' and girls' MVPA.

3.4 Discussion

The main purpose of the present study was to determine the time children spend in MVPA during the segmented school day and identify whether school day MVPA differences exist between boys and girls. The results of this study extend the current literature by providing an account of the time primary level children spend in MVPA during the segmented school day using accelerometers where low levels of daily physical activity was previously reported (Woods et al., 2010). The findings of the study will be discussed under five headings: school day MVPA, physical education MVPA, break- and lunch-time MVPA, class-time MVPA and boys' and girls' MVPA.

3.4.1 School day MVPA

Of the 330 to 340 minutes children in the present study spent at school, 18.5 of these minutes were spent in MVPA. As children spend approximately half their waking hours at school (Owen et al., 2000, Naylor et al., 2006a), researchers recommend children achieve 20 (Rush et al., 2012) or 30 minutes of MVPA at school (Fox et al., 2004a, Pate et al., 2006, Howells et al., 2010, The Report of the National Taskforce on Obesity, 2005) to help them achieve the daily MVPA guideline. The girls in the present study only accumulated an average of 14.2 minutes of MVPA at school, indicating many girls did not reach the school day MVPA targets. However, most boys in the present study reached the 20 minutes of MVPA school day target as they achieved an average of 22.8 minutes of MVPA during school. Unlike the girls but similar to the boys in the present study, an average of 29.9 minutes of MVPA was accumulated by 8-11 year old French boys (Guinhouya et al., 2009) and Australian children aged 5-7 years spent 24.8 and 27.4 minutes in MVPA during school hours (Engelen et al., 2013a). In contrast to the children from Australia, France and the present study, Canadian children aged 8-11 years accumulated 63.5 MVPA minutes (Nettlefold et al., 2011), New Zealander children aged 8-11 years accumulated 67.8 MVPA minutes (Rush et al., 2012), English children accumulated 43.6 MVPA minutes (Van Sluijs et al., 2011) and Swiss children accumulated 37 and 38 MVPA minutes (Kriemler et al., 2010) during school. One potential reason the boys and girls in the present study accumulated a lower amount of school day MVPA compared to the Canadian (Nettlefold et al., 2011), New Zealander (Rush et al., 2012), English (Van Sluijs et al., 2011) and Swiss participants (Kriemler et al., 2010) may be that there was more opportunities to be physically active in the latter schools than the schools in the present study. Participants in the English study spent 480 minutes at school (Van Sluijs et al., 2011) and the Canadian participants were at school for 387 minutes (Nettlefold et al., 2011) which represents 43% and 16% more time available for MVPA engagement at school respectively. The English (Van Sluijs et al., 2011), Canadian (Nettlefold et al., 2011) and New Zealander (Rush et al., 2012) schools scheduled 75.6, 75 and 90 minutes for break- and lunch-times each school day respectively which equates to a 51%, 50% and 80% increase in the number of minutes available to students for break- and lunch-time MVPA opportunities in these schools compared to participants in the present study. The Swiss schools held three physical education lessons each week (Kriemler

et al., 2010) whereas the schools in the present study held physical education once weekly. Previous research found children accumulated more physical activity on days with physical education compared to school days without physical education (Murtagh and McKee, 2013, Meyer et al., 2011, Tudor-Locke et al., 2006). Furthermore, the participants in the present study were also of an older age group than the 6-11 year old Canadian, English and Swiss children, with 76.5% of participants in the present study aged 11-12 years. As international trends have shown that physical activity levels decrease as children age (Hovell et al., 1999, Goran et al., 1998, Ridgers et al., 2011, Walter, 2011), the older ages of the children in the present study may explain their lower school day MVPA levels in comparison to the Canadian, English and Swiss children. Overall, it appears the children in the present study are closer to reaching the 20 minutes of MVPA school day target (Rush et al., 2012) than the more regularly cited 30 minutes of school day MVPA guideline (Fox et al., 2004a, Pate et al., 2006, Howells et al., 2010, The Report of the National Taskforce on Obesity, 2005). An examination of children's physical activity during segments of the day may highlight opportunities for physical activity at school.

3.4.2 Physical education MVPA

The children in the present study spent an average of 10.4% of physical education in MVPA. These children spent a lower percentage of physical education in MVPA than the 4-12 year old participants included in two systematic reviews of studies up to the year 2014 that examined primary school-aged children's physical activity during physical education. These reviews found children spent an average of 34.2% (Fairclough and Stratton, 2006) and 44% (Hollis et al., 2015) of physical education in MVPA. Furthermore, the children in the present study were not sufficiently active during physical education to meet the US and UK physical education target, that is to spend at least 50% of physical education in MVPA (US Department of Health and Human Services, 2000, Association for Physical Education, 2008). Globally, physical education curriculums contains broad aims such as the teaching of motor skills, becoming aware of the benefits of physical activity and developing social and affective competencies (Meyer et al., 2011). Therefore physical education lessons are not always designed for high intensity activity. Fairclough and Stratton (2005) suggest planning and delivering physical education lessons with MVPA goals in mind may make a significant contribution to children's daily physical activity levels. Furthermore, a systematic review showed children who participated in interventions designed to increase the time spent in MVPA during physical education spent 24% longer in MVPA during physical education than the control group (Lonsdale et al., 2013). Overall, it appears there is potential to increase children's daily MVPA perhaps by planning and delivering physical education lessons with MVPA goals in mind.

3.4.3 Break- and lunch-time MVPA

Participants in the present study spent between 12.9% and 30.8% of break-time in MVPA and 13.8% and 26.4% of lunch-time in MVPA. Similarly, 5-10 year old English girls and boys spent 25.3% and 32.9% of break- and lunch-times in MVPA (Ridgers et al., 2005), 6-9 year

old English girls spent 21.9% and 27% of break- and lunch-times in MVPA (Ridgers et al., 2007b), 6-9 year old English boys spent 30.8% and 33.7% of break- and lunch-times in MVPA (Ridgers et al., 2007b), 8-11 year old Canadian girls and boys spent 19.6% and 27.9% of break-times and 27.9% and 34.7% of lunch-times in MVPA (Nettlefold et al., 2011) and 8-12 year old South African children spent 33% of break- and lunch-times in MVPA (Walter, 2011). Playground markings and loose game equipment were available to all participants in the present study and previous research shows these strategies can increase the percentage of break- and lunch-times spent in MVPA when compared to control groups (Stratton and Mullan, 2005, Engelen et al., 2013b, Verstraete et al., 2006, Ridgers et al., 2007b, Blaes et al., 2013, Lopes et al., 2009). In the UK, it is suggested that spending 40% of break- and lunch-time in MVPA is an achievable goal for primary school children (Ridgers et al., 2005), yet the participants in the present study did not achieve this break- and lunch-time MVPA target. Belgian children aged 9-11 years (Verstraete et al., 2006) and English children aged 10-14 years (Bailey et al., 2012) spent as high as 47% to 56.6% of break- and lunch-times in MVPA which shows the potential MVPA levels children could achieve during break- and lunch-times. Perhaps the differences between the percentage of break- and lunch-time spent in MVPA in the present study and the Belgian and English children may be due to the time allotted for this segment of the school day. For example, the English children had 45 to 65 minutes for lunch-time whereas the children in the present study had just 30 minutes for the same segment of the school day. Perhaps providing more school time for break- and lunch-times may help children increase their MVPA. In summary, it appears there is potential to increase the time children spend in MVPA during break- and lunch-times.

3.4.4 Class-time MVPA

As expected of a usually seated segment of the school day (Tudor-Locke et al., 2006), participants in the present study spent the lowest percentage of school day MVPA during class-time (around 3% of class-time in MVPA). In contrast, English (Bailey et al., 2012) and Canadian children (Nettlefold et al., 2011) spent about four times the percentage of class-time in MVPA than the participants in the present study: the English boys and girls spent 11.2% and 10.2% of class-time in MVPA and Canadian boys and girls spent 14.1% and 12% of class time in MVPA. It is unclear why the Canadian and British children were more active in the class setting than the Irish children as no other details were provided regarding their class-time activity. However, the British children spent more time in the class (5-6 hours) than the children in the present study (4-5 hours) which may have allowed for more class-time activity. Furthermore, different curriculums and teaching styles may promote more activity in the class, however as these studies did not provide information on these aspects it is only speculative. Children worldwide spend a large amount of the school day in class-time. The findings of the present study show children only accumulate the smallest percentage of MVPA during class-time, suggesting this segment would provide an opportunity to increase children's daily MVPA. Perhaps class-time activity programmes like Take 10! (Stewart et al., 2004) and Bizzy Breaks! (Murtagh et al., 2013) coupled with

professional development for teachers (Till et al., 2011) may enable increases in children's class-time MVPA.

3.4.5 Boys' and girls' MVPA

Girls in the present study spent significantly less time in MVPA than boys in the entire school day, physical education, class-, break- and lunch-times. Previous research also found girls to be significantly less active than boys at school (Murtagh et al., 2013, Nettlefold et al., 2011, Guinhouya et al., 2009, Belton et al., 2010), during class-time (Nettlefold et al., 2011) and at break and lunch-times (Bailey et al., 2012, Nettlefold et al., 2011). The gender difference in physical activity participation noted in these studies confirms physical activity promotion is particularly warranted for girls. It was a surprise that girls in the present study spent significantly less time in MVPA during physical education than boys as three previous studies did not report a significant difference between boys' and girls' minutes of MVPA (Nettlefold et al., 2011) and step count (Brusseau et al., 2011, Tudor-Locke et al., 2006) during this segment of the school day. Physical education is a segment of the school day where children are typically directed by the teacher to engage in the same activities however, the findings in the present study show girls performed these activities at a significantly lower intensity than boys. Studies have suggested that one possible explanation for the difference between boys' and girls' physical activity may be due to girls reaching a higher biological maturity age than their male counterparts (Telford et al., 2016, Wickel et al., 2009). It is thus possible that puberty may have had an impact on the difference between boys' and girls' MVPA during physical education and throughout the entire school day. Overall, both boys and girls spent the lowest percentage of the school day in MVPA during class-time which indicates that activating the curriculum and implementing class-time activity breaks for lesson transitions that engage both sexes is warranted. Of the segments of the school day which children generally have the opportunity to be regularly active (i.e. physical education, break- and lunch-times), boys accumulated the highest percentage of MVPA during break-time and the lowest during physical education. In contrast to boys' MVPA patterns, girls accumulated the highest school day MVPA during physical education and the lowest during break-time. These findings show boys engaged in more MVPA during a time designated as unstructured play whereas girls participated in more MVPA when the activities were structured and led by the teacher. Similarly, previous studies found boys obtained the highest amount of steps (Sarkin et al., 1997, Brusseau et al., 2011, Tudor-Locke et al., 2006, Beighle et al., 2006) and MVPA (Nettlefold et al., 2011, Ridgers and Stratton, 2005, Ridgers et al., 2011) during break- or lunch-times rather than during physical education. Likewise, a systematic review of children's physical activity during break- and lunch-times noted that girls tend to view break- and lunch-times as an opportunity to socialise with friends whereas boys prefer to play competitive games that tend to take up much of the play area (Ridgers et al., 2012). Previous studies differed in their findings on girls' MVPA patterns (Sarkin et al., 1997, Brusseau et al., 2011, Tudor-Locke et al., 2006, Nettlefold et al., 2011). Two studies indicated girls were most active during physical

education (Sarkin et al., 1997, Brusseau et al., 2011) whereas two other studies showed that break- and lunch-times yielded the highest step count and MVPA for girls (Tudor-Locke et al., 2006, Nettlefold et al., 2011). Overall, the findings in the present study suggest girls may benefit from an intervention with structured activities during break- or lunch-times whereas an intervention during physical education may be more suited for boys.

3.4.6 Study strengths and limitations

The main strength of the present study is that accelerometers were used to measure children's physical activity which allows direct comparisons to be made to existing and future school day accelerometer studies. Furthermore, the sample consisted of an equal amount of boy (n=49) and girl (n=49) participants which facilitated a gender balanced analysis of physical activity.

Study limitations include that the majority of participants were in sixth class grade level at the time of monitoring, therefore caution needs to be taken when generalising the results against the third to sixth class national population as activity levels generally decrease with increasing age (Waring et al., 2007). Data for three days was not available for 63 participants (60.9% of participants) which may suggest that the data is biased if the missing data is not similar to the data included in the final analysis (Catellier et al., 2005, Marshall et al., 2010, White and Carlin, 2010, van der Heijden et al., 2006). It is a further limitation that comparisons were not made between the missing and included data. In addition, participants were selected through teachers that expressed an interest to take part in the study. Perhaps these teachers were particularly interested in physical activity and promoting physical activity in their classrooms, thus the findings may be biased.

3.5 Conclusion

Children in the present study were approaching the 20 minutes of MVPA at school target. The present study showed the physical education, class-, break- and lunch-time school day segments present opportunities to increase children's school day MVPA. Initiatives to increase girls' MVPA levels in particular is warranted as girls spent significantly less time than boys in MVPA in the entire school day and all segments of the school day. Implementation of class-time interventions may be particularly useful for boys and girls as they spent the lowest percentage of the school day in MVPA during this segment of the school day. Girls may also benefit from an intervention with structured activities during break- or lunch-times as girls participated in more MVPA during physical education, a time when activities are structured and led by the teacher, than during lunch-times, a time when girls choose the activities to play. In contrast to girls, it appears that an intervention during physical education may be more suited for boys as boys engaged in more MVPA during break- and lunch-times than physical education. Overall, this study identifies the potential of physical education, class-, break- and lunch-times to increase primary school children's physical activity.

Chapter 4. A non-randomised controlled trial of primary school children's moderate to vigorous levels of physical activity in a whole school initiative: the Active School Flag.

4.1 Introduction

Physical activity provides fundamental health benefits for children (Tirlea et al., 2015, Zarrett et al., 2009, Holt et al., 2011, Wiersma and Fifer, 2008, Fitzgerald et al., 2012, Chalkley et al., 2015, Gu et al., 2016, World Health Organisation, 2010, Strong et al., 2005, Must and Tybor, 2005, U.S. Department of Health and Human Services, 2008, Department of Health and Children, 2009). However, many children worldwide do not accumulate at least 60 minutes of MVPA each day to attain these health benefits (Griffiths et al., 2013b, NHS Information Centre, 2010, Verloigne et al., 2012, Woods et al., 2010, Riddoch et al., 2007a, Centers for Disease Control and Prevention, 2005, Standage et al., 2014, Akinroye et al., 2014, Wachira et al., 2014, Rodriguez et al., 2014, Harrington et al., 2014a, Liukkonen et al., 2014, Draper et al., 2014, Ocansey et al., 2014, Gray et al., 2014, Dentro et al., 2014, Gonzalez et al., 2014, Schranz et al., 2014, Reilly et al., 2014), rendering physical activity promotion essential. The school is a popular location to promote physical activity (Dobbins et al., 2013, Peterson and Fox, 2007). To date, interventions that target primary school children largely focus on a single setting within the school environment (Naylor et al., 2008) such as the playground markings lunch-time intervention (Ridgers et al., 2010), the Take 10! classroom intervention (Kibbe et al., 2011) and the Motiv8 physical education intervention (Rowlands et al., 2008). In contrast to these intervention designs, a whole school approach which involves a child-centred, health and activity driven school culture and policy has been recommended to increase children's physical activity (Fox et al., 2004a, Carson et al., 2014a, Institute of Medicine, 2013, Public Health England, 2015, Naylor and McKay, 2009, Fox et al., 2004b, Sebelius et al., 2010). In fact, a whole school approach has been identified as one of the seven best areas of investment to increase physical activity (Global Advocacy for Physical Activity the Advocacy Council of ISPAH, 2012) and has been listed as one of the eight promising principles that works in schools to increase physical activity (Public Health England, 2015). Yet very few studies show the effect of the whole school intervention on children's physical activity (Fox et al., 2004b, Timperio et al., 2004, Naylor et al., 2015, Heath et al., 2012) with the majority of the findings based on older children within middle and high schools (Naylor et al., 2008, Cale, 2000).

Six whole-school physical activity initiatives were trialled among primary school-aged children in Canada (Naylor et al., 2008, Ploeg et al., 2014), South Africa (Naidoo and Coopoo, 2012), Australia (NSW Health Physical Activity Demonstration Project, 2003), the US (Carson et al., 2014b, Burns et al., 2015) and the UK (Sahota et al., 2001a). The APPLES intervention requires school staff to develop actions plans on the basis of their perceived needs (Sahota et al., 2001a). The South African whole school intervention requires trained principals and educators to implement intervention activities during class-time, lunch-time and after

school (Naidoo and Coopoo, 2012). The Move It Groove It intervention provides professional development, teacher support, new equipment and a website to target children's physical activity (NSW Health Physical Activity Demonstration Project, 2003). The Action Schools BC intervention is implemented by customising the design of the physical activity programme based on the perceived needs of the school and is facilitated by a support team (Naylor et al., 2008). The goal of the CSPAP is to enable students to achieve the 60 minutes of MVPA guideline (Burns et al., 2015, Carson et al., 2014b) by targeting the provision of physical activity before, during and after school and providing the lead facilitator of the programme in each school with training (Burns et al., 2015, Carson et al., 2014b). The APPLES School model of Comprehensive School Health (CSH) places a full-time school health facilitator in each school to create positive social environments (Ploeg et al., 2014).

After participating in these whole school interventions, significant increases were found for 8-10 year old children's vigorous physical activity during physical education (NSW Health Physical Activity Demonstration Project, 2003), 10-11 year old Canadian children's daily step count (Ploeg et al., 2014), 9-11 year old American children's school day step counts (Burns et al., 2015) and 9-11 year old Canadian boys' daily step count (Naylor et al., 2008) but there was a decline in 9-14 year old American children's daily MVPA (Carson et al., 2014b) and no significant difference in 7-11 year old English children's (Sahota et al., 2001b) or 10-15 year old South African's (Naidoo and Coopoo, 2012) self-reported scores for physical activity. A national whole school initiative called the Active School Flag (ASF) was established in Ireland in 2009, however to date the impact on primary school children's physical activity has not been examined. Whole school initiatives derived from other countries cannot simply be implemented in Ireland due to a unique mix of students, teaching styles, curriculums and differently resourced education systems (McKenna, 2009). Therefore, the impact of children's daily physical activity after participation in the Irish whole school initiative was examined in the present study.

Questionnaires (Naidoo and Coopoo, 2012, Sahota et al., 2001a), direct observation (NSW Health Physical Activity Demonstration Project, 2003), pedometers (Burns et al., 2015, Ploeg et al., 2014, Naylor et al., 2008) and accelerometers (Carson et al., 2014b) were used to measure children's physical activity in these whole-school interventions. However, questionnaires are not recommended for research among children under the age of ten due to limited recall skills (Dollman et al., 2009). Direct observation is not useful for measuring total daily physical activity as the information learned is limited to a narrow timeframe, setting or context like physical education, break- and lunch-times (Shumaker et al., 2008). Pedometers do not allow comparisons to be made to the daily physical activity guideline as it only provides information on the number of steps taken (Dollman et al., 2009).

Accelerometers are becoming the objective tool of choice among researchers as it provides objective and dynamic information on the duration and intensity of the activity performed (Dollman et al., 2009) and while one study measured 9-14 year old children's MVPA in the CSPAP whole-school intervention using accelerometers (Carson et al., 2014b) this cohort is not representative of primary school-aged children only. The present study will be the first to exclusively examine primary school-aged children's physical activity in a whole-school intervention using accelerometers. The use of accelerometers will indicate the impact of this whole-school initiative on children's MVPA during segments of the school day and whether children compensate after school in response to this school-day initiative.

Although segmented school day MVPA analysis through the use of accelerometers can provide further information on the outcome of children's physical activity in a whole-school initiative, it does not indicate the factors that influence changes in physical activity. Factors that influence children's physical activity are psychological (Rowe et al., 2007) with self-efficacy and perceived benefits of physical activity considered to have the most direct influence on children's physical activity as they reflect the child's predisposition towards being physically active (Welk and Schaben, 2004). High levels of self-efficacy and perceived benefits of physical activity increase the likelihood of being physically active regularly (Welk, 1999). Self-efficacy refers to the child's belief in their own capabilities to perform the physical activities whereas children's perceived benefits towards physical activity examines whether they believe their performance will produce certain outcomes (Crocker et al., 2008). Previous evaluations of children's physical activity in a whole-school intervention did not examine participants' psychological factors (NSW Health Physical Activity Demonstration Project, 2003, Naylor et al., 2008, Sahota et al., 2001b) which is consistent with the limited investigation of these factors in school-based interventions generally (Lubans et al., 2008). Exploring participants' psychological factors of physical activity in a whole school initiative provides information that can determine the aspects of the intervention that were linked to changes in physical activity (Bauman et al., 2002, Eather et al., 2013b). This study is the first to determine the relationship between children's psychological factors, of self-efficacy and perceived benefits of physical activity, and daily physical activity in a whole-school intervention. Analysis of children's psychological correlates is imperative to provide information that can lead to future improvements in whole-school intervention effectiveness (Bauman et al., 2002).

In summary, an Irish whole school national initiative was established in 2009. Although children's physical activity in whole school interventions were studied previously in other countries, these findings may be context specific due to differently resourced education systems, curriculums and teaching styles (McKenna, 2009). In addition, exclusively primary school-aged children's physical activity in these whole school interventions were not

measured using accelerometers. An examination of children's psychological correlates of physical activity and MVPA during school day segments may provide further details on the outcome of children's daily MVPA and identify the aspects of the intervention that were linked to potential changes in physical activity. Therefore, the main purpose of the present study was to evaluate the impact of a whole-school activity promoting initiative on primary school children's daily MVPA. The three secondary objectives of this study were to 1) investigate children's MVPA in ASF schools during physical education, break- and lunch-times, 2) analyse participants' segmented school day MVPA with a separate gender analysis and 3) determine whether there was a correlation between the psychological correlates and daily MVPA after participating in the whole-school initiative.

4.2 Methods

4.2.1 The Active School Flag

The ASF (www.activeschoolflag.ie) is a whole school, national self-evaluation initiative which focuses on promoting physical activity through physical education, co-curricular physical activity and sport. Award of the ASF requires the school to provide at least 60 minutes of physical education weekly for each class group as per the Department of Education and Skills guideline (Department of Education and Science, 1999b). Schools must review, plan and implement improvements that will enhance physical education and physical activity for all students across three main areas: 1) physical activity, 2) physical education and 3) community links. See Appendix 3 for a list of samples improvements primary schools implemented to achieve the ASF. The physical activity review area requires schools to use discretionary time to enhance the physical education curriculum and provide extra opportunities for physical activity, make a range of team and individual extra-curricular activities available, promote activity during break- and lunch-times, provide inclusive physical activity, encourage active travel to and from school, involve pupils in the decision making for promotion and provision of physical activity and celebrate pupils' physical activity skills and achievements. Within the physical education review area, schools must provide a comprehensive school physical education plan, teach a minimum of five of the six strands of the primary physical education curriculum (aquatics, athletics, dance, gymnastics, games and outdoor and adventure activities) to each class every year, encourage staff to attend training courses in physical education/physical activity/sport and attain adequate equipment for comprehensive physical education, physical activity and sport. The community links review area involves working with parents and the local community to promote physical activity and seek help from National Governing Bodies, Local Sports Partnerships and the Health Service Executive to promote physical activity. Schools must also organise an Active School Week every year that encourages the whole school community to become more active. The National ASF screening committee awards the ASF by viewing the evidence which confirms that each of the improvements stated in the application form have been completed or implemented. Examples of evidence provided by schools may include planning documentation, written, photographic and/or DVD evidence

that document the schools' events and initiatives, conducting interviews with the school community and viewing display areas and demonstrations by the students. The ASF is a voluntary whole-school physical activity initiative open to all primary Irish schools (McMullen et al., 2015) which is unique among previous whole-school interventions in that it was not implemented as part of a trial with the explicit purpose of evaluating physical activity. The focus of the present study was to independently analyse participants' MVPA before (baseline) and after (follow-up) schools engage with the ASF process.

4.2.2 Study Design

A quasi-experimental, non-randomised evaluation design was employed in the present study to compare children's MVPA that participated in the ASF process and were awarded the ASF to children in schools that did not engage with the physical activity initiative. This design is a pre-test post-test design without randomisation (Thomas et al., 2011) of schools to intervention or control group. The Transparent Reporting of Evaluations with Non-Randomised Designs (TREND) (Des Jarlais et al., 2004) checklist was followed to ensure the evaluation of the study was clearly reported (Dudley et al., 2011) (see appendix 4). The TREND checklist is based on the CONSORT guidelines for the reporting of randomised controlled trials (Des Jarlais et al., 2004). Schools that registered to engage in the ASF initiative were invited to express their interest in participating in the research. The inclusion criterion for schools to participate in the study as the ASF group was primary schools that registered their interest in the ASF initiative and wished to take part in the study on the ASF website (www.activeschoolflag.ie). The first two schools that applied to participate in the research were chosen as the ASF group. A list of 26 potential control schools was identified on the SchoolDays.ie website under the criteria of school type and location. The principals of the first two schools on this list were contacted by phone and invited to participate as the control group. When schools declined to participate as the control group, the researcher removed them from the list and contacted the principals of the next schools on the list. In total, three schools declined to participate and two schools took part as the control group. The control schools did not participate in the ASF or other physical activity initiatives for the duration of the study. The ASF group completed or implemented the improvements stated in their application form at different times and independently of the researcher. One school was assessed and awarded the ASF by the National ASF screening committee after six months of participating in the process (November 2012- June 2013). The second school was assessed and awarded the flag one year after committing to the ASF process (November 2012- November 2013). Follow-up measurements were conducted with the ASF and matched control schools in June or November 2013 to account for potential seasonal variation in participants' physical activity levels and attitudes towards physical activity. Ethical approval was granted by MIREC in February 2012.

4.2.3 Participants

Figures 4.1 and 4.2 illustrate the flow of participants in the ASF and control groups respectively. Eighty-one 1^{st}-6^{th} class children from two mixed rural primary schools were

invited to participate in the study, after registering for the ASF but before enacting changes as part of the ASF process. Likewise, 95 1st-6th class children from two mixed rural primary school matched for school type and location were invited to participate as the control group. The children and guardians were informed of the nature of the study before participating in the research. Informed consent of both children and their guardians were obtained and participants were free to withdraw from the research at any stage. Seventeen of the 81 1st-6th class children in the two ASF schools and 23 of the 95 1st to 6th class children in the two control schools declined to participate in the study. A total of 64 and 72 children aged 9.4(1.5) years from the ASF and control schools (72 boys and 64 girls) opted to take part in the project.

As there was a surplus of participants with informed signed consent forms in the participating schools than accelerometers available for the research, the online random integer generator (http://www.random.org/integers/) was used to randomly select an approximate equal amount of boys (n=42) and girls (n=38) in the 1st-3rd and 4th-6th class groupings to participate in the present study. Forty-three participants in the ASF group and 37 participants in the control group were randomly selected to wear the accelerometer. Six ASF participants were lost to follow up due to three participants' absence from school, two accelerometers malfunctioning and one participant not wanting to wear the device. Two participants in the control group were lost to follow-up as they were no longer enrolled in the participating school. Thirty-seven participants in the ASF group and 35 participants in the control group wore the device at baseline and follow-up. Mattocks et al. (2008) investigated the influence of varying the minimum daily wear time for data analysis among English children aged 11 years and noted that the reliabilities remained constant using between seven to ten hours per day. Most recent research suggests that a minimum of three days wear time is the most commonly used criteria for children (Rich et al., 2013). Therefore, participants that did not wear the accelerometer for at least 420 minutes on at least three days out of seven was flagged as non-wear and excluded from the analysis. Six participants in the ASF group and five participants in the control group did not meet this wear-time criterion. Thirty-one and 30 participants in the ASF and control groups had valid accelerometer data. In total, 84.7% of participants had valid accelerometer data and were included in the final analysis (n=61).

The questions of the questionnaire in the present study were extracted from the Fife Active questionnaire (Rowe and Murtagh, 2012). As the Fife Active questionnaire was developed for children aged 10-14 years (Rowe and Murtagh, 2012), only 4th-6th class participants in the present study were invited to complete this survey. Fourteen and 12 of the 64 and 72 participants in the ASF and control groups respectively were in 4th-6th class at baseline, thus were invited to complete the questionnaire. One participant in the ASF group did not

complete the questionnaire as she had special needs and could not comprehend the questions. Two participants in the control group were lost to follow-up as they were no longer enrolled in the school. No questionnaire was excluded from the analysis, therefore 13 and 10 participants in the ASF and control groups respectively had valid questionnaire data at baseline and follow-up and were included in the final analysis. In total, 88.5% of participants had valid questionnaire data and were included in the final analysis (n=23).

Figure 4.1 Flow of ASF group participants

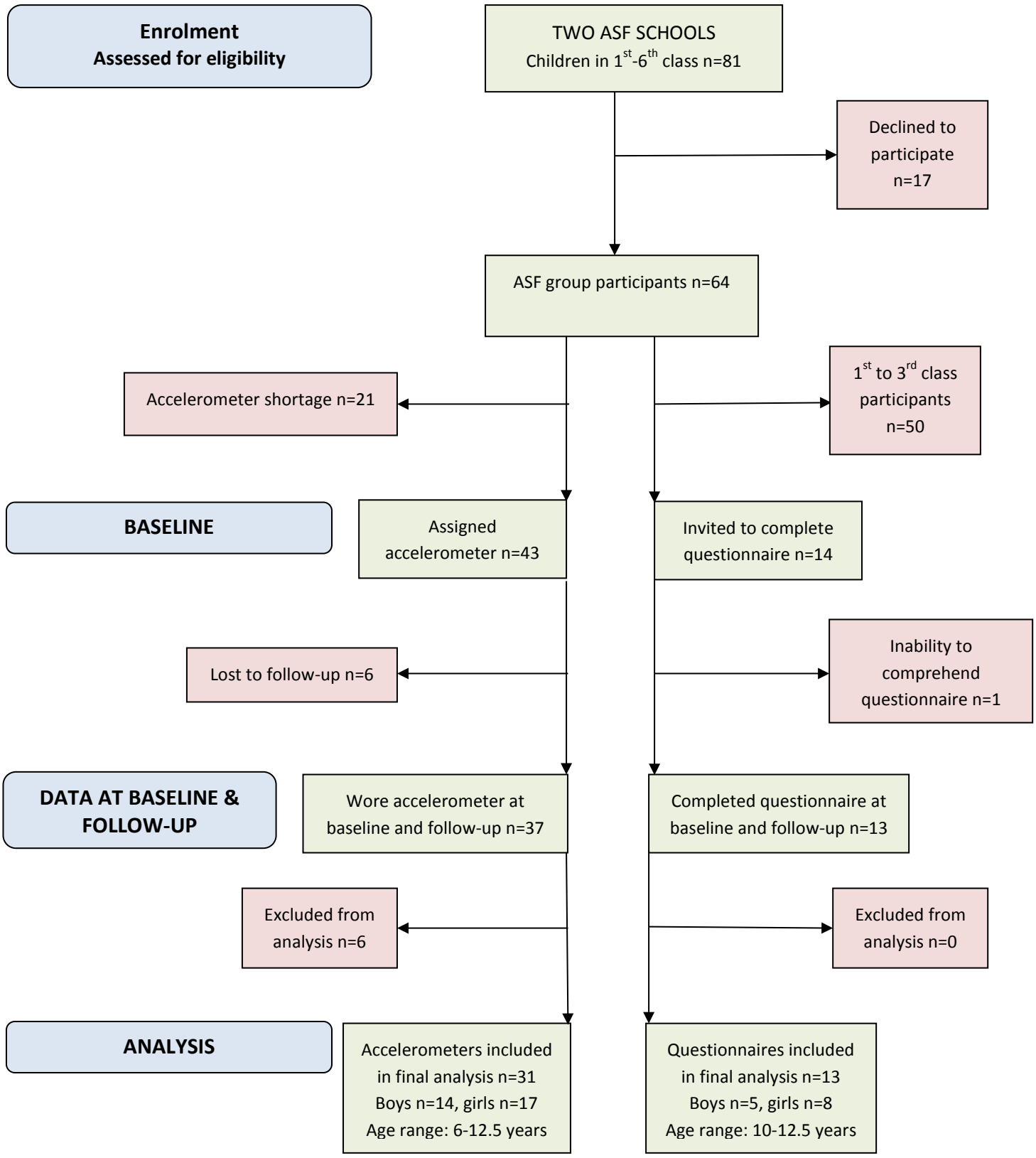
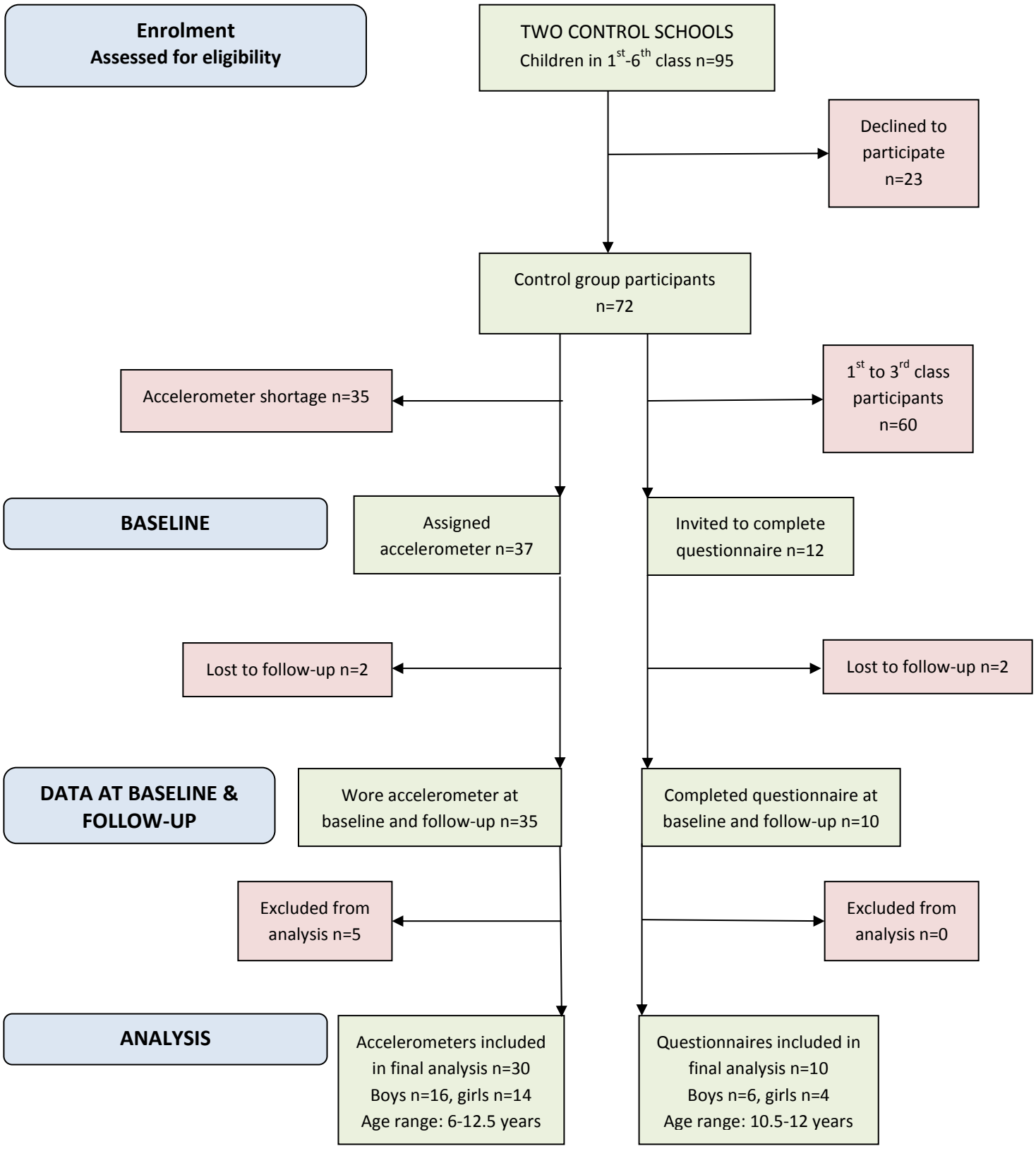


Figure 4.2 Flow of control group participants



4.2.4 Anthropometric characteristics

Participants' height and weight measurements were taken at baseline once on Wednesday, the day before the Thursday to Wednesday physical activity monitoring period. Participants' height and weight was measured by the principal researcher using a portable stadiometer (Seca Corp, Model #214 Road Rod, Hanover, MD) and an electronic personal scale (Seca Corp, Model #899, Germany) respectively. Height and weight were measured in single sex groups of four in a private room in the school to ensure confidentiality. Participants waiting to be measured were instructed to stand with their backs touching the wall so that they could not view other participants' height and weight measurements. The electronic personal scale (Seca Corp, Model #899, Germany) has a two metre-long cable that connects the display to the scales. This display was placed on a table facing the researcher and away from all participants' view. The height and weight protocol used was based on Lohman's (1988) Anthropometric Standardization Reference Manual (see Appendix 2). The participants were measured in their school uniform excluding shoes and accessories. Height and weight measurements were recorded to the nearest millimetre and 0.1kg respectively using PIDs rather than participants' names. A third measurement was taken when there was over a 1cm inconsistency in height or 1kg inconsistency in weight between the first and second measurements (Yildirim et al., 2013). When three measurements were taken, the closest two were averaged to calculate BMI (Yildirim et al., 2013). Height and body mass measurements were averaged for each participant. BMI was calculated as weight divided by height squared (kg/m^2). Decimal age was calculated using participants' date of birth and the date of height and body mass measurements. Participants were assigned to underweight, normal weight, overweight and obese categories according to the cut off BMI values specific to their age and sex, derived by Cole et al. (2007) and Cole et al. (2000). Participants' were not told their height and weight measurements. Only neutral comments such as "thank you" and "you can step off the scale" were made by the researcher (Kudat et al., 1996).

4.2.5 Physical activity

Actigraph accelerometers (Models GT3X/+, Pensacola, FL32502) were used to record participants' physical activity for seven consecutive days from Thursday to Wednesday at baseline and follow-up. The accelerometers were fully charged through a standard USB port and calibrated through the ActiLife software (Version 6.6.3, Pensacola, FL32502) to measure continuously in 5-second epochs (Trost et al., 2011) from 9am on Thursday, the first day of monitoring, to 9am on the following Thursday, the morning after the seventh day of monitoring. Labels with PIDs were stuck on the accelerometers for organisation and confidentiality purposes. Participants wore the accelerometers on Wednesday, the day before the physical activity testing period, to minimise the influence of possible behaviour change (Dossegger et al., 2014). At 9am on Wednesday, the day before each monitored week, the researcher fitted participants with an accelerometer on an elastic belt at the centre of the right hip (Cliff et al., 2009). Class teachers were shown the position the

participants were to wear the accelerometers and were asked to correct the placement of the accelerometer if worn incorrectly. The researcher verbally instructed participants to wear the accelerometer over or under their shirt, follow their normal daily routine, remove the accelerometer for water-based activities and leave it beside the bed while sleeping (e.g. on their bedside locker). Each morning of the physical activity monitoring week, the participants placed the accelerometers on their hip using the elastic belt. Class teachers were provided with the researcher's telephone number if they had any queries regarding the accelerometers. However, no issues with the accelerometer whilst they were in the care of the participants were brought to the attention of the researcher. The researcher collected the accelerometers from the class teacher on Thursday, the day after the seventh day of monitoring, and asked whether participants had any issues with the devices during the week. On the same day, the researcher downloaded the data through the Actilife software (Version 6.6.3, Pensacola, FL32502) (ActiGraph Software Department, 2012). Follow-up physical activity measurements were repeated one week after each school was awarded the ASF. To distinguish between non-wear time and sedentary behaviour, patterns of physical activity reading more than 20 minutes of consecutive zero counts were excluded from the analysis (Esliger et al., 2005). The Evenson et al. (2008) MVPA cut-point of ≥2296 cpm was utilised to calculate participants' minutes of MVPA. Class teachers recorded the start and end times for school day, break, lunch and physical education on a sheet provided (see Appendix 5). Time filters within the ActiLife data analysis software (Version 6.6.3, Pensacola, FL32502) were applied to extract the mean minutes of MVPA accumulated during the school day, after school (starting from end of school day until removed for sleep), physical education, break- and lunch-times (ActiGraph Software Department, 2012). Class teachers also logged when students wore their tracksuits and were inside or outside for physical education, break- and lunch-times during the monitored weeks (see Appendix 5). For confidentiality purposes, records were kept in a locked file cabinet, computer entry and networking programmes were completed using PIDs only, data was stored on a password protected computer and access to data was limited to the principal investigator.

4.2.6 Self-efficacy, perceived benefits of physical activity and perceived barriers towards physical activity

Participants in 4^{th}-6^{th} class completed a questionnaire on Wednesday, the day before the physical activity testing period, at baseline and follow up to compare the ASF and control groups' perceived benefits, barriers and self-efficacy towards physical activity participation (see Appendix 6). Questions were extracted from the Fife Active questionnaire (Rowe and Murtagh, 2012) that focused on self-efficacy, perceived benefits of physical activity and barriers towards physical activity participation. These questions have evidence of validity for use in children, are brief and appropriate for children aged 10-14 years (Rowe and Murtagh, 2012). As the Fife Active questionnaire was developed for children aged 10-14 years, only 4^{th}-6^{th} class participants answered questions derived from this survey. Eight items each were used to assess self-efficacy (e.g. I could do physical activity even if I was

tired), perceived benefits of physical activity (e.g. physical activity makes me healthy) and perceived barriers towards physical activity participation (e.g. I don't have enough time). Each scale asked participants to indicate the extent to which the statement was 'not at all true' to 'very true' on a scale of 1 to 4 with 4 indicating the highest level of this construct (scoring 'very true' to all of the items) and 1 indicating the very lowest of this construct (scoring 'not at all true' to all of the items). Questions that participants did not answer were not allocated a score. Schumacker and Lomax (2004) explain that a set of scores with missing data can affect the estimate of the mean and standard deviation if it is not missing completely at random. The missing data in the present study was completely at random as four participants did not respond to four different questions at baseline and two other participants did not respond to two different questions at follow-up. High levels of self-efficacy, perceived benefits of physical activity and perceived barriers towards physical activity were determined when mean values were above the mid-point of the scale (i.e >2.5) (Rowe and Murtagh, 2012). Within the classroom, participants completed the questionnaire in silence, in the presence of the researcher and class teacher during typically allocated class-time (i.e. not during break/lunch/physical education), to allow them to concentrate on the activity (Horstman et al., 2008). The role of the researcher during this activity was to remain present in the classroom to prevent contamination of the participant's individual ideas through teacher input (Horstman et al., 2008). Teachers were made aware that it was important not to lead or suggest ideas to the participants as the emphasis of the study was to record the participants' thoughts, rather than the teachers' perceptions (Horstman et al., 2008, Backett-Milburn and McKie, 1999). The researcher explained that the questionnaire was not a test and that it was an independent activity to avoid the potential influence of friends (Williams et al., 1989, Backett-Milburn and McKie, 1999, Knowles et al., 2013). Participants used their own pencils and erasers to complete the activity. Twenty to thirty minutes was provided for completion of the questionnaire. On completion, the researcher collected and removed the questionnaires from the school. Participants completed this questionnaire for the second time one week after the ASF schools were awarded the ASF.

4.2.7 Statistical analysis

Data manipulation was conducted in Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA) and statistical analysis was conducted with the statistical package for the social sciences (IBM SPSS Statistics version 21, US). Descriptive statistics were used to summarise mean scores for self-efficacy, perceived benefits of physical activity, perceived barriers to physical activity participation, subject characteristics, minutes of MVPA and percentage of time spent in MVPA. Three assumptions were checked to determine whether parametric tests could be performed on the accelerometer data. The three parametric assumptions require the dependent variable to be measured on interval or ratio scales, to be normally distributed and have homogeneity of variance and covariance between samples being compared (O' Donoghue, 2013). MVPA, the dependent variable, is measured on the

ratio scale as the numerical values measure quantities and zero represents an absence of the concept being measured (O' Donoghue, 2013). To determine whether MVPA was normally distributed, the Kolmogorov-Smirnov test was used as there were more than 50 cases of MVPA data (Field, 2013). The results of this test indicate that baseline and follow-up MVPA data were normally distributed ($p>0.05$) as the distribution of the sample was not significantly different from a normal distribution (Field, 2013). Levene's test was conducted to determine whether there was homogeneity of variance (Field, 2013). The results of this test indicate that baseline and follow-up MVPA have homogeneity of variance ($p=0.3$, 0.2 respectively). Sphericity determines the equality of variances of the difference between treatment levels (Field, 2005). As there needs to be at least three conditions for sphericity to be an issue (Field, 2009), sphericity was met as MVPA has only two levels (baseline and follow-up measurements). Parametric tests were used on the MVPA data as this analysis indicates that there is not enough evidence to reject the claims that the sampled population is not normally distributed. Independent samples t-tests were used to identify any significant group differences in terms of age, weight, height or BMI. A mixed ANOVA was used to determine time X group for daily MVPA, school day MVPA, after school MVPA, break MVPA, lunch MVPA, PE MVPA, self-efficacy scores, perceived benefits of physical activity scores and perceived barriers of physical activity scores. Spearman and Kendall non-parametric correlation techniques can be used to correlate ordinal variables with interval or ratio variables as they are all ranked (Diamantopoulos and Schlegelmilch, 1997). The Spearman correlation technique was used to examine the relationship between self-efficacy/perceived benefits/perceived barriers and daily MVPA among ASF and control groups from baseline to follow-up as there were at least 20 participants with paired values of questionnaire and accelerometer data. Effect sizes (ES) were calculated for the statistical tests using Cohen's d with <.10 interpreted as a negligible, .10 a small, .30 as a medium and .50 as a large effect size (Cohen, 1988). Significance was accepted at $P < .05$

4.3 Findings

4.3.1 Changes to physical activity provision in ASF schools

Details of the changes made to the provision of school physical activity as part of the ASF process were obtained from the school application forms. The four physical activity improvements made to the ASF schools' break- and lunch-times included providing loose equipment, playground leaders for infant classes, structured activities in the form of hockey and basketball leagues and being encouraged by Special Needs Assistants (SNAs) to play (see Appendix 7 for further details). Two of these improvements, the structured leagues and playground leaders, did not take place all-year long and ceased in December 2012 and February 2013 respectively.

4.3.2 Descriptive characteristics

Data are presented from 61 participants from four rural primary schools: ASF1 (n=11) and ASF2 (n=20) and Control1 (n=14) and Control2 (n=16). Participant characteristics are

presented in Table 4.1. Cole et al. (2007) and Cole et al. (2000) age and gender specific cut-points for underweight, overweight and obesity revealed that three participants were underweight, four were classified as obese, six as overweight and 18 were of normal weight in the ASF group. In the control group, one participant was underweight, one was obese, four were overweight and 24 were of normal weight. In total, 68.9% of the sample was of normal weight, 16.4% was classified as overweight, 8.2% as obese and 6.5% as underweight. No significant differences were found between groups for age, weight, height or BMI (P > .05).

Table 4.1 Mean (SD) measurements of participants' characteristics

	ASF (17 girls, 14 boys)	Control (14 girls, 16 boys)	All (31 girls, 30 boys)
Age (years)	9.4 (1.7)	9.1 (1.8)	9.2 (1.7)
Weight (kg)	35.9 (11.8)	31.8 (7.2)	33.7 (10)
Height (m)	1.4 (0.1)	1.3 (0.1)	1.4 (0.1)
BMI (kg/m^2)	18.6 (3.8)	17.4 (2.4)	18 (3.2)

4.3.3 Participants' daily MVPA and time spent in MVPA during and after school

Mean daily minutes of MVPA for the entire sample at baseline and follow-up were 52.9 ± 16.6 and 64.8 ± 21.9 respectively. At baseline, boys accumulated 57.6 ± 19 minutes of daily MVPA which was significantly greater than the 48.4 ± 12.5 minutes of daily MVPA accumulated by girls (P = .031, 95% *confidence interval [CI]* = .85, 17.47). Table 4.2 presents the mean daily minutes of MVPA at baseline and follow-up for boys and girls in the intervention and control groups. There was no significant difference in the daily minutes of MVPA from baseline to follow-up between the ASF and control groups (P = .424, ES = .011). There was also no significant difference in the change in minutes of daily MVPA for the time x group x school interaction (P = .331, .017) or the time x group x gender interaction (P = .331, ES = .017), indicating that the gender of the child and the individual school's approach to the ASF initiative did not determine a change in daily MVPA across time.

Table 4.2. Mean (SD) daily minutes of MVPA among ASF and control groups at baseline and follow-up

Group	Gender	Baseline	Follow-up	Change
ASF	Boys (n=14)	61.4(14.7)	71.5 (19.6)	+10.1
	Girls (n=17)	50.1 (13.6)	60.1 (20.3)	+10
	All (n=31)	55.2 (15)	65.3 (20.5)	+10.1
Control	Boys (n=16)	54.2 (22.1)	74.4 (25.4)	+20.2
	Girls (n=14)	46.3 (11.2)	52.8 (15.1)	+6.5
	All (n=30)	50.5 (18)	64.3 (23.6)	+13.8

Table 4.3 shows the minutes of MVPA spent in the school day and after school at baseline and follow-up. There was a significant difference in the change in minutes of after school

MVPA for the time x group x gender interaction (*P* = .029) and the effect is considered a negligible effect (*ES* = .081; (Cohen, 1988)). This test showed there was a greater increase in the change in after school MVPA from baseline to follow-up among the control boys (14.6 more MVPA minutes) than the ASF boys. The ASF girls increased their after school MVPA by 1.1 more minutes than the control girls from baseline to follow-up. It is unusual and unclear why the control boys greatly increased their after school MVPA from baseline to follow-up.

Table 4.3 Mean (SD) school day and after school minutes of MVPA among ASF and control groups at baseline and follow-up

Segment	Gender	Group	Baseline	Follow-up	Change
School day	Boys	ASF (n=14)	29 (8.3)	36.6 (9.6)	+7.6
		Control (n=16)	26.3 (10.1)	29.2 (5.4)	+2.9
	Girls	ASF (n=17)	22.4 (6.3)	25.3 (9.1)	+2.9
		Control (n=14)	20.2 (8.7)	20.6 (5.1)	+0.4
	All	ASF (n=31)	25.4 (7.9)	30.4 (10.8)	+5
		Control (n=30)	23.5 (9.8)	25.2 (6.8)	+1.7
After school	Boys	ASF (n=14)	32.4 (10.8)	34.9 (14.3)	+2.6
		Control (n=16)	27.9 (18)	45.1 (22.6)	+17.2
	Girls	ASF (n=17)	27.7 (9.8)	34.8 (15.9)	+7.1
		Control (n=14)	26.1 (8.1)	32.1 (12.6)	+6
	All	ASF (n=31)	29.8 (14.9)	34.9 (14.9)	+5.1*
		Control (n=30)	27 (14.1)	39.1 (19.5)	+12.1*

*Significant difference in the change in the time spent in MVPA between groups and gender

4.3.4 Segmented school day MVPA

The school day consisted of 342.5 ± 4.6 minutes (range 340-350 minutes). At baseline, an average of 12.5 ± 3.8 minutes (range 10-20 minutes) was allocated for break-time and 32.5 ± 3.8 minutes (range 30-40 minutes) for lunchtime. At follow-up 14.6 ± 5.5 minutes (range 10-30 minutes) was allotted to break-time and 34.2 ± 8.6 minutes (range 30-75 minutes) for lunch-time. Physical education was scheduled once-twice per week and held for 40.5 ± 11.5 minutes (range 30-60 minutes) per week at baseline and 57.5 ± 12.2 minutes (range 42.5-75 minutes) per week at follow-up. At baseline the ASF schools failed to achieve the recommended 60 minutes of physical education per week target (Department of Education and Science, 1999b). In contrast, all ASF schools at follow-up achieved this guideline as it is a requirement to be awarded the ASF. There was no physical education MVPA data from ASF participants in one class of one school due to wet weather and an absence of a hall. Similarly, previous research found the provision of physical education among rural primary schools is weather dependent as many do not have access to a sports hall (Hegarty, 2013). A maximum of two break-/lunch-times were held indoors among ASF and control groups at baseline and follow-up due to bad weather. Table 4.4 presents the percentage of time spent in MVPA during physical education, break- and lunch-time while indoors and outdoors. Mixed ANOVAs indicated that there were small statistically positive intervention effects for the change in physical education (*P* = .008, *ES* = .182) and outdoor only break-

time MVPA (*P* = .001, *ES* = .171) and a small negative intervention effect for the change in all combined lunch-time MVPA (indoor and outdoor) (*P* = .004, *ES* = .136) from baseline to follow-up between groups. There was also a small positive intervention effect for the change in boys' physical education MVPA from baseline to follow-up between groups (*P* = .007, *ES* = .199).

Table 4.4 Mean (SD) percentage of time spent in MVPA of ASF and control groups during segments of the school day

Segment	Group	Baseline	Follow-up	Change
Break-time	ASF All (n=31)	26.6 (13.2)	26.1 (16.5)	-0.5
Indoors and outdoors	Control All (n=30)	24.4 (10.8)	18 (11.2)	-6.4
Outdoors only	ASF All (n=31)	26.6 (13.2)	28.7 (16.4)	+2.1 [a]
	Control All (n=30)	26.1 (11)	18 (11.2)	-8.1 [a]
Lunch-time	ASF All (n=31)	27.5 (10.7)	20.8 (11.3)	-6.7 [a]
Indoors and outdoors	Control All (n=30)	27.8 (11.2)	29.7 (11.1)	+1.9 [a]
Outdoors only	ASF All (n=31)	30.7 (12.3)	24.6 (13.6)	-6.1
	Control All (n=30)	30.9 (11.8)	29.7 (11.1)	-1.2
Physical education	ASF All (n=17)	18 (9.6)	26.2 (15.5)	+8.2 [ab]
	Control All (n=20)	24.2 (17.3)	21.9 (13.1)	-2.3 [ab]

[a] Significant difference in the change in the percentage of time spent in MVPA between groups

[ab] Significant difference in the change in the percentage of time spent in MVPA between groups and gender

4.3.5 Correlations between psychological correlates and daily MVPA

The ASF mean (SD) scores for self-efficacy at baseline and follow-up were 3.1 (.5) and 3.1 (.8). Corresponding values for the control group were 2.6 (.7) and 2.8 (.6). The mean (SD) scores for perceived benefits among the ASF group at baseline and follow-up were 3.5 (.3) and 3.5 (.5). Equivalent values for the control group were 3.4 (.4) and 3.3 (.5). ASF and control groups' baseline and follow-up scores for self-efficacy and perceived benefits of physical activity were above the mid-point of the scale (i.e. >2.5 (Rowe and Murtagh, 2012)) indicating high levels of self-efficacy and perceived benefits of physical activity. The mean (SD) scores for perceived barriers among the ASF group at baseline and follow-up were 2 (.6) and 2.1 (.5). Corresponding values for the control group were 2.2 (.7) and 2 (.6). The mean ASF and control groups' baseline and follow-up scores for perceived barriers towards physical activity were below 2.5, signifying low perceived barriers towards physical activity participation. Mann Whitney U tests indicated that there were no significant differences for scores of self-efficacy (*P* = .186), perceived benefits of physical activity (*P* = .446) and perceived barriers towards physical activity (*P* = .738) between the ASF and control groups at baseline. Mixed ANOVA tests revealed that there was no significant difference between the ASF and control groups' scores for self-efficacy (*P* = .479, *ES* = .024), perceived benefits of physical activity (*P* = .639, *ES* = .011) or perceived barriers towards physical activity (*P* = .307, *ES* = .05) from baseline to follow-up. Spearman's correlations showed there were no significant associations between the ASF and control groups' daily MVPA and self-efficacy, perceived benefits and perceived barriers from baseline to follow-up (*P* > .05). Associations

between the change in self-efficacy, perceived benefits, perceived barriers and daily MVPA from baseline to follow-up are summarised in Table 4.5. Although not significantly correlated, there were very weak, non-significant positive correlations between self-efficacy and daily MVPA (r_s= .15, *P* >.05) and perceived barriers and daily MVPA (r_s= .12, *P* >.05) among the ASF group. There were also very weak, non-significant negative correlations between perceived benefits and daily MVPA among the ASF (r_s= -.1, *P* >.05) and control groups (r_s= -.19, *P* >.05), and perceived barriers and daily MVPA (r_s= -.11, *P* >.05) among the control group.

Table 4.5. Correlations between self-efficacy, perceived benefits, perceived barriers towards physical activity and daily MVPA among 4th-6th class ASF and control participants

	Group	Daily MVPA	P-value
Self-efficacy	ASF (n=13)	.15	.63
	Control (n=10)	-.62	.06
Perceived benefits	ASF (n=13)	-.1	.59
	Control (n=10)	-.19	.75
Perceived barriers	ASF (n=13)	.12	.69
	Control (n=10)	-.11	.77

4.4 Discussion

The purpose of this study was to evaluate primary school children's daily MVPA in a whole school initiative. To provide further insights into the outcome of children's daily physical activity after ASF participation, MVPA within segments of the school day and psychological factors associated with physical activity will be discussed in relation to participants' overall daily MVPA. The main finding of the present study was that the ASF group did not significantly alter their daily MVPA in comparison to the control group. Both the ASF and control group participants had high levels of self-efficacy and perceived benefits of physical activity however there was a weak non-significant correlation between these psychological correlates of physical activity and their daily MVPA between baseline and follow-up in both groups. Analysis of MVPA during segments of the school day revealed that the ASF group significantly increased the percentage of time spent in MVPA during physical education and outdoor break-time only in comparison to the control group. These findings are discussed under the following four headings: 1) daily MVPA, 2) the contribution of physical education, break- and lunch-times to daily MVPA, 3) psychological correlates of physical activity and 4) study limitations and strengths.

4.4.1 Daily MVPA

Engagement in the ASF whole school physical activity initiative did not significantly increase primary school children's daily minutes of MVPA in comparison to the control group. The ASF group accumulated a relatively high amount of daily MVPA at baseline (55.2 minutes), when compared to the 60 minutes of MVPA daily guideline. A ceiling effect occurs when many of the scores on a variable are at or approaching the maximum possible score (Ary et al., 2013, Cramer and Howitt, 2004). Most ASF participants were at or near achieving the

World Health Organisation (2010) 60 minutes of MVPA daily target at baseline, which may have created a 'ceiling effect' (Corder et al., 2008) and limited the scope of the initiative to improve this behaviour. Children in the ASF group increased their daily MVPA by 10.1 minutes from baseline to follow-up, however this increase in daily MVPA was not significantly different to the control group. In contrast to the finding of the present study, the Canadian APPLES Schools model of CSH significantly increased 10-11 year old children's daily step count (Ploeg et al., 2014) and the Canadian Action Schools BC whole school physical activity intervention successfully increased 9-11 year old boys' daily step count (Naylor et al., 2008) in comparison to the control groups. The ASF, APPLES Schools model of CSH and Action Schools BC (Naylor et al., 2008) implemented the whole school interventions in a similar manner as the programmes were customized based on the needs of the school and generalist teachers implemented the intervention. However, APPLES Schools model of CSH placed a full-time school health facilitator in each school and Action Schools BC trained and supported the teachers with a team and set a weekly target of providing 75 minutes of classroom physical activity each week, which may partly explain the children's improvement in physical activity. This reflection suggests that generalist teachers may be in a position to assist children in increasing their daily physical activity through the ASF initiative by providing a weekly physical activity target and support from trained facilitators.

The boys in the control group significantly increased their after-school MVPA from baseline to follow-up which may further explain why there was no significant change between the groups' daily MVPA across time. As accelerometers do not provide details on the type and context of the activities performed (Dollman et al., 2009), it is unclear what activities the boy participants of the control group participated in at follow-up to significantly increase their after-school MVPA between the two measurement points. In terms of activity during school hours, there was no significant difference between the ASF and control groups' school day MVPA from baseline to follow-up. However, it is promising that after participation in the ASF initiative children accumulated an average of 30.4 minutes of MVPA at school, thus meeting the 30 minutes of school day MVPA target (Fox et al., 2004a, Pate et al., 2006, Howells et al., 2010, The Report of the National Taskforce on Obesity, 2005). This finding indicates the potential of the ASF initiative at supporting high levels of school day physical activity.

4.4.2 The contribution of physical education, break- and lunch-times to daily MVPA

The ASF initiative had a positive impact on participants' MVPA during physical education. Children in the ASF group significantly increased their physical education MVPA from baseline to follow-up in comparison to the control group. The ASF group's significant increase in MVPA during physical education did not however influence their daily MVPA levels in comparison to the control group. This finding is surprising as studies have shown that school days with physical education can lead to an increase in children's daily physical

activity (Meyer et al., 2011, Pate et al., 2011, Morgan et al., 2007, Dale et al., 2000, Morgan et al., 2003, Tudor-Locke et al., 2006). A reason that children did not significantly increase their mean daily minutes of MVPA, may be that physical education was held on only one to two days out of the seven monitored days. Furthermore, for physical education to meaningfully contribute towards the accumulation of physical activity, the US Department of Health and Human Services (2000) and the UK Association for Physical Education (2008) recommend children engage in MVPA for at least 50% of PE time. The ASF children in the present study did not reach this target at only 26.2% of physical education time was spent in MVPA at follow-up which may partly explain why the ASF group did not significantly increase their daily MVPA in comparison to the control group. There is scope to improve children's MVPA levels during physical education as part of the ASF initiative as two systematic reviews of primary school-aged children's physical activity during physical education found children spent a higher percentage of physical education in MVPA than the ASF group. These reviews found children spent an average of 34.2% (Fairclough and Stratton, 2006) and 44% (Hollis et al., 2015) of physical education in MVPA without engaging in physical activity interventions. Furthermore, a previous review found interventions that intentionally aim to increase children's MVPA during physical education spent 24% more physical education time in MVPA than control groups (Lonsdale et al., 2013). Further increases in physical education MVPA, through a focus on physical activity engagement within the lesson, may help ASF children significantly increase their daily MVPA.

Participation in the ASF initiative led to a significant increase in outdoor break-time MVPA in comparison to the control group. Providing loose equipment and being encouraged by SNAs to play were improvements made to the ASF break-times that appear to have assisted children in significantly increasing their break-time MVPA in comparison to the control group. Previous research also found that providing game equipment (Verstraete et al., 2006), adult supervision (Sallis et al., 2001, Willenberg et al., 2010) and teachers to organise or play games with the children (Ommundsen et al., 2006) increased physical activity in the playground. To assist children in reaching the daily physical activity guideline, a threshold of 40% of break-time is recommended to be spent in MVPA (Ridgers et al., 2005). On average, ASF children were engaged in MVPA for 28.7% of outdoor break-time which is lower than the recommended break-time MVPA target. Therefore, further strategies to increase outdoor break-time MVPA such as providing playground markings and physical structures (Ridgers et al., 2007b) may assist ASF children in increasing the percentage of time spent in break-time and daily MVPA. Another important finding in the present study was that children did not significantly alter their MVPA during indoor and outdoor break-times when examined together in comparison to the control group. Children remained in the classroom during wet weather break-times and the ASF group did not state any strategy to provide physical activities indoors during wet weather break-times. A previous study found that participation in the ten minute Bizzy Breaks classroom-based activity significantly increase

nine year old Irish children's school day steps (Murtagh et al., 2013). Therefore, the implementation of classroom-based activities on wet weather break-times and providing a stimulus for outdoor break-time physical activity may assist ASF children in increasing their break-time and daily MVPA.

After attaining the ASF, children spent a significantly lower percentage of the combined indoor and outdoor lunch-times in MVPA than the control group. The ASF group spent 20.8% of indoor and outdoor lunch-times in MVPA which is also less than the recommended 40% MVPA target (Ridgers et al., 2005). Furthermore, there was no significant difference between the ASF and control groups' time spent in MVPA during outdoor-only lunch-times from baseline to follow-up. The changes the ASF schools made to their outdoor lunch-times for the entire year included the provision of loose equipment and encouragement to be physically active from SNAs. The ASF group also held hockey and basketball leagues and assigned older students to lead playground activities for infant classes during specific periods of the year. It is unusual that these initiatives did not alter the ASF group's outdoor-only lunch-time MVPA in comparison to the control group as previous studies found primary school-aged children significantly increased their lunch-time MVPA in comparison to control children when they had access to loose game equipment (Verstraete et al., 2006, Lopes et al., 2009), were encouraged to be physically active by adult supervising the yard (Willenberg et al., 2010, Sallis et al., 2001) and participating in organised games (Scruggs et al., 2003, Howe et al., 2012, Huberty et al., 2011, Larson et al., 2014) during lunch-times. However, perhaps these lunch-time initiatives did not have a positive impact on the ASF group's MVPA in comparison to the control group as they were not all implemented throughout the entire year. Additionally, two ASF lunch-times were held indoors at follow-up which may have had a negative impact on their MVPA levels as these schools did not provide alternative activities for indoor lunch-times, further indicating the importance of providing indoor activity for wet weather lunch-times. These findings suggest the implementation of lunch-time initiatives throughout the school year and providing indoor activities during wet weather lunch-times may assist children in increasing their lunch-time and daily MVPA.

4.4.3 Psychological correlates of physical activity

There was a non-significant, weak relationship between scores for self-efficacy and perceived benefits of physical activity and daily MVPA among 4^{th}-6^{th} class ASF and control groups at baseline and follow-up. Although the ASF group had high levels of self-efficacy (score >2.5), perceived benefits (score >2.5) and low perceived barriers (score <2.5), the children did not significantly alter their daily MVPA in response to the ASF initiative. This finding is consistent with two systematic reviews as there were inconsistent (Bauman et al., 2012) or no association (Van Der Horst et al., 2007) found between perceived barriers and physical activity levels among 4-12 year olds. Furthermore, similar to the present study, there was a low correlation between 10-12 year old American children's psychological

correlates (children's perception of their physical self) and physical activity (Welk and Schaben, 2004). However, both the participants' psychological correlates and daily physical activity in the present study were high at baseline which may have limited the possibility of further improving these constructs. An investigation into other correlates of physical activity (e.g. level of enjoyment) warrants investigation among the ASF group to determine the psychological correlates that can be addressed that may assist ASF children in significantly increasing their daily MVPA.

4.4.4 Study limitations and strengths

A limitation of the present study is that a small sample (n=23) of only 4^{th}-6^{th} class children's completed the questionnaire on psychological correlates of physical activity as the questions were only suitable for children aged 10-14 years (Rowe and Murtagh, 2012). Therefore, the correlates of physical activity among 1^{st}-3^{rd} class children are unknown. A second limitation of the present study is that accelerometers do not capture some movements such as cycling and swimming, therefore some of children's daily physical activity may not have been quantified (Dollman et al., 2009). Thirdly, this study did not employ a randomised controlled trial design, therefore the findings cannot be generalised to 6-12 year old children nationally. Furthermore, there were different time frames for follow-up measures between schools. One school achieved the ASF after six months of engaging with the process and it took the second school twelve months to complete the initiative.

The main strength of the present study is that MVPA was measured for the entire day. Many school based interventions only measured physical activity during school hours, which leaves the debate open to whether children would sustain the increased school day activity after school or compensate after school in response to school day activity (Kriemler et al., 2011). A second strength of the present study is that measurement of MVPA through accelerometers allows for analysis of specific segments of the school day (Dollman et al., 2009). By examining children's physical activity during various segments of the school day, children's patterns of physical activity were identified. A third strength of the present study was that a high percentage (84.7%) of participants met the wear-time criteria.

4.5 Conclusion

This study examined primary school children's daily MVPA in a whole school initiative. Participants did not significantly alter their daily MVPA by participating in the ASF initiative in comparison to the control group, however high baseline daily MVPA levels may have caused a ceiling effect that limited the scope to improve this behaviour. The ASF initiative had a positive effect on participants' MVPA during physical education and outdoor-only break-times. The ASF group spent a significantly lower percentage of the combined indoor and outdoor lunch-times in MVPA than the control group that may be attributed to the ASF schools not providing indoor activities for wet weather lunch-times and only implementing two of the four outdoor lunch-time initiatives for the entire school year. The psychological

correlates of physical activity measured had a weak non-significant relationship with children's daily MVPA, thus did not explain why there was no change in the ASF group's daily MVPA from baseline to follow-up compared to the control group. The participating schools in this study were not representative of primary schools nationally. Future research is warranted that examines the impact of the ASF initiative on primary school children's daily MVPA using a randomised controlled trial design to enable generalisations to be made regarding the impact of the ASF initiative on Irish primary school children's daily MVPA.

Chapter 5. The involvement of children in the design of a lunch-time intervention: a pilot study

5.1 Introduction

Girls have generally been found to be less active than boys (World Health Organisation, 2008, Sallis, 2000b, Woods et al., 2010). The findings of chapters 3 and 4 of this thesis also found girls were significantly less active than boys daily and during school-time. Low levels of girls' physical activity have been identified in several studies with less than 40% of 4-12 year old girls in Europe and America found to attain the recommended daily guideline of 60 minutes of MVPA (NHS Information Centre, 2010, Troiano et al., 2008, Woods et al., 2010, Griffiths et al., 2013a) which is worrying due to the poor health associated with an inactive lifestyle (World Health Organisation, 2010). Research shows that an early establishment of good activity patterns is important in laying the foundation for activity habits later in life (Telama et al., 2014, Telama, 2009). Therefore, it was determined that a physical activity intervention was warranted to increase this health behaviour among primary school girls.

Engaging student voice was listed as one of the eight promising principles for practice on what works in schools to increase physical activity among children (Public Health England, 2015). This is a promising strategy for interventions as it enhances children's ownership of physical activity delivery and ensures activities are appropriately tailored to their needs (Public Health England, 2015). It is recommended that the perspectives of participants are integrated early in the development of intervention designs to increase the likelihood of participants adopting the ideas of the intervention, the successful implementation of the trial and intervention sustainability (Van Sluijs and Kriemler, 2016, Public Health England, 2015). However, few health interventions integrate participants' views of the intervention design prior to the implementation of the main trial (O' Cathain et al., 2013). Smith's (2009) model is designed specifically for physical activity interventions and incorporates student voice during the intervention development stages. Student voice was highlighted as an important strategy in this model as Smith's experiences as an exercise scientist (Smith, 2004) and his reflections on the evidence underpinning physical activity interventions (Dugdill et al., 2009) led him to acknowledge that participants are the experts in what will assist them in becoming physically active. The physical activity intervention in the present study will be guided by Smith's (2009) model to ensure participants' views will be integrated in the development of the design (see Figure 5.1).

This chapter describes the first three stages of the development of a physical activity intervention for primary school girls; 1) reviewing published and unpublished literature, 2) creating an intervention design and 3) attaining feedback on the intervention design from a representative sample of the target population. The remaining two phases will be described

in the following chapter and include 4) implementing the intervention in two stages, allowing for a mid-intervention review to evaluate the intervention with participants and restructure as necessary and 5) conducting a formal evaluation of the intervention after implementation to determine whether it achieved the research objectives and to document the experiences of the participants.

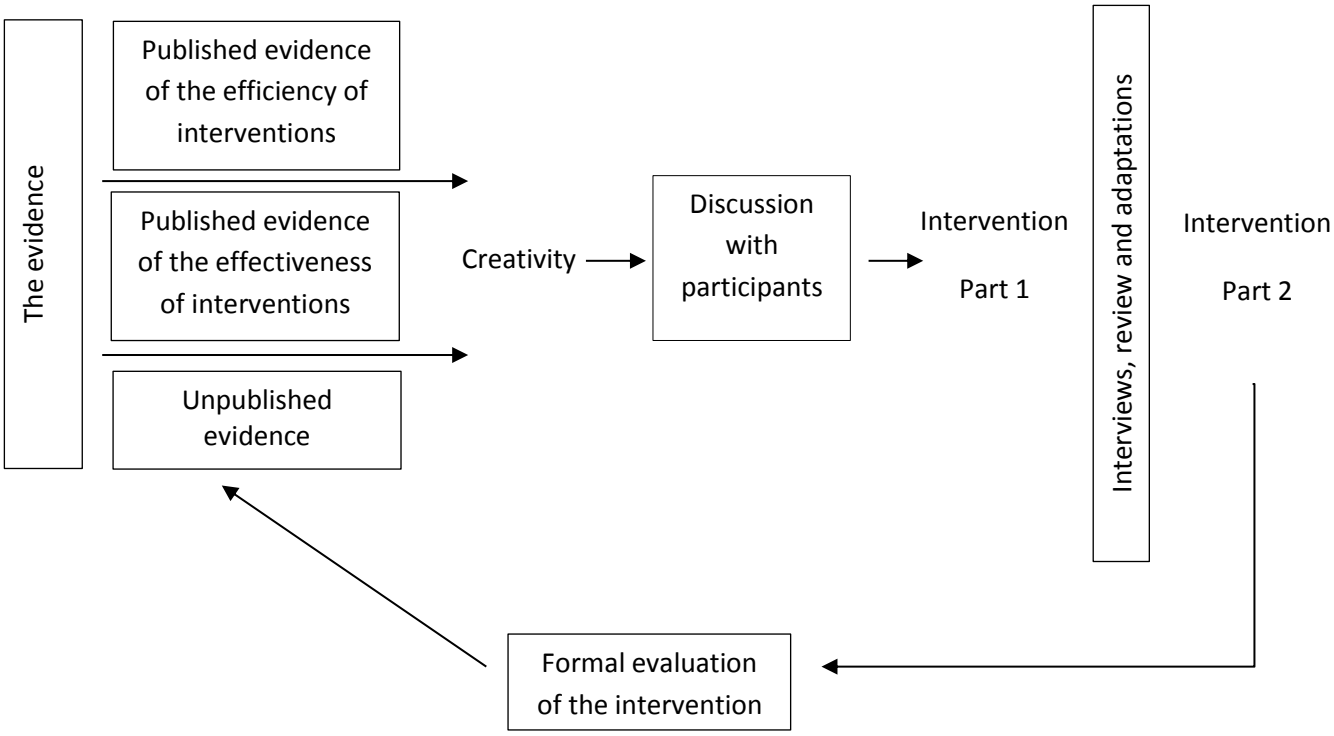


Figure 5.1. An illustration of a model for physical activity intervention as depicted in Smith (2009)

5.2 Phase 1: Review of published and unpublished literature

The first phase of developing the intervention involved reviewing studies that detailed primary school girls' physical activity patterns. The physical activity of girls aged 7-8 years was targeted in the present study as previous research shows children's participation in physical activity decreases as they age (Hovell et al., 1999, Goran et al., 1998, Ridgers et al., 2011, Waring et al., 2007, Woods et al., 2010), with one study finding a decline of 38 minutes of MVPA per day per year from the age of nine years (Bradley et al., 2011). Girls attending single-sex primary schools were sought in the present study as a meta-analysis of interventions aimed at promoting physical activity among 5-11 year old girls found that interventions targeted at girls only rather than boys yielded a higher effect size for physical activity participation (Biddle et al., 2014). Furthermore, promoting physical activity among girls in a single sex school setting may lead to: 1) greater increases in physical activity than in a co-educational setting as there may be less concern about body image, 2) receiving greater attention from instructors, 3) not being compared to boys or criticised by boys and 4) having better opportunities to develop skills and relationships (Biddle et al., 2014, Whitehead and Biddle, 2008, Olafson, 2002, Hannon and Ratliffe, 2005, Hannon and Ratliffe,

2007, Derry, 2002, Camacho-Minano et al., 2011). Four intervention design features were also identified from the review of literature on girls' physical activity which include that 1) the intervention is to take place during lunch-times, 2) the activities are to be structured, 3) the school game equipment and playground markings available are to be used and 4) the intervention activities are to be led by older students in the schools. The key rationales for these intervention design features are outlined in Table 5.1.

The second part of this phase involved attaining practical advice on implementing peer-led lunch-time activities in an all-girl primary school. One all-girl primary school in Munster implemented peer-led structured activities at lunch-time as part of the Active School Flag initiative. The lunch-time sessions involved all of the students in the school as third to sixth class students acted as the leaders for the junior infant to second class groupings. The structured lunch-time activities consisted of Chinese skipping, where two students stand opposite each other and stretch the elastic until it is taut around the ankles and a third student performs a series of jumping moves over the elastic, regular skipping, netball and hula hooping. Sixth class leaders that returned informed signed consent forms (n=16) and the teacher that organised the lunch-time sessions participated in a focus group discussion in January 2014. The participants made six recommendations for implementing peer-led lunch-time activities based on their experiences: 1) assign two to three leaders per area, 2) select other leaders to replace leaders absent from school, 3) provide the leaders with the responsibility of collecting, distributing and storing the equipment, 4) display the lunch-time rotas on the wall, 5) schedule the leaders to lead for one week and take part in their own activities the following weeks and 6) assign one day a week for second class to engage in their own lunch-time activities without leaders.

Table 5.1. Intervention design features with key supporting rationale

Intervention design features	Key rationale
To take place during lunch-times	• The studies described in chapters 3 and 4 found girls spend a low percentage of lunch-time in MVPA. • A target of spending 40% of lunch-time in MVPA is deemed achievable (Ridgers et al., 2005), however less than 17% of girls meet this threshold (Nettlefold et al., 2011, Ridgers et al., 2005). • Research shows the MVPA children accumulate during this segment of the school day can make a considerable contribution towards their daily MVPA (Ridgers et al., 2006).
To implement structured activities	• The study described in chapter 4 of this thesis revealed girls accumulated more MVPA during structured activities in physical education than during unstructured lunch-times. • Similarly, two published studies indicated girls were more active in physical education than during break- or lunch-times (Sarkin et al., 1997, Brusseau et al., 2011). • Structured fitness breaks (Scruggs et al., 2003) significantly increased primary school girls' lunch-time physical activity.
To use the available school game equipment and playground markings	• Redesigning the school playground with markings (Stratton and Mullan, 2005) and providing loose game equipment (Engelen et al., 2013b, Verstraete et al., 2006) significantly increased primary school girls' lunch-time physical activity.
To be led by older students	• Support from friends to be physically active positively influences children's lunch-time physical activity (Hohepa et al., 2007, Leatherdale et al., 2010, Sallis et al., 2000b, Ommundsen et al., 2006) • A systematic review of interventions that promote physical activity among young and adolescent girls recommended peer-based interventions for future physical activity research as peers and friendship groups are the primary influence as youth move from childhood to adulthood (Camacho-Minano et al., 2011).

5.3 Phase 2: Preliminary intervention design

The second phase of the intervention development involved creating an intervention design based on the phase one findings. The features of the preliminary intervention design are outlined in Table 5.2. The girls in second class (aged 7-8 years) in the intervention schools are named *players* throughout the current and the following chapter as they played the lunch-time games and the girls in fifth class (aged 10-11 years) are entitled *leaders* as they led the lunch-time activities.

Table 5.2. Details of the preliminary intervention design

Design features	Details
1. Leader training session	• Led by the researcher for 90 minutes • Focus on developing leadership qualities, communication skills, management skills, an awareness of safety concerns and knowledge of playground activities • Content based on the Peers Running Organised Play Stations leader training guide for primary school lunch-time leaders in Canada (Durham Lives!, 2002) and the content listed for the Girls Lead Achieve Mentor Activate secondary school physical education leader training programme in Australia (Jenkinson et al., 2012).
2. Folders for the leaders	• Assembled by the researcher • Details the leader and player groupings, the locations for the activities, the equipment required, how to play the activities and the order for leading the activities
3. Lunch-time activities	• Consists of games without (e.g chasing) and games with equipment (e.g. skipping), using playground markings where available (e.g. hopscotch)
4. A rota detailing player groupings	• Players divided into six groups • Groups rotated to a different zone each lunch-time
5. A rota detailing leader groupings	• Leaders lead in groups of three • Leaders remain in the same zone, leading the same activities each week • Leaders alternate between leading in the second class yard and participating in their own activities in their own yard weekly
6. Zones	• Areas of the yard assigned to activities • Diagram provided in the folder illustrating location for activities

5.4 Phase 3: Pilot study

The third phase of developing the intervention involved attaining feedback on the intervention design from a representative sample of the target population. Ethical approval was granted by MIREC in November 2013 (see Appendix 8). The second (n=30) and fifth class students (n=22) of an all-girl primary school who returned informed signed consent

forms participated in a one-week trial of the intervention design in February 2014. The leader training session was led by the researcher in the morning of the first day of the trial for 90 minutes without breaks for those in attendance and followed the content described in Table 5.2. The researcher distributed the folders to the leaders at the end of the training session. These folders listed games that did not require equipment or playground markings as well as games that involved playground markings and loose game equipment due to the availability of these resources in this school. The leaders and players were divided into six groups, as per the preliminary intervention design, which meant there were three to four leaders and five players per group. The second class section of the yard in this school was assigned to the peer-led lunch-time activities. The following sections describe the philosophical assumptions underpinning this research and the procedures used to collect information on participants' experience of the intervention at the end of the one-week trial.

5.4.1 Philosophical assumptions

The philosophical assumptions underpinning this research are presented in this section in relation to the beliefs on ontology, epistemology and methodology. Ontology deals with the nature of existence and what constitutes reality (Gray, 2013). In social science, the two main ontological positions are realism and idealism (Ritchie et al., 2013). Realism holds the perspective that the external reality exists independently of people's beliefs about or understanding of it whereas idealism holds the viewpoint that the external reality does not exists independently of people's beliefs and understandings of it (Ritchie et al., 2013). In contrast to these ontological viewpoints, soft ontology is fluid and open ended (Kaipainen et al., 2008) and uses adjustable lenses to view the external reality and make sense of it (Bergman, 2008). By adopting a soft ontological positioning in the present study, it was accepted philosophically that there is the singular reality of children's physical activity and multiple realities of children's experiences of the intervention that were open to investigation (Bergman, 2008, Feilzer, 2009, Creswell and Clark, 2007).

Epistemology refers to how knowledge about reality is learned and what forms the basis of the 'truth' of knowledge (Gray, 2009, Ritchie et al., 2013). The present study holds a pragmatic epistemological position and believes that the 'truth' of knowledge is tentative (Bazeley, 2013), which means the truth is provisional and based on what works at that time (Creswell, 2013). Under a pragmatic epistemological outlook, truth is tested through action and is determined by whether it is matched by experience (Bazeley, 2013). For example, Bazeley (2013) explains that an adult may associate a plank of wood supported by two short posts as a seat whereas a child might view it as a balance beam. The experience is then defined and labelled and the features from a wider perspective that does not fit the definition are discarded (Bazeley, 2013). Methodology refers to the process of research (Creswell and Clark, 2007). A pragmatic epistemological outlook utilises a 'what works' methodological approach as the focus under this viewpoint is on how best to answer the

research questions, using all of the research tools available to understand the problem, rather than focusing on using particular methods (Creswell, 2013). In the present study, the research questions centred on investigating whether a peer-led lunch-time intervention impacted on girls' daily MVPA, enjoyment or perceived social support for physical activity and what the players and leaders experienced in this type of intervention. Under the pragmatic epistemological position, the present study selected the accelerometer, questionnaire, draw and write and focus group data collection methods as these research tools best answered these research questions.

5.4.2 Procedures used to collect information on participants' experience

After the last lunch-time session of the one-week pilot in February 2014, the leaders and players completed a draw and write activity to collect information on the participants' experience of the preliminary intervention design. Three leaders were then randomly selected to participate in a focus group discussion to further explore their experience of the intervention design. Modifications to the preliminary intervention design were made based on the analysis of this draw and write and focus group data. The consolidated criteria for reporting qualitative research (COREQ) was checked (Tong et al., 2007) to provide an explicit and comprehensive account of the focus group and draw and write methods applied. As outlined by Tong et al. (2007), the researchers' background and personal experience will affect the interaction with participants during data collection. The lead author in the present study, a female PhD candidate who holds a BSc. in physical education, conducted all of the draw and write and focus group sessions in this study and the following study described in chapter 6. Prior to the study commencement, the researcher did not have any personal or professional knowledge of the participants. The following sections outline the rationale for using the draw and write technique with focus groups, the data collection procedures and the inductive thematic analysis of the data.

5.4.2.1 The draw and write technique combined with focus group discussions rationale

The use of image based research is a developmentally appropriate method for children to help them to express their ideas and meanings of experiences to adults (Moss and Clark, 2011, Clark, 2005, Enright and O'Sullivan, 2012, Veale, 2005, Knowles et al., 2013). Image based research varies from found, researcher-generated or participant-produced videos, photographs, drawings, cartoons, maps and other visual forms of expression and representation (Freeman and Mathison, 2009). Participant-produced drawings is one of the research tools of participatory methods which engages participants in knowledge production and has the potential to involve children in the interpretation and analysis of that knowledge (Veale, 2005). In general, drawing is considered an activity that is enjoyable for children of all ages (Horstman et al., 2008, Backett-Milburn and McKie, 1999, Fargas-Malet et al., 2010). The main advantage is that almost all school-age children have experience of producing and writing about drawings (Horstman et al., 2008). Participant-produced drawing is also recognised as a tool that facilitates children to express their emotions (Kearney and Hyle, 2004), describe, analyse and give meaning to their individual

experiences (Veale, 2005), represent their worldview (Golomb, 2003) and produce a concise presentation of their experiences (Kearney and Hyle, 2004). Researchers have used this tool in child development, sociology, geography, art therapy, psychology, anthropology, health promotion and education-based research (Knowles et al., 2013, Backett-Milburn and McKie, 1999). Drawings have also been used to examine children's insights into exercise and sport (Burrows et al., 1999), sport education (MacPhail and Kinchin, 2004), learning physical education skills (Koekoek et al., 2009) and school playground experiences (Knowles et al., 2013).

The main limitation of using drawings in research is that they can have several meanings (Prosser, 2007) and a researcher's interpretation of the drawing may not be useful, meaningful or close to what the child was trying to convey about their experience (Freeman and Mathison, 2009). Therefore, drawings as a research tool should not be used alone (Freeman and Mathison, 2009). A written or verbal explanation from participants, even one word, helps stabilize the meaning of an image (Walker, 2007, Gauntlett, 2005). Participants' explanation of the drawings are essential to accurately understand the content of the participants' drawing and meanings they wish to convey (Kearney and Hyle, 2004), especially if that content is unrecognisable to the researcher (Walker, 2007). Focus groups have been identified as a valuable method for eliciting children's experiences (Morgan et al., 2002), however previous research noted that children who drew and discussed the research topic in focus groups provided more than twice as much information than children who participated in the focus groups without drawing a picture (Gross and Hayne, 1998). Drawings also help focus children's ideas on the topic to be discussed later in the focus groups (Willenberg et al., 2010, Hume et al., 2005, Horstman et al., 2008). By asking children to draw a picture and later ask them to talk about that picture in the focus groups, the children are put in the role of the 'expert', providing children with the sense that their ideas are valued (Rollins, 2005). Children engage well when drawings are used as a guide in focus group discussions as participants enjoy talking about familiar and comfortable contexts (Armour and Macdonald, 2012) and it creates a strong collaboration between the researcher and participants (Kearney and Hyle, 2004). Furthermore, drawings act as a catalyst in focus group discussions and participants can frame their own experiences within unstructured interviews which combats researcher biases (Kearney and Hyle, 2004).

5.4.2.2 Draw and write design

Child-produced individual drawings, rather than group drawings, were chosen as the most efficient method to gather information about children's experiences of the intervention design because individual drawings offer insight into children's individual experiences (Veale, 2005). The researcher asked participants to draw a picture on the A4 size paper provided that illustrated them participating in or leading the lunch-time intervention activities. Participants were also invited to include a written explanation of the picture they

drew on the lined section of the page (see Appendices 9 and 10). As prompts or questions are typically used to guide participants' individual drawings in a specific direction (Freeman and Mathison, 2009), written instructions were included on the drawing sheet for the players and leaders. The instructions for the players included '*draw a picture of yourself in the playground at lunch-time* and *write words or a sentence that describe the picture you drew*'. The written instructions for the leaders included '*draw a picture of yourself leading activities in the playground at lunch-time* and *write a sentence that describe the picture you drew*'.

5.4.2.3 Draw and write data collection

At the end of the trial, the leaders and players were invited to complete a draw and write activity to illustrate and describe their experience of the intervention design. Players and leaders completed the draw and write activity using their own pencils, erasers and colouring utensils. The researcher and class teacher were present in the second or fifth classrooms while the draw and write activity was conducted. Teachers were made aware that it was important not to lead or suggest ideas to the students as the emphasis of the study was to record the participants' thoughts, rather than the teachers' perceptions (Horstman et al., 2008, Backett-Milburn and McKie, 1999). To avoid the drawing of only easily depicted pictures or drawing to please the teacher (Williams et al., 1989, Backett-Milburn and McKie, 1999, Knowles et al., 2013), the researcher explained that the activity was designed to ascertain participants' experience of the intervention rather than for competition purposes. The researcher also prompted participants to detail who and what was in their drawing and why they chose to draw it (Kendrick and McKay, 2004) to avoid leading the child to what they feel is the 'right' answer (Horstman et al., 2008, Backett-Milburn and McKie, 1999). Participants completed this activity in silence to allow them to concentrate on the activity (Horstman et al., 2008) and to minimise the potential influence of friends (Williams et al., 1989, Backett-Milburn and McKie, 1999, Knowles et al., 2013). The draw and write activity was completed within 20 minutes.

5.4.2.4 Focus group discussions

Three leaders aged ten years were randomly selected, through an online random generator (http://www.random.org/integers/), to participate in a focus group after completing the draw and write activity to further explore their experience of the intervention design. A small group of three leaders was chosen for the focus group discussion as groups of three to eight participants generate rich discussion and are easier to manage than larger groups (Braun and Clarke, 2013). The focus group guide consisted of questions regarding the six features of the preliminary intervention design (see section 5.4). The focus group was held in a vacant classroom, recorded with a digital voice recorder and lasted 20 minutes.

5.4.2.5 Thematic analysis

The qualitative data were analysed through an inductive thematic approach. Thematic analysis is a method in its own right, used to search across the data set to identify, analyse

and report patterns (themes) of meaning (Braun and Clarke, 2006, Willig, 2013). This method of analysis is commonly used in qualitative research (Petty et al., 2012). For example, thematic analysis has been used to examine children's insights of an after-school physical activity programme (Jago et al., 2015), playing active/inactive video games with regards to physical activity participation (Baranowski et al., 2012) and their views on reducing screen-viewing (Sebire et al., 2011). An inductive approach rather than a deductive approach was selected to analyse the qualitative data in the present study as the researcher was interested in grounding the analysis in the data rather than reflecting the researcher's theoretical interests in the topic (Braun and Clarke, 2006, Willig, 2013). An inductive approach involves identifying themes in a bottom-up manner (Frith and Gleeson, 2004) and is strongly linked to the data (Patton, 1990, Willig, 2013) as it involves coding the data without trying to fit it into a pre-existing coding frame (Braun and Clarke, 2006, Willig, 2013). An inductive thematic approach was chosen to analyse the qualitative data in the present study and the study described in chapter 6 as the analysis would be strongly linked to the data (Willig, 2013, Patton, 1990) and may provide a rich, detailed and complex account of the data (Braun and Clarke, 2006).

Before commencing the qualitative data analysis, it was decided what the themes would represent (Willig, 2013). Themes were identified as aspects of the data which represent a level of patterned response that described the leaders' and players' experiences of the intervention (Braun and Clarke, 2006). Braun and Clarke's (2006) guide to performing thematic analysis was applied to analyse the qualitative data as the approach is of a high quality (Willig, 2013). The three main strengths of using this approach to analyse the qualitative data in the present study included that 1) it was relatively quick and easy to learn, therefore suitable for the researcher with no experience of qualitative research (Braun and Clarke, 2006), 2) it was a quick method to do (Braun and Clarke, 2006) which was beneficial as the researcher dealt with large amounts of quantitative and qualitative data and 3) it was useful for working with participants as collaborators (Braun and Clarke, 2006) for identifying the modifications to be made to the intervention at mid-intervention. Other strengths of this approach include that the method can produce unanticipated insights, is not complex and offers flexibility in the way of analysing the data (Braun and Clarke, 2006). Furthermore, the results are usually accessible to the educated general public and can be used to inform policy development as they are a summary of the key features of a large body of data and present a dense description of the data (Braun and Clarke, 2006). The flexibility of the method in terms of the wide range of analytic options is also a limitation of thematic analysis as it can potentially paralyse the researcher in deciding what aspects of the data to focus on (Braun and Clarke, 2006). This limitation was overcome in the present study by identifying the epistemological stance for analysing the data, which was pragmatic, and referring to the research questions (Willig, 2013). Furthermore, the status of thematic analysis was previously tarnished potentially due to many studies claiming to use the

method but poorly analysing the data (Braun and Clarke, 2006). To avoid poorly analysing the data, the Braun and Clarke (2006) 6-phase thematic analysis was utilised as it clearly and comprehensively outlines how to conduct high quality thematic analysis (Willig, 2013).

Firstly, the researcher became immersed and familiarised with the data. The researcher prepared the focus group data by transcribing it into text. The draw and write documents were analysed using a table that contained five headings: ID, Class Group, What I See, What They Say and Direct Quotes. The questions of the literal reading of the subject matter questions within the Freeman and Mathison (2009) framework were used to catalogue the contents of the drawings. The literal reading of the subject matter questions include: *What are the physical features of the image, who or what is portrayed and what is the setting?* (Freeman and Mathison, 2009). The *What They Say and Direct Quotes* headings dealt with writing verbatim the children's descriptions of their drawings and the children's writing within the drawing respectively. These word documents were then uploaded to the NVivo qualitative data analysis software (QSR International, Version 10, 2012) for further analysis. After preparing the qualitative data for analysis, the researcher read through the entire data set once without coding (Braun and Clarke, 2006). Next, the researcher re-read the data in an active way by noting initial ideas for coding (Braun and Clarke, 2006). The data was then coded in the NVivo qualitative data analysis software (QSR International, Version 10, 2012) using nodes to indicate potential patterns in the data. Each data item was given equal attention throughout the entire data set as all the data files were coded inclusively and into as many potential themes as possible. This meant that each extract of text was uncoded, coded once or coded many times (Braun and Clarke, 2006).

Next, the codes were sorted into theme-piles by considering how the various codes assembled to form overarching themes (Braun and Clarke, 2006). The researcher also determined whether there were sub-themes within the themes. Sub-themes are themes-within-a-theme. Sub-themes provide structure within the themes and demonstrated the hierarchy of meaning within the data (Braun and Clarke, 2006). Then, the candidate themes were reviewed and refined. Two levels of reviewing and refining were conducted in this phase (Braun and Clarke, 2006). Level one consisted of reading all of the extracts for each theme and considering whether they appear to form a coherent pattern (Braun and Clarke, 2006). The purpose of level two refining of the candidate themes was to determine the validity of the individual candidate themes in relation to the entire data set and whether the thematic map accurately reflected the meanings evident in the data set as a whole (Braun and Clarke, 2006). By reading the data set again, it was determined that the candidate themes 'worked' in relation to the data set and no further adjustments to the themes were required. Finally, the researchers clearly defined the themes and gave them a concise title that could be described in a few sentences.

5.5 Findings

The findings of the pilot are based on the draw and write data from 26 players and 15 leaders, plus the data from three randomly selected leaders that took part in a focus group discussion are presented below. Two main themes were identified in the data set: participant enjoyment was based on the games selected, and management issues disrupted the lunch-time activities. These themes highlight aspects of the intervention that warranted improvement and the modifications made to the intervention design based on these findings.

5.5.1 Participant enjoyment was based on the games selected

The leaders and players enjoyed the lunch-time sessions. For example a leader explained "I had so much fun" (leader 502, writing) and a player stated "it was a fun time at playtime, it was so fun I couldn't stop laughing" (player 213, writing). The players' favourite activity was skipping. For example, "this is one of the games I like the best, doing skipping" (player 219, writing). Figure 5.2 shows a leader and player happily skipping at lunch-time.

Figure 5.2. Leader and player happy to be skipping at lunch-time (leader 504, drawing)

Some players and leaders became tired of repeating games they had played during the pilot, for example "the girls were like "*oh we already played this game*"" (leader 1, focus group). The leaders also did not want to lead the same activities repeatedly and suggested that they rotate to a different zone to play new games, "we were leader 6 and I think the next day we should have changed to leader 5, to have a different box… we don't want the same games all the time" (leader 2, focus group). The leaders also explained they wanted to be able to choose the order of playing the games "maybe we should all get the same games but we choose whatever game we go with" (leader 2, focus group). Overall, the findings indicate players particularly enjoyed skipping activities but did not enjoy repeatedly playing the same games. Therefore, approximately 20 activity cards were added to each folder. Similarly, the leaders did not enjoy leading the same games repeatedly and wanted to be able to choose the order of playing the activities. Thus, the leaders were allowed to lead similar active playground games to those listed in the folders and chose the order for playing the activities. Furthermore, the players and leaders were provided with timetables that were constructed to rotate the players and leaders to a different zone each lunch-time. The researcher randomly assigned every fifth student on the class list to a group or partner. The number of zones was reduced to four to provide the players and leaders with the opportunity of attending each of the zones each week. The boxes, folders and names of the zones were colour co-ordinated for organisational purposes.

5.5.2 Management issues disrupted the lunch-time activities

The leaders had difficulties with managing the players and equipment in the yard as they had no physical boundary to their zone. For example, the leader explained "when we are doing peep and freeze you have to run and then the other group is in a circle with a ball… some of them were running through the circle" (leader 2, focus group). Therefore, the leaders will be provided with cones to outline the boundary of their zones and prevent the players from disturbing other group activities. During future training sessions, the researcher will demonstrate how to outline the zone boundary to the players. The leaders thought being familiarised with the activities prior to leading the lunch-time sessions was better than reading the activities from the folders during the lunch-time sessions. The leaders became familiarised with the activities by playing a selection of the games during the training session, reading the activity instructions in the folders and talking about the activities with their leader partner. For example "before we went out we'd talk about it" (leader 2, focus group) and "it's easier to know them [the activities] beforehand because then you won't be spending a few minutes reading through them and getting to know it" (leader 1, focus group). To promote the good practice of becoming familiar with the activities prior leading the lunch-time sessions, the researcher will encourage the leaders to read the activities in the folders and discuss the activities with their partners prior to leading the lunch-time sessions. The researcher will also assist the leaders in becoming familiar with the lunch-time activities by playing many of the lunch-time games with the leaders during the training session. The leaders highlighted that the uneven number of players in

each group meant that one player was always without a partner for the activities that required the players in pairs. The uneven number of players per group became an issue when the players did not want to be partnered with a leader for the game "I don't think there should be five in a group because they'd be like I don't have a partner and we'd be like oh I'll be your partner and they be like I hate that" (leader 3, focus group). Therefore, the researcher will demonstrate methods of incorporating groups of three into paired activities during future training sessions to prepare the leaders for leading activities with uneven numbers of players in the groups.

5.6 Discussion

The purpose of this study was to develop a physical activity intervention for primary school girls. Through the use of Smith's (2009) model, a peer-led lunch-time intervention was developed based on the gaps in the research and consultations with a representative sample of the target population. The following discussion outlines the strengths of the intervention design and the next steps for implementation and evaluation of the intervention.

This study is innovative as it the first peer-led lunch-time intervention designed to address the issue of inactivity among primary school girls. In schools, there are budgetary constraints and growing pressure on teachers to increase academic achievement scores (Mahar et al., 2006). Therefore, it is an advantage that this intervention design takes place during a time when children normally take a break from classroom studies and only requires school game equipment, cheap resources such as boxes and folders and minimal adult involvement in the form of training the leaders and organising the resources. The inclusion of student voice in the development of the intervention is the main strength of this study. This strategy is supported by the UK Children's Act (Department of Health, 1989), the Irish National Children's Strategy (Department of Children and Youth Affairs, 2000) and Article 12 of the United Nations Convention on the Rights of the Child (United Nations, 1989) where it is recommended that the child is consulted and involved in all matters that regard them. This approach is also recommended to help the participants adopt the ideas of the intervention (Van Sluijs and Kriemler, 2016, Public Health England, 2015). The findings of the thematic analysis show the players and leaders enjoyed the activities and the modifications made to the intervention design based on the student voice data may further help the participants to embrace the ideas of the present study intervention.

Two main themes, derived from the student voice data, were identified in the present study; participant enjoyment was based on the games selected and management issues disrupted the lunch-time activities. Within the first listed theme, the players and leaders stated that they had fun and enjoyed participating in the intervention. This is a positive

finding as the level of enjoyment experienced during physical activity influences children to begin, maintain or withdraw from physical activity participation (O' Reilly et al., 2001, Salmon et al., 2009, Eather et al., 2013b, Sallis et al., 2000a, Lubans et al., 2008, Biddle et al., 2005, Van Der Horst et al., 2007). Revising the design in line with students' feedback is undertaken with the intention of maintaining the participants' enjoyment in physical activity during the trial of the intervention. The main modifications to the intervention design, such as providing the leaders with cones to outline the zone boundaries, were based on the leaders' issues with management as outlined in the second listed theme. Participants' level of enjoyment in physical activity will be examined throughout the main trial to determine whether the players and leaders continue to accept the ideas of the intervention.

The main limitation of this trial was that the participants' physical activity was not examined. However, the purpose of this phase of study was to involve the participants in the design of the intervention rather than conduct a full scale evaluation of the impact of this intervention on their MVPA levels. The players' physical activity will be examined in the main trial (chapter 6) to provide details on children's physical activity in a peer-led lunch-time intervention. Three previous studies examined primary (Eather et al., 2013a) and secondary (Peralta et al., 2009, Lubans et al., 2011) school children's physical activity in multi-component interventions that contained lunch-times activities led by peers. Only one of these studies examined children's physical activity in a peer-led lunch-time intervention using accelerometers (Peralta et al., 2009). The findings of this study can be compared to the daily physical activity intensity guideline, however the calibration of the accelerometers to record in 60-second epochs meant it was more likely to reflect multiple behaviours of physical activity intensity than the use of a lower epoch like 5-seconds (Mc Clain et al., 2008). The main trial of the peer-led lunch-time intervention, described in the following chapter, will examine children's physical activity using accelerometers calibrated to record in a 5-second epoch. Thus, this study will provide the first examination of children's physical activity in a single component peer-led lunch-time intervention using an epoch that is less likely to reflect multiple behaviours of physical activity intensity than previously used.

5.7 Conclusion

In conclusion, this pilot study outlines the steps followed to develop an intervention for primary school girls. A novel intervention design for this cohort was created, piloted among a representative sample of the target population and modified based on feedback from these participants. It appears that the participants adopted the ideas of the intervention as both the players and leaders enjoyed participating in the study. The enjoyment levels in physical activity will be examined in the main trial to determine whether the players continue to embrace the ideas of the intervention. Players' physical activity will also be examined in the main trial to determine whether the intervention was successful at improving this behaviour.

Chapter 6. A cluster randomised controlled trial of a peer-led lunch-time physical activity intervention for primary school girls

6.1 Introduction

This chapter describes the remaining two phases of the development of a physical activity intervention for primary school girls: 1) implementing the intervention in two stages, allowing for a mid-intervention review to evaluate the intervention with participants and restructure as necessary and 2) conducting a formal evaluation of the intervention after implementation to determine whether it achieved the research objectives and to document the experiences of the participants. The primary outcome of this formal evaluation focuses on the impact of the peer-led lunch-time intervention on primary school girls' daily MVPA. Participants' enjoyment levels, perceived social support for physical activity participation and experiences of the intervention are also described.

The present study sought the perspectives of the participants in this trial as the knowledge attained of children's lives is incomplete without consideration of their knowledge of themselves (Jones, 2004, Loveridge and Hetherington, 2010). In the past, the predominant focus of the social scientific empirical research conducted on and with children viewed the child as the object of research rather than as subjects (Greene and Hogan, 2005). Article 12 of the United Nations Convention on the Rights of the Child (United Nations, 1989) supports children's participation in research as it promotes the right of the child to be consulted and involved in all matters that regard them. In the UK and Ireland, children's rights have also been acknowledged in the Children Act (Department of Health, 1989) and The National Children's Strategy (Department of Children and Youth Affairs, 2000) respectively. In line with these publications, children's views of their experiences have become an important component of childhood studies (Clark, 2005) and are no longer regarded as objects of research (Loveridge and Hetherington, 2010). By seeking the participants' experiences of the intervention in the present study, they are acknowledged as experts of their own lives (Clark and Moss, 2001, Clark, 2004, Moore et al., 2008, Cook and Hess, 2007, Loveridge and Hetherington, 2010)) that constantly contribute and engage with their community in their daily lives (Loveridge and Hetherington, 2010, Greene and Hogan, 2005). Seeking information regarding children's experience can reveal their understandings, interpretations, negotiations and feelings about their daily lives (Greene and Hogan, 2005, Loveridge and Hetherington, 2010) and this was important in deciphering the knowledge attained on children's physical activity in the present study intervention.

The intervention targets two correlates of physical activity: perceived social support for physical activity and enjoyment of physical activity. These correlates of physical activity are examined to improve the understanding of the factors that influence girls' physical activity

(Kirby et al., 2011, Davison and Lawson, 2006). The social support that can influence children's activity levels occur through actors such as parents, teachers and friends (Leatherdale et al., 2010). Ecological models suggest that influencers closest to the target group have the strongest effect on children's physical activity (Spence and Lee, 2003, Hohepa et al., 2007). During lunch-time, peers are the most proximal social influence on children's physical activity (Hohepa et al., 2007, Ommundsen et al., 2006). For example, a study found perceived support from friends to be significantly related to 9-11 year old New Zealander children's lunch-time physical activity meaning that children with perceived low support from friends were more likely to partake in sedentary or light physical activity than play games at a moderate to vigorous level (Hohepa et al., 2007). It was thus important to seek to develop or maintain perceived peer social support for physical activity during the intervention. The level of enjoyment experienced during physical activity is another important factor that influences children to begin, maintain or withdraw from physical activity participation (O' Reilly et al., 2001, Salmon et al., 2009, Eather et al., 2013b, Sallis et al., 2000a, Lubans et al., 2008, Biddle et al., 2005, Van Der Horst et al., 2007). Enjoyment is the most commonly targeted correlates of physical activity within interventions aimed at children aged 5-12 years (Brown et al., 2013, Lubans et al., 2008, Lewis et al., 2002, Salmon et al., 2009) and a study found that enjoyment of physical activity among Norwegian children aged nine years was strongly correlated with playing lunch-time games (Ommundsen et al., 2006). It is thus plausible to suggest that an increase in children's enjoyment of physical activity may lead to increases in children's physical activity. As previously stated in section 5.2, primary school girls aged 7-8 years were targeted as a study showed a marked decrease in MVPA levels from the age of nine years (Bradley et al., 2011). Therefore, the present study sought to implement lunch-time activities that were enjoyable for 7-8 year old girls.

To date, the impact of a peer-led lunch-time intervention on primary school girls' daily physical activity has not been evaluated. The evaluation of this intervention includes details on girls' MVPA levels, perceived social support, enjoyment and experiences of the intervention. The primary aim of the present study was to use the rigour of a randomised controlled trial to determine the impact of a peer-led lunch-time intervention on second class primary school girls' daily MVPA. The secondary research questions included: 1) does the intervention change the second class girls' perceived social support of physical activity or their enjoyment of physical activity and, 2) what are the second and fifth class girls' experiences of the peer-led lunch-time intervention?

6.2 Methods

6.2.1 Study design

A cluster randomised controlled trial was employed in the present study. When appropriately designed, conducted and reported, randomised controlled trials represent the

gold standard in evaluating interventions (Schulz et al., 2010). To ensure the present study was designed, conducted and reported appropriately, the CONSORT 25 item checklist for reporting cluster randomised controlled trials was adhered to (Campbell et al., 2012) (see Appendix 11). As the present study experimental trial is school-based, randomisation by group (cluster: school) was the only feasible method of conducting the trial to control contamination between groups (Puffer et al., 2005, Jaycox et al., 2006). The primary outcome measure of the present study was daily minutes of MVPA at level of participant. Secondary outcome measures were perceived social support and enjoyment of physical activity as well as participants' experiences of the intervention at level of participant.

The present study implemented a mixed methods study design following the recommendations of Smith (2009) to attain qualitative feedback from participants during quantitative evaluation of interventions. The research questions, such as what are the players' and leaders' experiences of the peer-led lunch-time intervention and what impact does this type of intervention have on the players' daily MVPA, could not be answered using only quantitative or qualitative methods (Bryman, 2006), therefore a mixed method design was required for the present study. The qualitative findings may provide a richer explanation of the quantitative findings, help explain unexpected findings in the quantitative data and provide a more comprehensive account of participants' physical activity engagement while participating in the lunch-time intervention (Bryman, 2006).

An embedded experimental mixed methods design where one strand is given priority and the other strand plays a supporting role (Creswell, 2009, Creswell et al., 2003) was chosen as it reflected the decisions made regarding the priority, level of integration, timing and mixing of the quantitative and qualitative strands (Creswell and Clark, 2011). According to Creswell and Clark (2011), priority refers to the relative importance of the quantitative and qualitative strands to answer the research questions. The quantitative strand in the present study was given priority over the qualitative strand as the primary research question was to determine the impact of the peer-led lunch-time intervention on primary school girls' daily MVPA. Based on Smith's (2009) physical activity intervention model, the quantitative and qualitative strands were mixed at design level. An interactive level of integration was required as the mid-intervention focus groups determined the modifications to be made to the quantitative-measured intervention. A one-phase approach to embedding the qualitative strand was applied as the quantitative data was collected at baseline, mid- and end-intervention and the qualitative data was collected at mid- and end-intervention. After the quantitative and qualitative data collection, both sets of results were interpreted. The qualitative strand in the present study is attached to but different from the primary purpose of examining whether the intervention has an impact on primary school girls' daily MVPA (Creswell and Clark, 2011). Therefore, the qualitative data is not meaningful without being

embedded within the quantitative strand (Creswell and Clark, 2007, Creswell and Clark, 2011). The main advantage of using the embedded design is that less time and resources are spent collecting the qualitative data than mixed-method designs that require equally extensive quantitative and qualitative data collections (Creswell and Clark, 2011, Creswell and Clark, 2007).

The findings of the quantitative data need to be generalisable (Andrew and Halcomb, 2009). Generalisations from a sample to a population can be achieved by using valid and reliable research tools (Gray, 2009) and designing the study to do what is intended (Andrew and Halcomb, 2009). Validity of research tools means that the tool measures what is intended (Gray, 2009) and meaningful interpretations of the data are yielded (Creswell, 2013). For example, the questions in a questionnaire need to be relevant and reflect the topic being explored and the items of the questionnaire must be representative of the content they were intended to measure (Andrew and Halcomb, 2009). The primary outcome measure of the present study was daily minutes of MVPA, as measured by accelerometers. Previous studies validated accelerometers in laboratory and field-based settings and found strong positive correlations between accelerometers and energy expenditure or exercise intensity (Trost, 2007, Trost et al., 2005, Freedson et al., 2005). Comparisons between accelerometers and heart rate monitoring (Ott et al., 2000), direct observation (Sirard et al., 2005), indirect calorimetry (Trost et al., 1998), whole-room calorimetry (Puyau et al., 2002) and doubly labelled water (Ekelund et al., 2004), indicated that accelerometers accurately measure children's physical activity. The reliability of a tool means that it's measurement is internally consistent, is stable over time and consistent in test administration and scoring (Gray, 2009, Andrew and Halcomb, 2009, Creswell, 2013). Actigraph accelerometers were found to be reliable in measuring children's physical activity (Trost et al., 2005, Freedson et al., 2005). Details regarding the validity and reliability of the questionnaire used in the present study are provided in section 6.2.5.3.

To design a study so that it does what is intended, the researcher must reduce the threats to internal and external validity (Andrew and Halcomb, 2009). Internal validity refers to the extent to which differences in results can be attributed to the experimental treatment rather than other factors affecting the research process (Maree and van der Westhuizen, 2009, Gray, 2009). Factors that may threaten internal validity include changes in measuring instruments and test administrators, selection bias, missing data and maturation changes that may take place within respondents themselves (Maree and van der Westhuizen, 2009). Therefore, potential confounding variables need to be controlled (Gray, 2009) such as ensuring participants in each group are of similar ages and educational level (Gray, 2009) and that there is no selection bias (Andrew and Halcomb, 2009). Approaches for ensuring internal validity in the present study included randomly selecting schools for participation in

the study and to ensure children of a similar age and educational level were measured by only inviting second class children in the intervention and control groups to wear an accelerometer. Furthermore, one researcher administered the questionnaire, distributed and provided instructions on when and how to wear the accelerometers. To determine whether the missing data was ignorable or informative data, a statistical test was used to compare the data of participants with continuous variables of missing data versus complete data sets (see section 6.2.6 for further details). External validity is the extent to which the findings can be inferred or generalised to other groups or situations other than the present study participants (Andrew and Halcomb, 2009, Gray, 2009, Maree and van der Westhuizen, 2009). A case can be made that the findings can be generalised by presenting the similarities between the present study participants and essential characteristics of other groups, settings or periods (Gray, 2009). Therefore, schools and participants were randomly selected and were of an adequate size that sufficiently represented the second and fifth class students in all-girl primary schools (Maree and van der Westhuizen, 2009).

6.2.2 Intervention

The intervention was implemented in four schools in two stages and included a mid-intervention review to evaluate the intervention with participants and restructure as necessary (Smith, 2009). The lunch-time activities were led by fifth class students from Mondays to Thursdays over eight weeks in March to June or September to December 2014. Evidence shows that physical activity levels vary with seasonality (Tucker and Gilliland, 2007, McKee et al., 2012), however two intervention and two control schools were measured during each school term (March-June or September-December) one week apart to control for the effect of season on physical activity levels. The players did not participate in the intervention activities on Fridays as Scruggs et al. (2003) recommended that all traditional unstructured lunch-times should not be eliminated as they have important educational and developmental implications (Pellegrini and Smith, 1993). For example, unstructured lunch-times can provide children with an opportunity to interact with peers informally and have a breaks from cognitive tasks (Pellegrini et al., 1995, Pellegrini and Bjorklund, 1997). On wet days, which ranged from zero to two days per physical activity monitored week, the players and leaders remained in their classrooms and did not participate in the lunch-time intervention.

A section of the second class yard was allocated for the lunch-time activities. Four coned zones per second class were outlined within this sectioned area. A box with designated school equipment (e.g. hoops, balls, skipping ropes, bean bags) was allocated to each zone. The researcher constructed timetables that randomly listed the player and leader groupings, rotated the players and leaders to a different zone each lunch-time and alternated the leaders between leading the lunch-time activities and participating in their own activities in their own yard weekly. The player groupings consisted of six to eight students and the

leaders led in pairs or groups of threes. Fifth class teachers in one school grouped the leaders to ensure that students with limited English or students with behavioural issues were not grouped together. These timetables were displayed on the players' and leaders' classroom walls for the duration of the study.

The researcher provided the leaders with activity folders specific to each zone. Each folder contained approximately 20 activity cards that were based on the Chinese skipping sequences watched on YouTube (see Appendix 12 for links to YouTube videos and corresponding activity cards) and described in Croi Chorca Dhuibhne (2013) and the chasing, racing, action and jumping activities outlined in Sabin (2011), Playworks (2013) and The Australian Sports Commission (2014). These activities consisted of games without (e.g. chasing) and games with equipment (e.g. skipping). Leaders could choose the order for playing the activities and lead similar active playground games that were not listed in the folders. Details of the leader and player groupings, the locations for the activities, the equipment required and the instructions for playing the activities were also provided in each folder. Two intervention schools only allowed students to run on the grass area. Therefore, one school allocated the field area for the intervention zones and the other school allocated four additional zones on the grass area to be used when the grass was dry. In the latter intervention school, the running activity cards were put into separate folders to be used only in the grass area. The player and leader timetables, equipment boxes, activity folders and names of the zones were colour co-ordinated for organisational purposes.

6.2.3 Participants

A priori power analysis was performed using the G*Power 3 software package (Faul et al., 2007) to determine the appropriate sample size to detect the statistical significance of the intervention that is of practical importance (O' Shea, 2013). Physical activity researchers have also utilised this programme to calculate appropriate sample sizes for child physical activity interventions (Mendoza et al., 2011, Aarts et al., 2009, De Coen et al., 2012, Gallotta et al., 2011, Powell et al., 2015). The sample size in the present study was computed by selecting the statistical test appropriate for the problem, a power analysis and the input parameters required for the analysis in the G*Power 3 software package (Faul et al., 2007). The ANOVA repeated measures within-between interaction was selected as the statistical test for the present study as there was a within-subject repeated measures of participants' physical activity and there was a between-subject measure of comparison between the intervention and control groups (O' Donoghue, 2013). A priori power analysis was selected which meant the required sample size was computed based on the alpha, power and effect size. Alpha and power (1-beta) were set at the conventional figures of .05 and .80 (80% power) respectively as a value smaller than .80 would lead to too great a risk of a type two error (Cohen, 1992, O' Donoghue, 2013). Given 80% power, two groups (intervention and control), three time-points (baseline, mid- and end-intervention) and a within-between

repeated measures design, 66 participants would be required to detect a medium (f = .25) standardised effect (Cohen, 1988) in a simple random sample study.

Power calculations conducted in G*Power 3 are based on a simple random sample which implies that every constituent in the population has an equal probability of being selected for the sample (Berg and Wayne Latin, 2008, Matthews and Kostelis, 2011). Unlike simple random sampling, participants in clustered samples can often have many similarities such as socioeconomic, ethnic, religious, geographic backgrounds, age-related similarities, etc., which tend to yield responses more similar to one another than the responses of a group of individual participants chosen at random (Killip, 2004). The similar response in clustered samples (intra-cluster correlations) leads to a decrease in the variation among responses of participants in the same cluster or the variance of the within-cluster responses which can magnify the apparent difference in outcomes or responses between groups (Killip, 2004). As cluster samples are not as statistically efficient as simple random samples, the total required sample size in the present study needed to be adjusted using the design effect formula and the effective sample size formula (Killip, 2004) (see Appendix 13). In order to conduct the design effect formula, the number of participants per cluster and the intra-cluster correlation coefficient were required. A selection of four intervention and four control schools was deemed appropriate for the present study as a minimum of four clusters per arm was recommended to ensure valid analysis (Hayes and Moulton, 2008, Campbell et al., 2012) and was manageable in terms of implementation and data collection (Bundy et al., 2011). An intra-correlation of 0.04 was utilised in a previous sample size calculation for accelerometer-based measurements of Australian 5-7 year old children's school day physical activity in a lunch-time intervention (Bundy et al., 2011), therefore was included in the present study design effect formula. The effective sample size calculation indicated that an additional 51 participants were required to account for the clustered sample in the present study. Therefore, 117 participants (66 + 51) with 15 girls per school was the sample size required for the present study.

The inclusion criteria for schools in the present study was that they were (i) all-girl primary schools, (ii) with a minimum school enrolment of 160 students, (iii) situated in a town or city in the Munster province, (iv) not currently participating in another physical activity initiative and (v) interested in taking part in the study. A randomly selected representative sample of primary school girls in Munster, one of the four provinces of Ireland, could allow generalisations of the findings to be made to the national population of girls aged 7-8 years. A simple random sampling procedure was utilised to select the schools (Matthews and Kostelis, 2011). A list of all-girl Munster urban primary schools with an enrolment of at least 160 students from the SchoolDays.ie website was compiled in Microsoft Excel 2010. Thirty-two all-girl Munster primary schools with at least a 160 student enrolment were listed on

this website. Four schools were measured on each school term as a rolling weekly schedule over two school terms (March-June and September-December 2014) was required to measure participants' physical activity with accelerometers in each school at three time-points. At the beginning of each school term, two intervention and two control schools were randomly selected from the list of all-girl Munster primary schools using an online random integer generator (http://www.random.org/integers/). The principals of the corresponding schools of the first two generated numbers were contacted by phone and invited to participate as the intervention group. The schools matched to the last two numbers generated were telephoned and invited to participate as the control group. When schools declined to participate as intervention or control schools, the researcher removed the school from the list, generated another number from the online random integer generator and invited the school corresponding to the assigned number to participate in the study. Of the 32 schools with a minimum of 160 students enrolled, ten schools declined to participate as the intervention or control group, one school took part in the pilot study (as described in chapter 5) and eight schools took part as the intervention or control group. Informed consent of the participating schools' principals was obtained prior to commencing the research. Parents and second class girls enrolled in the intervention and control schools and fifth class girls in the intervention schools were informed of the nature of the study before participating in the research. Informed consent of both children and parents were obtained and participants were free to withdraw from the research at any stage. See Figure 6.1 for flow of schools through the trial.

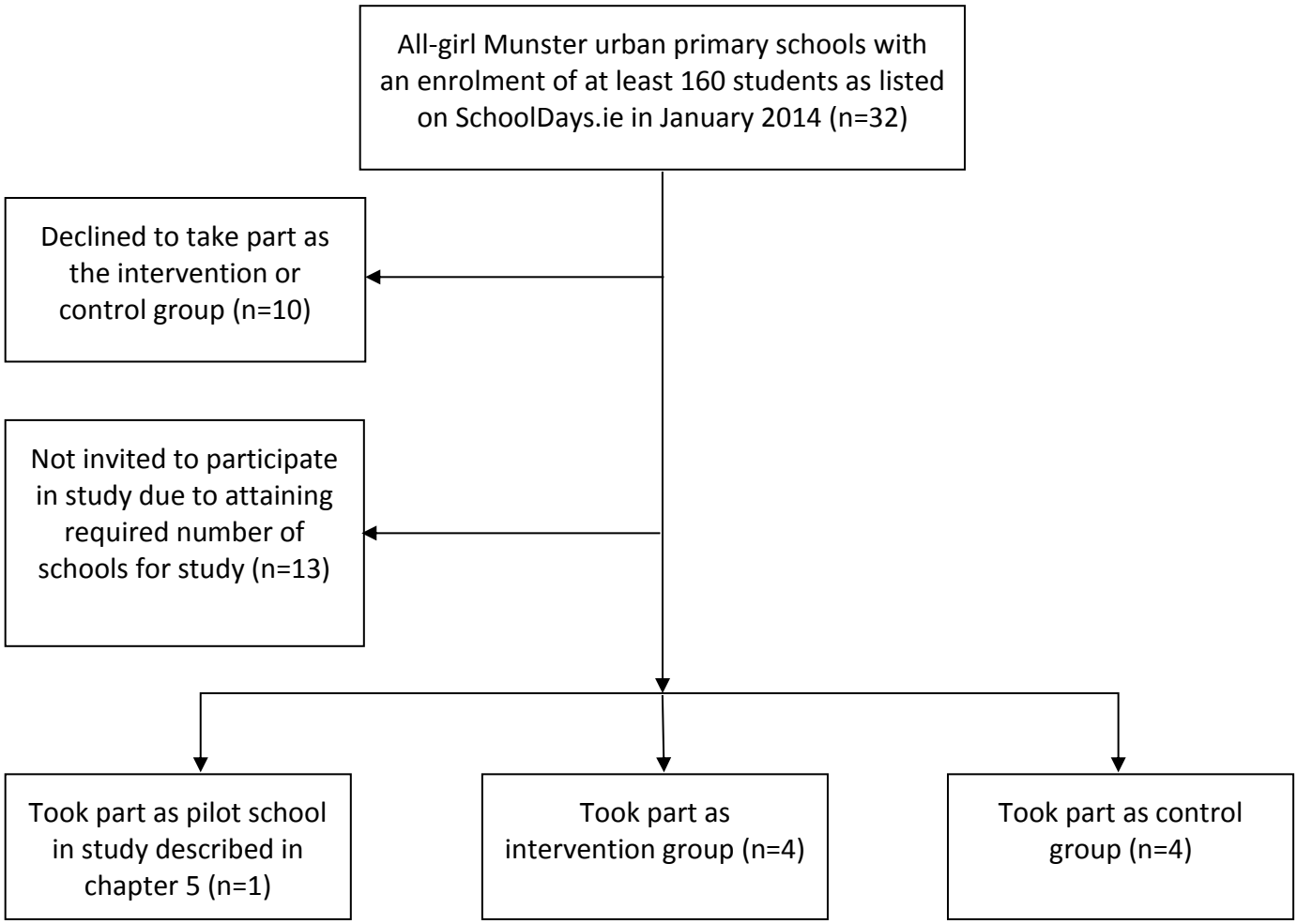


Figure 6.1 Flow of schools through the trial

6.2.4 Leader training

At baseline, fifth class leaders underwent a 90 minute training session led by the researcher that focused on developing leadership qualities, communication skills, management skills, an awareness of safety concerns and knowledge of playground activities. The researcher led 12 of the lunch-time activities for the leaders in this session. The content of the session was based on the Peers Running Organised Play Stations leader training guide for primary school lunch-time leaders in Canada (Durham Lives!, 2002) and the content listed for the Girls Lead Achieve Mentor Activate secondary school physical education leader training programme in Australia (Jenkinson et al., 2012). An example of an activity conducted during these training sessions includes participants drawing items or characteristics onto an image of a girl on a sheet of paper provided to illustrate important qualities of a good leader. The items and characteristics drawn by the participants were discussed with the group and good practices for leaders highlighted. In addition to this content, the researcher demonstrated how to outline the cone boundary to the players and how to incorporate groups of three into paired activities. The researcher then divided the leaders into groups of six and provided an activity card to each pair of leaders within these groups. To determine the leaders' understanding of the task cards, the researcher observed and questioned the

leaders while they took turns reading and leading the activities described on these cards. One limitation of the leader training session was that the leaders' level of understanding of all activity cards was not checked due to time constraints. At the end of the training session, the researcher distributed the folders that contained the lunch-time activity cards, encouraged the leaders to read and discuss the activities with their partners prior to leading the lunch-time sessions and were invited to verbally provide feedback to the researcher on their experiences of the training session.

Prior to the first lunch-time activities session, the researcher met with the leaders to check for understanding and address any concerns or apprehensions (Jenkinson et al., 2012). The researcher also observed each leader groups' first lunch-time session to provide support and address issues if necessary. In an attempt to motivate participants to continue leading the lunch-time activities, a certificate was awarded to the leaders that led all of the assigned lunch-time sessions at the end of the study. This strategy was implemented based on the findings that an intervention with a peer-led lunch-time component had a relatively large proportion of participant attendance at the optional lunch-time sessions (about 70%), potentially due to the leaders receiving a leadership certificates having attended at least six school sport sessions, five lunch-time sessions, physical activity leadership sessions and submitting a physical activity and nutrition handbook (Lubans et al., 2011).

6.2.5 Outcomes

A formal evaluation of the intervention was conducted to determine whether it achieved the research objectives and to document the experiences of the participants (Smith, 2009). The subsequent sections describe the procedures used to collect information on participants' physical activity, perceived social support, enjoyment of physical activity and experience of the intervention.

6.2.5.1 Anthropometric characteristics

Participants' anthropometric measurements were taken once by the principal researcher at baseline on the Monday morning of the first day of the Monday to Friday physical activity monitoring period. Participants' height and weight was measured by the principal researcher using a portable stadiometer (Seca Corp, Model #214 Road Rod, Hanover, MD) and an electronic personal scale (Seca Corp, Model #899, Germany) respectively. Height and weight were measured in single sex groups of four in a private room in the school to ensure confidentiality. Participants waiting to be measured were instructed to stand with their backs touching the wall so that they could not view other participants' height and weight measurements. The electronic personal scale (Seca Corp, Model #899, Germany) has a two metre-long cable that connects the display to the scales. This display was placed on a table facing the researcher and away from all participants' view. The height and weight protocol used was based on Lohman's (1988) Anthropometric Standardization Reference Manual (see Appendix 2). The participants were measured in their school uniform excluding

shoes and accessories. Height and weight measurements were recorded to the nearest millimetre and 0.1kg respectively using PIDs rather than participants' names. Participants' were not told their height and weight measurements. Only neutral comments such as "thank you" and "you can step off the scale" were made by the researcher (Kudat et al., 1996). Height and weight measurements were recorded to the nearest millimetre and 0.1kg respectively. A third measurement was taken when there was over a 1cm inconsistency in height or 1kg inconsistency in weight between the first and second measurements (Yildirim et al., 2013). When three measurements were taken, the closest two were averaged to calculate BMI (Yildirim et al., 2013). Height and body mass measurements were averaged for each participant. BMI was calculated as weight divided by height squared (kg/m^2). Decimal age was calculated using participants' date of birth and the date of height and body mass measurements. Participants were assigned to underweight, normal weight, overweight and obese categories according to the cut off BMI values specific to their age and sex, derived by Cole et al. (2007) and Cole et al. (2000).

6.2.5.2 Physical activity

Actigraph accelerometers (Models GT3X/+, Pensacola, FL32502) were used to record second class participants' physical activity continuously for five consecutive weekdays (Monday-Friday) at baseline (week 0), mid- (week 4) and end-intervention (week 8). Data and forms were identified only by a PID to maintain confidentiality. Labels with PIDs were stuck on the accelerometers for organisation and confidentiality purposes. The accelerometers were fully charged through a standard USB port. These devices were initialised through the ActiLife software (Version 6.6.3, Pensacola, FL32502) to start at 9am on Monday, the first day of monitoring, and continuously record until the end of the school day on Friday (2.20pm/2.30pm/2.40pm/3pm), the fifth day of monitoring. The accelerometers were calibrated to measure in 5-second epochs (Trost et al., 2011). After participants' anthropometric measurements were recorded on the first day of each monitored week between 9.30am and 11am, the researcher fitted participants with an accelerometer on an elastic belt at the centre of the right hip (Cliff et al., 2009), verbally instructed participants to wear the accelerometer over or under their shirt, follow their normal daily routine, remove the accelerometer for water-based activities and leave it beside the bed while sleeping (e.g. on their bedside locker). Class teachers were shown the position the participants were to wear the accelerometers and were instructed to correct the placement of the accelerometer if worn incorrectly. During the monitoring weeks, the class teachers recorded the lunch-time duration, amount of days students were required to wear tracksuits for physical education lessons (see Appendix 5) as longer lunch-time durations (Verstraete et al., 2006, Parrish et al., 2009, Ridgers et al., 2007a, Zask et al., 2001) and the wearing of suitable clothing for physical activity (Parrish et al., 2012, Norrish et al., 2012) positively influences children's lunch-time activity. Teachers were instructed to only provide information regarding participants' physical activity within this log sheet (see Appendix 5), therefore no additional information on participants' physical activity was gathered from

teachers during the monitoring periods. The accelerometers were collected at the end of the last school day monitored and the data downloaded through the ActiLife software (Version 6.6.3, Pensacola, FL32502) (ActiGraph Software Department, 2012) the day after the last day of monitoring. At mid- and end-intervention, the procedures for distribution and collection of the accelerometers and questionnaires were repeated. Based on Trost *et al.*'s (2005) strategies to enhance compliance with the monitoring protocol, the researcher telephoned the schools to remind the participants to return the devices, notified the teachers of the monitoring protocol, asked teachers and students to complete wear-time logs (see Appendices 5), told participants whether they met the wear-time criteria during the previous physical activity monitoring period, displayed a poster in the classroom that had an image of an accelerometer with a written reminder to wear the device (see Appendix 14), and provided a small gift to participants who returned the device on time at baseline, mid- and end-intervention. As there was a limited amount of accelerometers available to measure participants' physical activity at three time-points during the two school terms (March-June and September-December), participants did not wear the accelerometers the day before the physical activity testing period which is a limitation of the present study due to potential reactivity to the device on the first day of measurement (Dossegger et al., 2014). The Evenson et al. (2008) MVPA cut-point of ≥2296 cpm was utilised to calculate participants' minutes of MVPA. Time filters within the ActiLife data analysis software (Version 6.6.3, Pensacola, FL32502) were applied to extract the mean minutes of MVPA accumulated during the school day, physical education, break- and lunch-times (ActiGraph Software Department, 2012). For confidentiality purposes, records were kept in a locked file cabinet, computer entry and networking programmes were completed using PIDs only, data was stored on a password protected computer and access to data was limited to the principal investigator.

6.2.5.3 Enjoyment and social support

The 16 item Physical Activity Enjoyment Scale (PACES) questionnaire was used to provide a numerical measure of players' enjoyment of physical activity (see question 3 in Appendix 15). PACES is a valid and consistent measure of enjoyment of physical activity in children (Moore et al., 2009). The questionnaire contains 16 statements that begin with the stem "When I am physically active…" (Moore et al., 2009). The readability of PACES is suitable for children verified by a review of reading teachers and a pilot study with third grade US students aged 8-9 years (Moore et al., 2009). However, this questionnaire was not piloted in an Irish primary school setting. The answers in the present study to the 16 statements on the 5-point Likert scale were scored from one (disagree a lot) to five (agree a lot) (Motl et al., 2001, Davison et al., 2007). Negatively worded statements, such as "when I am physically active it is no fun at all", were reverse coded (Davison et al., 2007). An enjoyment score for each participant was determined by calculating the average of the 16 items (Moore et al., 2009, Davison et al., 2007). A total enjoyment score was then computed by

calculating the average of the individual participant's enjoyment scores (Moore et al., 2009, Davison et al., 2007) for the intervention and control groups at each time point.

Questions from the Health Behaviour Questionnaire (HBQ) used in the Child and Adolescent Trial for Cardiovascular Health (Parcel et al., 1995) were used to quantitatively measure the players' perceived social support (see question 4 in Appendix 15). This questionnaire assesses perceived social support in two ways: positive social support and negative social support (e.g. criticism) (Edmundson et al., 1996a). The positive social support physical activity subscale was measured in the HBQ with 11 items and the negative social support was assessed with seven items (Edmundson et al., 1996a). As parental support is not the focus of the present study, six items were used to assess positive social support and four items to measure negative support for physical activity participation from teachers and peers. These subscales were evaluated for internal consistency, content validity and factorial validity (Parcel et al., 1995, Edmundson et al., 1996a). The reliability values were found to be reasonable for third-grade US children aged 8-9 years (Edmundson et al., 1996b) and is of a 7-8 year old US second-grade reading level (Berry et al., 2012, Berry et al., 2007). Participants' answers to the ten statements at baseline, mid- and end-intervention were scored one (yes) or minus one (no) for positive perceived social support for physical activity and reverse coded for answers to questions on negative social support for physical activity (Edmundson et al., 1996a). The ten items were summed to produce an individual participant perceived social support score (Edmundson et al., 1996a). A total perceived social support score was then computed by calculating the average of the individual participant's perceived social support scores for the intervention and control groups at each time point. The findings of this data are reported in section 6.3.5.

Participants in second class completed a questionnaire during typically allocated class-time (i.e. not during break/lunch/physical education) on the Monday of each physical activity monitored week (at baseline, mid- and end-intervention) to compare the intervention and control groups' enjoyment and perceived social support for physical activity participation (see Appendix 15). Participants completed the questionnaire as the researcher read the questions aloud. Teachers were made aware that it was important not to lead or suggest ideas to the participants as the emphasis of the study was to record the participants' thoughts, rather than the teachers' perceptions (Horstman et al., 2008, Backett-Milburn and McKie, 1999). The researcher explained that the questionnaire was not a test and that it was an independent activity to avoid the potential influence of friends (Williams et al., 1989, Backett-Milburn and McKie, 1999, Knowles et al., 2013). Participants used their own pencils and erasers to complete the activity. Twenty to thirty minutes was provided for completion of the questionnaire. On completion, the researcher collected and removed the questionnaires from the school.

6.2.5.4 Participants' experiences

Draw and write and focus groups were the methods used to evaluate the players' and leaders' experiences of the intervention. The design of the draw and write activity is outlined in section 5.4.2.2 and the draw and write data collection procedure is described in section 5.4.2.3. All players and leaders completed the draw and write activity within a 20-30 minutes period at mid- and end-intervention. The students that wanted more time to colour or provide further detail to the drawing were not allowed due to time constraints. The development of the focus group guide and the data collection procedures are outlined in the following sections.

6.2.5.4.1 Focus group guide

The focus group guides were not treated as fixed at the start of data collection, therefore it evolved across the data set (Charmaz and Belgrave, 2002, Braun and Clarke, 2013). The focus group guides differed across the data set according to the class group targeted (second/fifth), the point of the study in which the focus groups were held (mid-/end-intervention) and the content of the draw and write documents. To assist in developing the focus group guides, the researcher analysed the children's draw and write documents. A table contained six headings: ID, Class Group, What I See, What They Say, Direct Quotes and Interpretation/Comments. The *What I See* heading referred to what the researcher saw in children's drawings. The questions of the literal reading of the subject matter questions within the Freeman and Mathison (2009) framework were used to catalogue the contents of the drawings (Lundby, 2013). The literal reading of the subject matter questions include: *What are the physical features of the image, who or what is portrayed and what is the setting?* (Freeman and Mathison, 2009). The *What They Say and Direct Quotes* headings dealt with writing verbatim the children's descriptions of their drawings and the children's writing within the drawing respectively. The final column included the researcher's interpretations and comments about the children's draw and write documents which yielded ideas for potential focus group questions. For example one player wrote that "I feel good when I play with fifth class girls" and another player wrote "I don't like playing the games because we have to play what the fifth class say". The interpretation made from these narratives was that the leadership style may influence the players' motivation for participating in the lunch-time activities. Therefore, the researcher included the following questions in the focus group guide: Do you like playing with the leaders? How do you feel when you are playing with the leaders? What do the leaders do that make you feel good or bad in the zones?

The guides differed for the second and fifth class focus groups as the second class focus group questions were phrased to obtain information from the point of view of the participants in the intervention such as: *What equipment do you enjoy playing with?* The fifth class focus group questions were asked to elicit the experience of the leaders for

example: *What are the good/difficult things about being a leader?* There were also different questions asked at mid- and end-intervention. At mid-intervention, questions were asked to determine whether changes could be made to improve the intervention through seeking the advice of the second and fifth class students. Therefore, the following questions were asked in each school at mid-intervention: *What in the programme works well? What needs to be changed? If you were in charge, how would you change the programme to make it better? What advice would you give the leaders to make the programme better?* At end-intervention, questions were asked about the changes made at mid-intervention such as: *Did you get stickers from the leaders at lunch-time? What difference did the stickers make to your lunch-time activities?* The mid-intervention questions also dealt with their current participation in the intervention such as: *Do you enjoy playing with the girls in your group? What difference would it make to be given a choice to play with your friends?* The end-intervention questions were mainly used to evaluate the mid-intervention changes to the intervention for example: *Do you think that by being grouped with your friends changed the amount of activity you did?*

The common components of all the focus group guides included the opening, closing and sequencing of questions. The opening question of each focus group was an introducing question regarding the picture they drew of themselves at lunch-time which included: *Tell me about the picture you drew. Who's in it? What are they doing?* The final question of each focus group was a clean-up question for example: *Is there anything that you haven't told me about the programme that you would like to tell me?* This type of closing question was included it has the potential to trigger useful unanticipated data and provide an opportunity for the participant to express issues that are important to them that were not already discussed (Braun and Clarke, 2013). The questions in each focus group guide were clustered into topics and ordered in a logical flow. For example the following questions were clustered as they dealt with enjoyment: *Do you enjoy playing with your group? What equipment do you enjoy playing with? Do the leaders make any difference to how much you enjoy the activities?* The questions were ordered logically in a funnel approach by beginning with general questions and gradually moving into specific questions (Gray, 2013, Braun and Clarke, 2013). An example of a general question at the beginning of a focus group is: *What type of activities do you do with the leaders?* An example of a specific question in the guide is: *What equipment do you enjoy playing with?* Also questions asked early in the focus group were less probing such as: *What activities do you do in the zones?* Whereas an example of a question asked later in the guide includes: *What kind of things do the leaders say to you? How does that make you feel? Do you like being led through physical activities by the leaders?*

6.2.5.4.2 Focus group data collection

Homogenous groups were selected for focus group participation as heterogeneous groups threatens external validity (Gray, 2013). Separate second or fifth class focus groups of girls aged 7-8 or 10-11 years respectively were homogenous as they had a similar experience of the intervention by taking part as either a participant or leader (Halcomb et al., 2007, Petty et al., 2012). The homogenous composition of the focus group was used to avoid responses that may be stifled by negative power relationships and to capture a range of perspectives from individuals that approached the topic from different perspectives (Jun et al., 1998, Morgan, 1995). The homogenous groupings also ensured participants were of a similar age with no more than two years of a difference within the group (Krueger, 2009). The age of participants in focus groups is an important consideration as diverse age ranges do not mix well together (Gray, 2013) whereas similar ages are likely to facilitate discussion and increase the cohesion of the group (Stewart and Shamdasani, 2014). Furthermore, the capturing of different perspectives from second and fifth class participants allows for triangulation of the data which provides a greater insight into the experience of the intervention than using a single participant level to gain information (Halcomb et al., 2007).

The inclusion criteria for participants in the focus group discussions was that they had (i) participated in a minimum of two peer-led lunch-time sessions each week and (ii) completed the draw and write activity. Three students were randomly selected from each of the 12 intervention class groups to participate in a focus group at mid- and end-intervention. In total, 24 focus groups were held which included six second and fifth class focus groups each at mid- and end-intervention. Small groups of three students was deemed appropriate for each focus group discussion as groups of three to eight participants generate rich discussion and are easier to manage than larger groups (Braun and Clarke, 2013). Participants were selected randomly, through the online random generator, as an adequate number of homogenous focus groups with randomly selected participants allows for results to be generalised to the population from which the groups originated (Krueger, 1994). Participants were randomly selected at mid- and end-intervention to minimise bias in the selection process and all participants had experiences of the intervention that interested the researcher (Morgan and Krueger, 1998). Although researchers recommend holding three to four focus groups with each type of participant (i.e. second or fifth class) to ensure sufficient data is collected (Krueger, 2009, Halcomb et al., 2007), six specific second or fifth class focus groups were held at each review point (mid- and end-intervention) to determine each class groups' experience of the intervention. Through the 24 focus groups, data saturation and the redundancy of data was reached as the same information was continually encountered (Pitney and Parker, 2009).

School hours was deemed the most appropriate time to hold the focus group sessions as fatigue among children after school may affect concentration (Kennedy et al., 2001) and weekend sessions would rely on travel, cost and time commitments from families (Gibson, 2007). The school setting is an ideal location to conduct focus groups with children as the participants are considered 'insiders' therefore the power imbalance between participants and the researcher may be lessened (Morgan et al., 2002, Broome and Richards, 2003, Hill, 2005). However, limitations were identified with conducting focus groups in the school setting which include children viewing the researcher as a teacher (Hill, 2006, Goodenough et al., 2003) and perceiving the research as school work (Kellett and Ding, 2004). Therefore, participants may seek to provide the 'right' answers to the research questions (Punch, 2002) or wait for permission to answer the questions (Green and Hart, 1999). In an attempt to overcome the limitations associated with the school setting, the researcher explained to the participants that the focus group was a discussion among the group members and there were no right or wrong answers. Furthermore, the focus group discussions were held in a vacant room in the school (e.g. music, resource room) which represented an in-between of the formal and informal worlds of the school (Fargas-Malet et al., 2010). As the presence of non-participants during focus groups may affect the opinions expressed by participants (Scott, 2000, Tong et al., 2007) only the researcher and participating second or fifth class children were present. The discussions were recorded with a digital voice recorder and lasted an average of 27.4 minutes. All focus groups were conducted a week after completing the draw and write activity and took place during April, May, June, November and December 2014.

6.2.6 Statistical analysis

To distinguish between non-wear time and sedentary behaviour, patterns of physical activity reading more than 20 minutes of consecutive zero counts were excluded from the analysis (Esliger et al., 2005). Data manipulation was conducted in Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA) and statistical analysis was conducted with the statistical package for the social sciences (IBM SPSS Statistics version 21, US). Descriptive statistics were used to summarise subject characteristics and minutes of MVPA. Mattocks et al. (2008) investigated the influence of varying the minimum daily wear time for data analysis among English children aged 11 years and noted that the reliabilities remained constant using between seven to ten hours per day. Most recent research suggests that a minimum of three days wear time is the most commonly used criteria for children (Rich et al., 2013). Therefore, participants that did not wear the accelerometer for at least 420 minutes on at least three days out of four was flagged as non-wear and excluded from the analysis.

Conducting analysis using only the accelerometer data that met the wear-time criteria at baseline, mid- and end-intervention (complete data sets) has the potential to be biased

(Catellier et al., 2005). As a high percentage of participants did not meet the accelerometer wear-time criteria at all three time-points (54.8%), the missing data was examined in the statistical package for the social sciences (IBM SPSS Statistics version 21, US) to determine whether multiple imputations were required. Missing data can be informative or ignorable which means that the data is either missing and dependent or missing and not dependent on earlier observations and predictors respectively (Twisk, 2003). For example, were the students from the larger schools more likely to have missing data than students from the smaller schools? Of the 154 girls that were assigned an accelerometer at baseline, 17 participants did not meet the wear-time criteria (a minimum of three days of seven hours per day) at baseline, mid- or end-intervention, thus, were excluded from the analysis. Descriptive analysis of the missing data in SPSS indicated that there was a large amount of missing data. Of the 137 participants that met the accelerometer wear-time criteria at either baseline, mid- or end-intervention, 9.5% had missing baseline values, 29.2% had missing mid-intervention values and 39.4% had missing end-intervention values. Twisk (2003) recommends conducting an independent sample t-test between participants with continuous variables of missing data and those with complete data sets when there was only a few repeated measurements and when there was a high amount of missing data at each of the measurements.

Prior to conducting a statistical test on the entire missing and complete MVPA data sets (n=137), the three parametric assumptions were checked. The three parametric assumptions require the dependent variable to be measured on interval or ratio scales, to be normally distributed and have homogeneity of variance and covariance between samples being compared (O' Donoghue, 2013). MVPA, the dependent variable, is measured on the ratio scale as the numerical values measure quantities and zero represents an absence of the concept being measured (O' Donoghue, 2013). To determine whether MVPA was normally distributed, the Kolmogorov-Smirnov test was used as there were more than 50 cases of MVPA data (Field, 2013). Levene's test was conducted to determine whether there was homogeneity of variance (Field, 2013). Although the results indicated that the entire MVPA data had homogeneity of variance at baseline, mid- and end-intervention ($P > .05$), baseline and end-intervention MVPA were not normally distributed ($P < .05$). As the MVPA data did not meet the parametric assumptions, the non-parametric Mann Whitney U test was performed to determine whether there was a statistical significance between participants with missing data (n=81) and those with complete data sets of MVPA (n=56) ($P < .05$). The findings of these statistical tests indicated that there was no significant difference between participants with missing MVPA data and participants with complete MVPA data sets at baseline, mid- and end-intervention ($P > .05$). Therefore, the missing data was ignorable and multiple imputations were not required.

Prior to conducting statistical tests on the complete accelerometer data sets (n=56), the data was examined to determine whether it met the parametric assumptions. The Kolmogorov-Smirnov test indicated that mid-intervention MVPA was normally distributed (*P* > .05) as the distribution of the sample was not significantly different from a normal distribution (Field, 2013), however baseline and end-intervention MVPA were not normally distributed (*P* = .018, .014 respectively) and were positively skewed (*P* = .018 and .014 respectively). Sphericity refers to the homogeneity of variance and covariance between samples (O' Donoghue, 2013). Mauchly's test of sphericity was used to determine the equality of variances of the difference between baseline, mid- and end-intervention MVPA data (Field, 2005). The assumption of sphericity was violated among baseline, mid- and end-intervention MVPA as the sphericity value was less than .05 (*P* = .03). O' Donoghue (2013) recommends transforming the data when it does not satisfy the parametric assumptions. A log transformation of the MVPA data was conducted (see Appendix 16) as this process can correct for positive skew and unequal variances (Field, 2013). The Kolmogorov-Smirnov test of the transformed MVPA data revealed that the baseline, mid- and end-intervention data was normally distributed (*P* = .2, .158 and .2 respectively). Sphericity of the transformed MVPA data was met as the value was greater than .05 (*P* = .07). As the three parametric assumptions were met after transforming the MVPA data, the analysis indicated that there was not enough evidence to reject the claims that the sampled population was not normally distributed, thus parametric tests were used to analyse this data. Independent samples t-tests were used to identify any significant group differences in terms of age, weight, height, BMI, baseline school day and daily MVPA. Mann Whitney U tests were used to determine whether there was a significant difference between baseline perceived social support and enjoyment of physical activity between the intervention and control groups. A mixed ANOVA was used to determine time X group for daily, school day, after school, break-time, lunch-time and PE MVPA as well as enjoyment and perceived social support of physical activity. Effect sizes (ES) were calculated for all statistical tests using Cohen's d with <.10 interpreted as a negligible, .10 as a small, .30 as a medium and .50 as a large effect size (Cohen, 1988). Significance was accepted at *P* < .05

6.2.7 Thematic analysis

The Braun and Clarke (2006) 6-phase thematic analysis was utilised to analyse the draw and write and focus group data in the present study as it clearly and comprehensively outlines how to conduct high quality thematic analysis (Willig, 2013). The first phase focused on the researcher becoming immersed and familiarised with the draw and write and focus group data (Braun and Clarke, 2006). To become immersed and familiarised with the data, first the researcher needed to prepare the data. The focus group discussions were transcribed into text. Both these transcriptions and the tables used to analyse the draw and write documents (see section 6.2.5.4.1) were then uploaded to the NVivo qualitative data analysis software (QSR International, Version 10, 2012). After preparing the qualitative data for analysis, the researcher read through the entire data set once without coding (Braun and

Clarke, 2006). Next, the researcher re-read the data in an active way by noting initial ideas for coding (Braun and Clarke, 2006). The outcome of this phase of analysis was a familiarisation with the data, an initial list of ideas of what is in the data and what is interesting about these ideas (Braun and Clarke, 2006).

The second phase involved generating initial codes by identifying the aspects of the data that appeared interesting to the researcher (Braun and Clarke, 2006). The data was coded in the NVivo qualitative data analysis software (QSR International, Version 10, 2012) using nodes to indicate potential patterns in the data. The process of coding the draw and write table and focus group transcripts was systematic (Braun and Clarke, 2006) as the data from each school was coded separately and the mid-intervention data was coded before the end-intervention data. Each data item was given equal attention throughout the entire data set as all the data files were coded inclusively and into as many potential themes as possible. This meant that each extract of text was uncoded, coded once or coded many times (Braun and Clarke, 2006). See Table 6.1 for an example of a code applied to an extract of the focus group data. The outcome of this phase was an initial list of various codes identified across the data set (Braun and Clarke, 2006).

Table 6.1. Data extract with codes applied

Data extract	Coded for
Player 1: No. We didn't even finish one game Researcher: And is it that you don't understand how to play the games? Player 1: No, no, it's just because we never get to finish any games or anything. We always move on in the middle of a game	Leaders change the game too quickly or/and did not involve the players in the decision-making

The third phase focused on analysing the data at the broader level of themes rather than the codes (Braun and Clarke, 2006). The codes were sorted into theme-piles by considering how the various codes assembled to form an overarching theme (Braun and Clarke, 2006). The researcher also determined whether there were sub-themes within the themes. Sub-themes are themes-within-a-theme. Sub-themes provide structure within the themes and demonstrated the hierarchy of meaning within the data (Braun and Clarke, 2006). Braun and Clarke (2006) recommend using a visual representation (e.g. tables, mind maps) to aid sorting the codes into different themes. Figure 6.2 illustrates the initial thematic map generated in the present study to visually represent the data. Codes that did not fit into the main themes were inserted into a theme called 'miscellaneous' (Braun and Clarke, 2006) due to a lack of description (e.g. code: player out of Ship Sea Shore game), evidence (e.g.

code: player was trying to take equipment home) or irrelevant to the research question (e.g. code: sunny weather when playing in the zone). The outcome of this phase was a collection of candidate themes and sub-themes with all the relevant coded data extracts collated within the identified themes (Braun and Clarke, 2006).

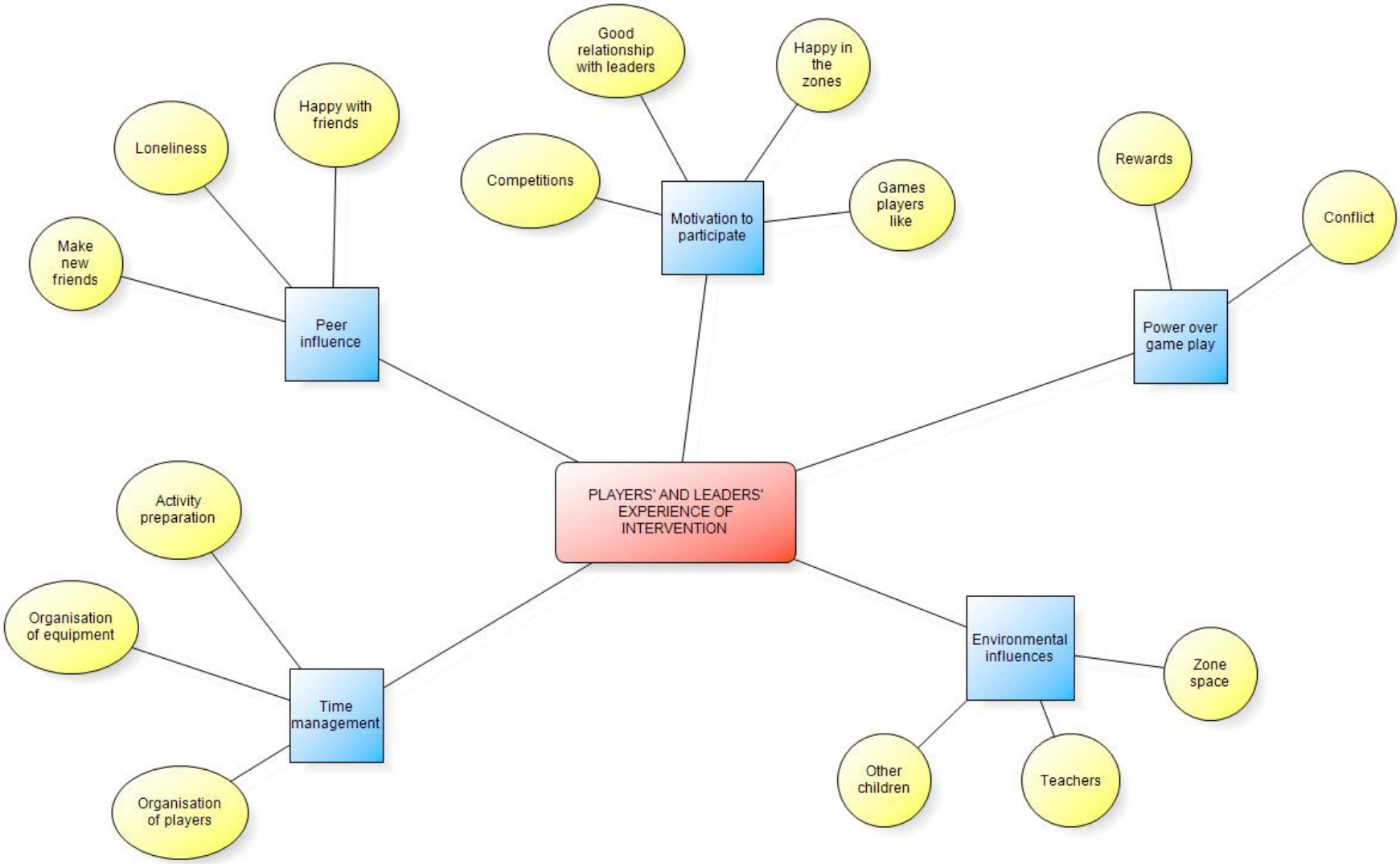


Figure 6.2. Initial thematic map, showing five candidate themes

The fourth phase involved reviewing and refining the candidate themes (Braun and Clarke, 2006). Based on Patton (1990) criteria for judging categories of themes, the data within themes had to cohere together meaningfully (internal homogeneity) whereas there needed to be identifiable differences between themes (external homogeneity). Two levels of reviewing and refining were conducted in this phase (Braun and Clarke, 2006). Level one consisted of reading all of the extracts for each theme and considering whether they appear to form a coherent pattern (Braun and Clarke, 2006). At the end of this level of reviewing and refining, the thematic map was revised (see Figure 6.3). The *Good Relationship with Leaders, Happy in the Zones*, *Teachers a*nd *Games Players Liked* sub-themes were inserted into the *Miscellaneous* theme as there was insufficient data to support them. The *Peer Influence* theme was renamed *Friendship,* the *Environmental Influences* theme was retitled *Influential Factors Of Game Play* and the *Loneliness* sub-theme was renamed *Unhappy Without Friends* to provide a better description of the data within the candidate themes. The *Time Management* and *Power over Game Play* sub-themes were collapsed into the *Influential Factors of Game Play* and *Motivation to Participate* candidate themes respectively to ensure the data was matched together meaningfully.

The purpose of level two refining of the candidate themes was to determine the validity of the individual candidate themes in relation to the entire data set and whether the thematic map accurately reflected the meanings evident in the data set as a whole (Braun and Clarke, 2006). By reading the data set again, it was determined that a few refinements were required to make the candidate themes 'work' in relation to the data set. The *Competitions* sub-theme was collapsed into the *Rewards* sub-theme to coincide with the data gelling together meaningfully. The *Time Management* sub-theme was divided into *Equipment Management* and *Managing Players* sub-themes as there was sufficient data to support them and there were identifiable differences between these sub-themes. The codes within the *Miscellaneous* theme were discarded as they did not fit into any of the themes. When these changes were made to the thematic map, it was determined that the candidate themes 'worked' in relation to the data set, therefore further reviewing and refining of the codes were not required (Braun and Clarke, 2006). The outcome of this phase was the identification of the different themes, how they assembled together and the overall story they tell about the data via the production of a thematic map that accurately reflects the meanings evident in the entire data set (Braun and Clarke, 2006).

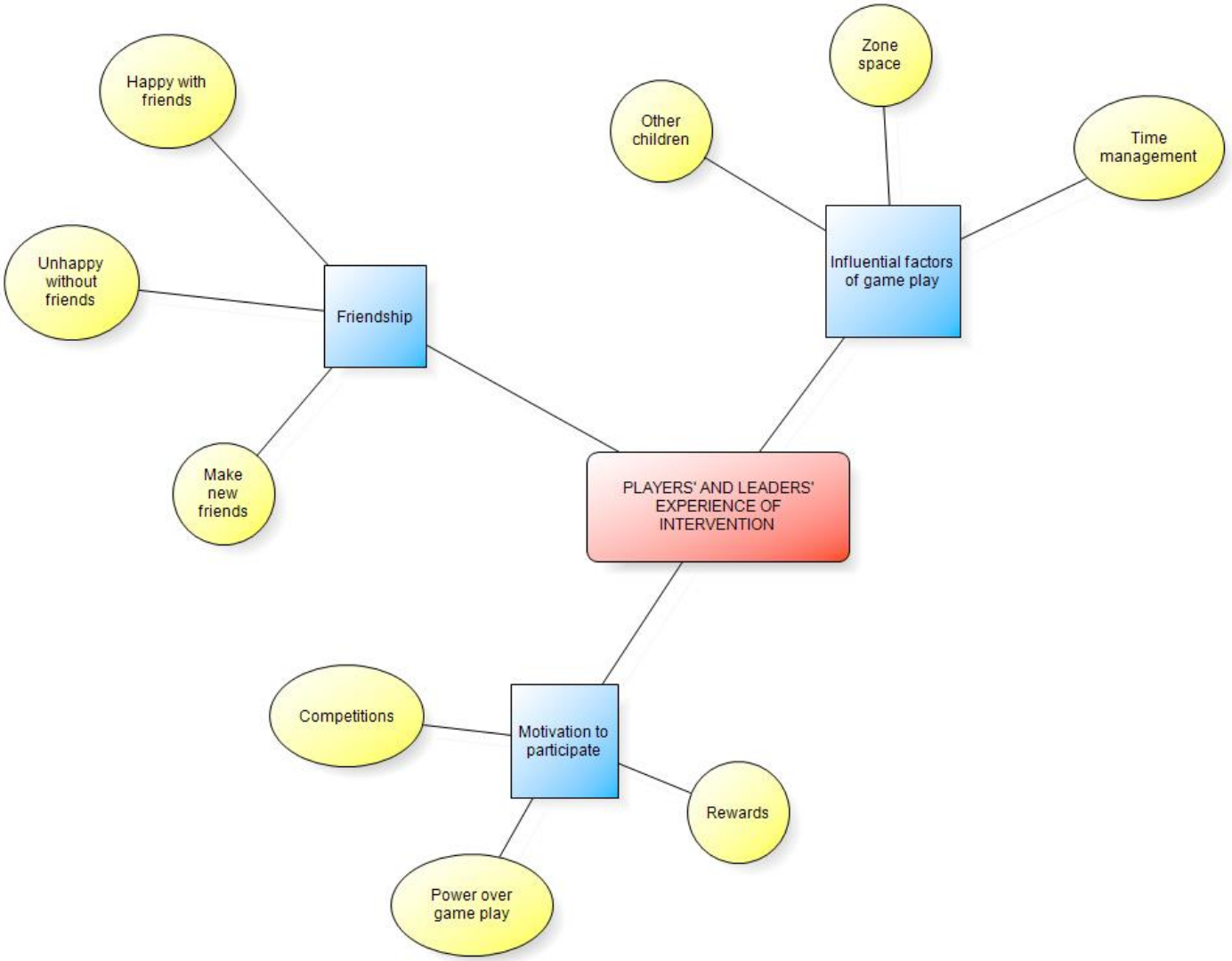


Figure 6.3. Developed thematic map, showing three candidate themes

The fifth phase involved defining and refining the themes. This process was conducted by identifying the essence of each theme and determining what aspects of the data each theme captured. The researcher organised the data extracts of each theme into a coherent and internally consistent account with accompanying narrative that explained the recurring ideas from the data extracts and the implications of these ideas. See Appendix 17 for an example of the theme piles organised within the *Leaders were Challenged to Manage Play and Players* theme. Appendix 18 presents an example of the narrative that describes the recurring ideas from the compiled data extracts in the *Managing Other Children in the Yard* sub-theme and the implications of these ideas. An examination of where the story of each theme fitted into the broader story of the entire data in relation to the research question was conducted to ensure there was not too much overlap between themes. The outcome of this phase yielded clearly defined themes (see Figure 6.4) with concise titles that could be described in a few sentences (Braun and Clarke, 2006) (see Appendix 19).

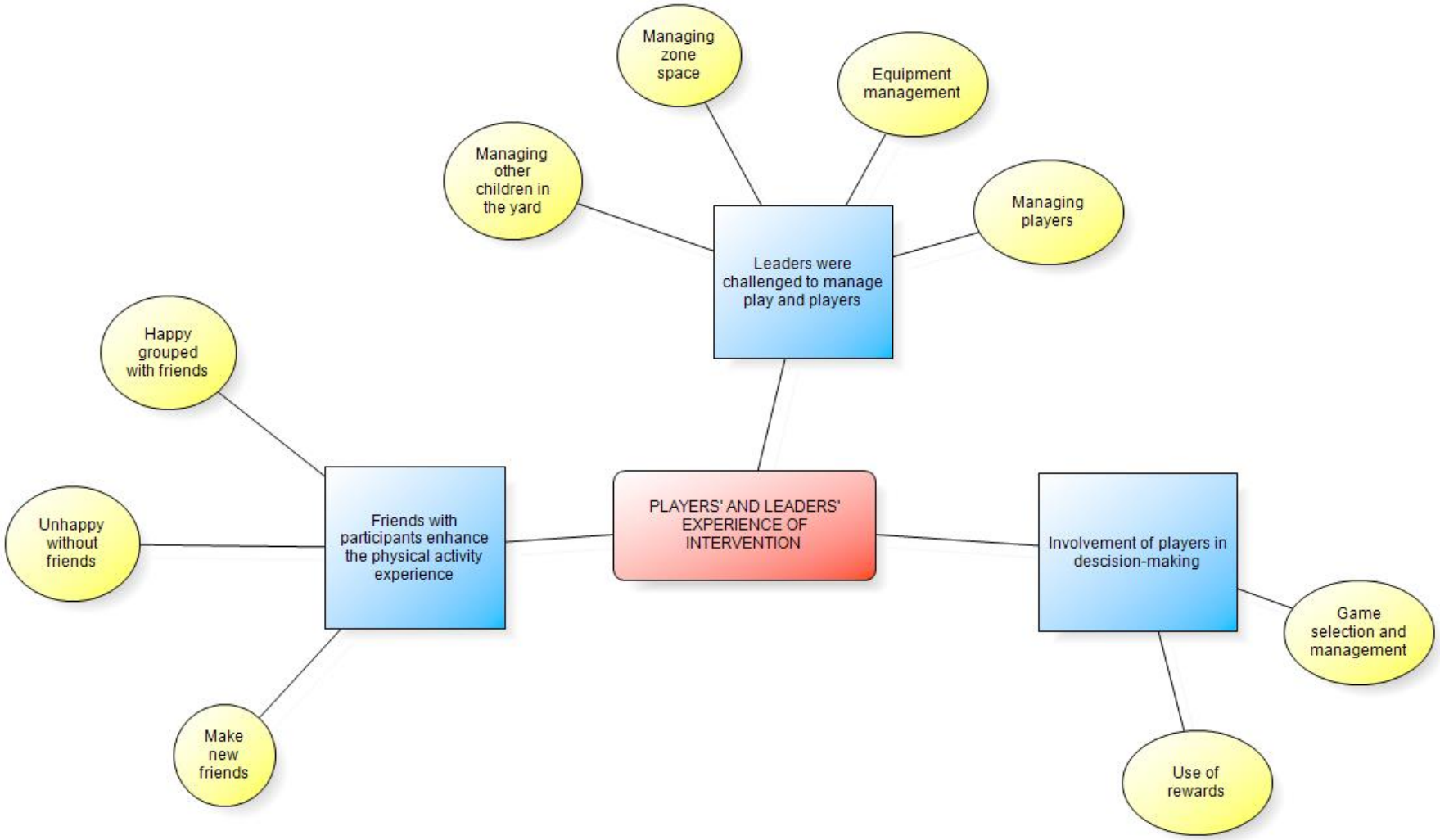


Figure 6.4. Final thematic map, showing three main themes

6.2.7.1 Validation strategies

The qualitative validation strategies listed in Andrew and Halcomb (2009) were applied in the present study. These strategies are based on the work of Creswell and Clark (2007) and Patton (2002). Andrew and Halcomb (2009) explain that using all or most of the eight strategies validates qualitative research. As only one researcher analysed the data, two validation strategies were not applicable in the present study, including other researchers examining the data to confirm the decision-making process and conclusions made, and ensuring reliability across multiple coders on a team (Andrew and Halcomb, 2009). The remaining six validation strategies were employed in the present study. The first strategy was clearly explaining the research question to guide the data collection and analysis, enabling the research question to be answered by the findings (Andrew and Halcomb, 2009). The second qualitative validation strategy applied was triangulating the methods of data collection via the draw, write and focus group data (Andrew and Halcomb, 2009). The sources of the draw, write and focus group data was also triangulated as they were collected from both second and fifth class participants (Andrew and Halcomb, 2009). An audit trail of the decisions made throughout the data collection and analysis processes was another validation strategy employed in the present study (Andrew and Halcomb, 2009). For example, the initial, developed and final thematic maps, as illustrated in Figures 6.2, 6.3 and 6.4, provide a clear account of the decisions made throughout the qualitative data analysis. The fourth qualitative validation strategy employed in the present study was indicating the relevance of the present study to other research to enable transferability. This strategy was achieved by providing a detailed account of the findings to determine whether they apply to similar settings. The fifth validation strategy employed in the present study was the use of the negative case to consider the data that was contrary to the pattern established by the inductive qualitative analysis (Andrew and Halcomb, 2009), ensuing an increased understanding of the patterns in the data (Patton, 1999). This strategy involved searching the data for information that contradicted the candidate themes. The data that contradicted the candidate themes was inserted into the miscellaneous theme and discarded when there was insufficient data to support this stance. The final qualitative validation strategy applied in the present study involved the researcher seeking clarification of ambiguous responses or responses from the same child that appeared contradictory during the focus group discussions (Greene and Hogan, 2005). The findings of the present study will be outlined in the following section.

6.3 Findings

6.3.1 Participants

The flow of participants through the trial is illustrated in Figures 6.5, 6.6, 6.7 and 6.8. Four intervention and four control all-girl primary schools in Munster were recruited. Twenty-six of the 100 second class students enrolled in the four control schools, 12 of the 162 second class students and 20 of the 166 fifth class students registered in the four intervention schools declined to participate in the study. As the second class students in the control

schools did not take part in the intervention peer-led lunch-time activities, the fifth class students in these schools were not invited to partake in the study. In summary, 150 second class students took part in the peer-led lunch-time activities that were led by 146 fifth class students in four schools. Seventy-four second class students in four control schools provided opted to take part in the study.

As there was a surplus of second class children with informed signed consent forms in five of the eight participating schools than accelerometers available for the research, the accelerometers were assigned randomly to participants using the online random integer generator (http://www.random.org/integers/). Eighty one and 73 accelerometers were randomly assigned to second class participants in the intervention and control groups respectively on week 0 (see Figures 6.5 and 6.6). Fourteen and 16 participants in the intervention and control groups were lost to follow-up due to loss of accelerometer, not wanting to wear the device, shortage of accelerometers, accelerometer malfunction and absence from school during the monitoring period. Sixty-seven and 57 participants in the intervention and control groups respectively wore the accelerometer on weeks 0, 4 and 8. However, 35 and 33 participants in the intervention and control groups did not meet the wear-time criteria of at least 420 minutes on at least three days therefore were not included in the final analysis. Thirty-two and 24 participants in the intervention and control groups had valid accelerometer data. In total, fifty-six intervention and control group participants (45.2% of participants) had valid accelerometer data.

One hundred and twenty eight second class participants in the intervention group and 70 participants in the control group were invited to complete the questionnaire (see Figures 6.5 and 6.6). The questionnaire was not completed by one girl in the control group and three girls in the intervention group as they had special needs and could not comprehend the questions. Due to absence from the classroom when the questionnaire was administered, 21 participants in the intervention group and 3 participants in the control group did not complete the questionnaire on weeks 0, 4 or 8. Therefore, 104 intervention and 66 control group participants had valid questionnaire data on weeks 0, 4 and 8. In total, 85.9% of participants had valid questionnaire data and were included in the final analysis (n=170).

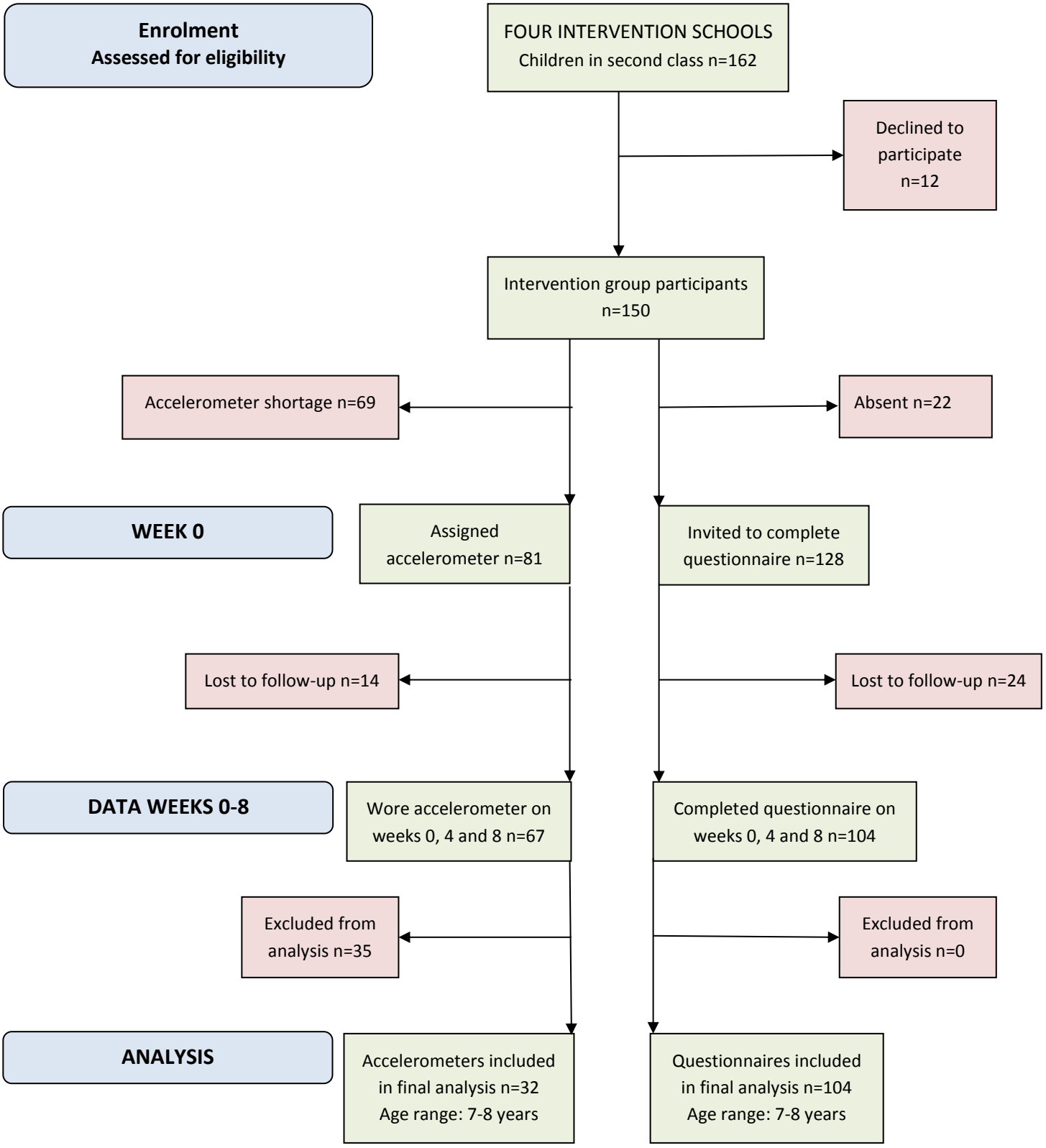


Figure 6.5 Flow of second class intervention participants through the trial: Accelerometer and questionnaire data

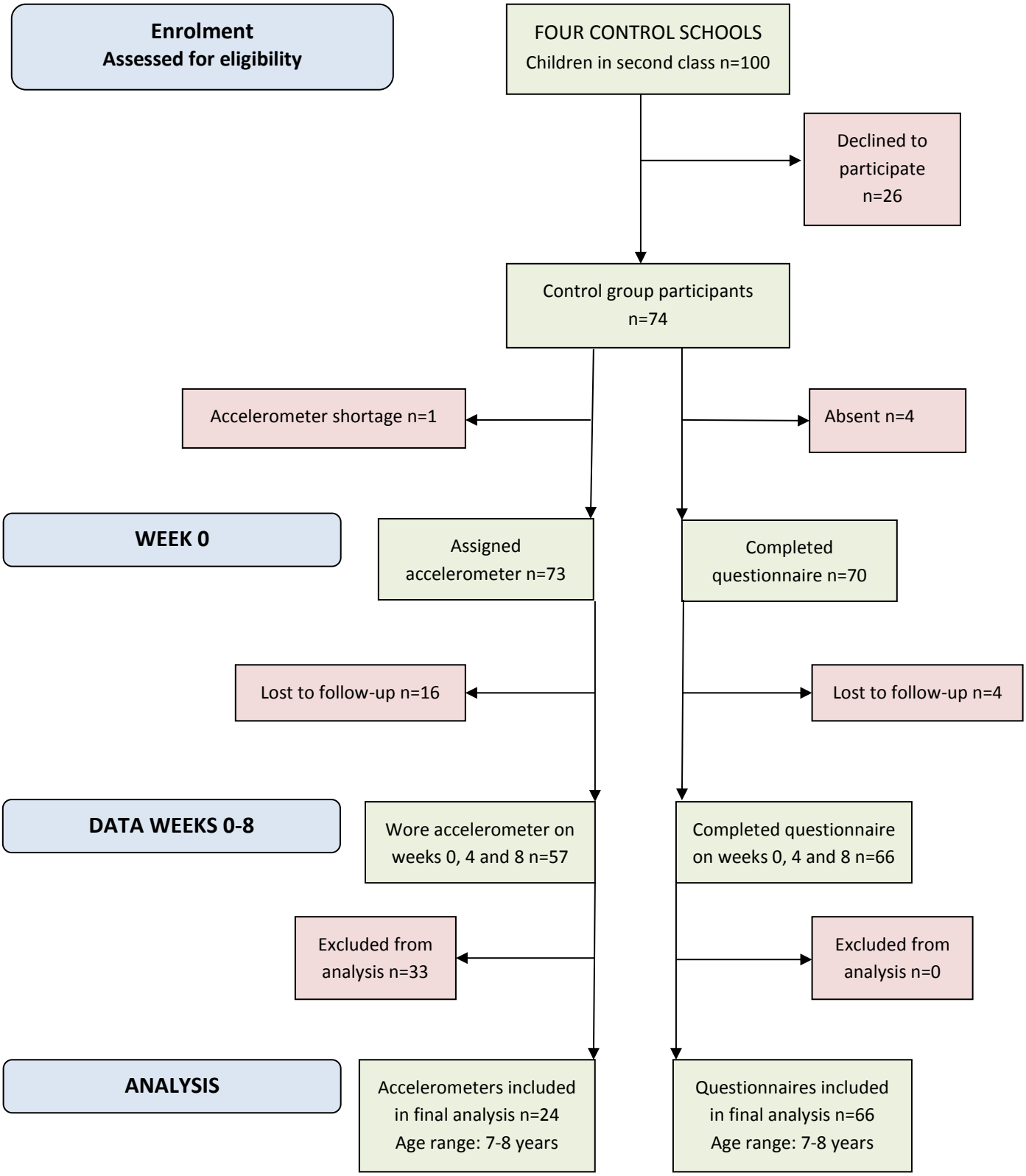


Figure 6.6 Flow of second class control participants through the trial: Accelerometer and questionnaire data

One hundred and sixty two children in second class and 166 children in fifth class of the four intervention schools were invited to participate as a player or leader in the study. Twelve girls in second class and 20 girls in fifth class declined to participate in the study. Therefore, 150 participants in second class acted as the players and 146 participants in fifth class acted as the leaders. These leaders and players were invited to complete a draw and write activity on weeks 4 and 8 (see Figure 6.7). 150 players and 132 leaders completed the draw and write activity at both mid- and end-intervention (players n=113, leaders n=102) or mid- (players n=28, leaders n=27) or end-intervention (players n=9, leaders n=3) only. All participants that completed the draw and write activity were included in the analysis.

Figure 6.8 illustrates the flow of players and leaders participating in the focus group discussions. The researcher randomly selected three players and three leaders to participate in each focus group (Morgan and Krueger, 1998) on weeks 4 and 8 using the online random integer generator (http://www.random.org/integers/). Eighteen players engaged in focus groups on week 4 and another 18 players took part in focus groups on week 8. In total, 36 players contributed to the focus group data that was included in the final analysis. Eighteen leaders took part in the focus groups held on week 4 and another 18 leaders engaged in focus group discussions on week 8. On week 5, one focus group was conducted with six of the eight leaders that ceased leading in the zones after week 4. In total, 42 leaders took part in the focus groups that were included in the final analysis.

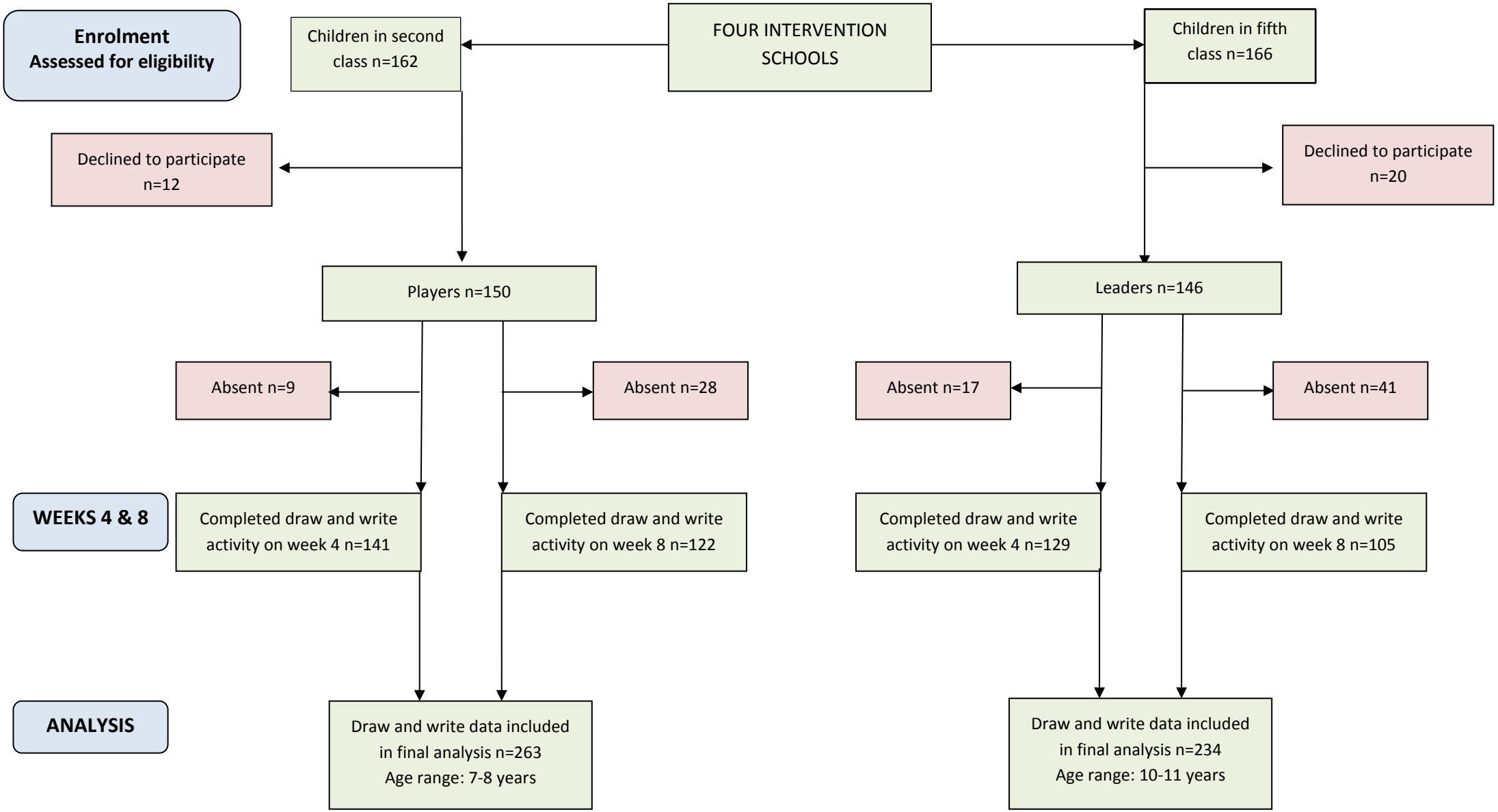


Figure 6.7 Flow of second and fifth class intervention participants through the trial: Draw and write data

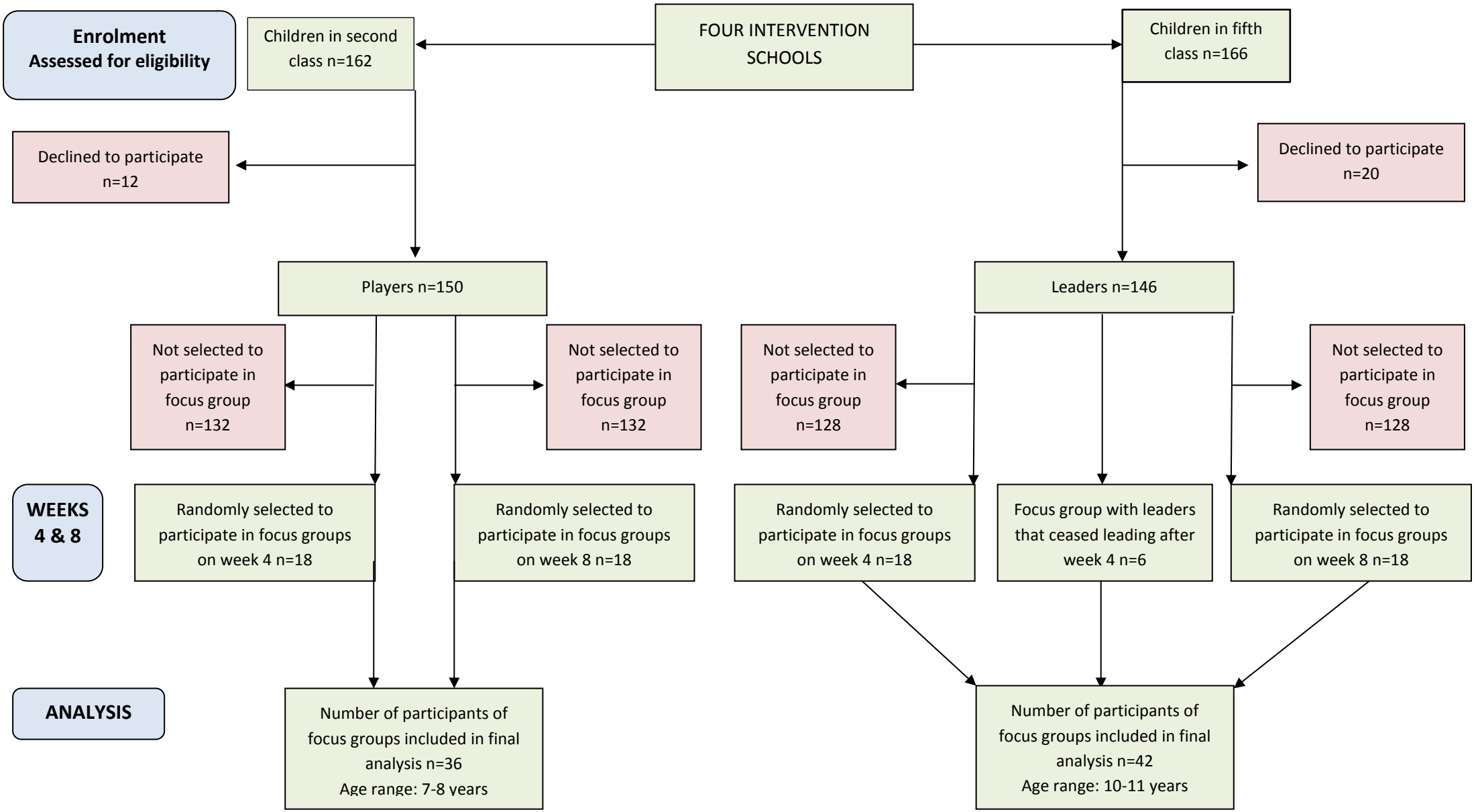


Figure 6.8 Flow of second and fifth class intervention participants through the trial: Focus group data

6.3.2 Descriptive characteristics

Data are presented for 56 participants from eight all girl urban primary schools: Intervention group (INT) 1 (n=12), INT2 (n=7), INT3 (n=8), INT4 (n=5), control group (CTL) 1 (n=11), CTL2 (n=5), CTL3 (n=5) and CTL4 (n=3). Participant characteristics are presented in Table 6.2. Anthropometric measurements of four players are unavailable as they were absent when measurements were taken. Cole et al. (2007) and Cole et al. (2000) age and gender specific cut-points for underweight, overweight and obesity revealed that one participant was underweight, three were obese, four were overweight and 20 were of normal weight in the intervention group. In the control group, two participants were underweight, one was obese, four were overweight and 17 were of normal weight. In total, 5.8% of the sample was underweight, 71.1% was of normal weight, 15.4% was classified as overweight and 7.7% as obese. No significant differences were found between groups for age, weight, height or BMI ($P > .05$).

Table 6.2. Mean (SD) measurements of participants' characteristics

	Intervention (n=28)	Control (n=24)	All (n=52)
Age (years)	7.6 (0.5)	7.6 (0.5)	7.6 (0.5)
Weight (kg)	29.1 (7.7)	26.3 (4.4)	27.8 (6.5)
Height (m)	1.3 (0.1)	1.3 (0.1)	1.3 (0.1)
BMI (kg/m^2)	17.6 (3.6)	16.4 (2.1)	17.0 (3.0)

6.3.3 Entire day, school day and after school MVPA

Mean daily minutes of MVPA for the entire sample at baseline, mid- and end-intervention were 54.7 ± 20.6, 55.3 ± 19.9 and 52.0 ± 22 respectively. There was no significant difference between groups of the baseline transformed daily MVPA ($P > .05$). These variables for groups at baseline, mid-intervention and end-intervention are presented in Table 6.3. A mixed ANOVA using the transformed daily MVPA revealed that there was a small statistically positive interaction effect for the change in daily MVPA from across time between groups ($P = .043$, ES .112). Specifically, there was a small positive interaction effect for the change in daily MVPA from baseline to mid-intervention between groups ($P = .014$, $ES = .106$). There was no significant difference in the change in minutes of daily MVPA for the time x group x school interaction ($P > .05$), indicating there was no difference at the school level in terms of change in daily MVPA.

Table 6.3. Means (SD) daily minutes of MVPA at baseline, mid- and end-intervention in the intervention and control groups

Condition	Baseline	Mid-intervention	End-intervention	p-Value	ES
Intervention (n=32)	49.6 (15)	55.6 (17.1)	50.5 (19.1)	.043*	.112
Control (n=24)	61.4 (25.1)	54.9 (23.5)	54.1 (25.6)		

* Significant difference in the change in the time spent in MVPA between groups

Mean minutes of MVPA during school and after school at baseline, mid- and end-intervention in the intervention and control groups are presented in Table 6.4. A mixed ANOVA indicated that there was no significant difference in the change in minutes of school day MVPA from baseline to end-intervention between groups (P > .05). There was a statistically negligible positive interaction effect for the change in minutes the players spent in MVPA after school from baseline to mid-intervention in comparison to the control group (*P* = .025, *ES* .089). However, there was no significant overall interaction effect (baseline to end-intervention) on players' after school MVPA when compared to the control group (*P* > .05).

Table 6.4. Mean (SD) school day and after school minutes of MVPA at baseline, mid- and end-intervention in the intervention and control groups

Segment	Group	Baseline	Mid-intervention	End-intervention	p-Value	ES
During school	Intervention (n=32)	15.7 (5.3)	20.6 (5.7)	15.7 (5.8)	.258	.05
	Control (n=24)	19.4 (10.3)	22.2 (14.1)	16.4 (4)		
After school	Intervention (n=32)	33.9 (13)	35 (14.2)	34.8 (15.8)	.053	.105
	Control (n=24)	42 (18.8)	32.7 (13.9)	37.7 (22.3)		

6.3.4 Segmented school day MVPA

Table 6.5 presents the minutes spent in MVPA during physical education, break-time and lunch-time while indoors and outdoors. A mixed ANOVA indicated that there was a small statistically positive interaction effect for the change in minutes the players spent in MVPA during outdoor-only break-times from baseline to end-intervention in comparison to the control group (*P* = .023, *ES* = .133). There was a medium significant negative interaction effect for the change in minutes spent in MVPA during physical education (*P* < .001, *ES* = .475) and a small negative interaction effect for the change in minutes spent in all lunch-times (indoor and outdoor) (*P* = .017, *ES* = .142) from baseline to end-intervention between groups. There was no significant difference in the change in minutes spent in MVPA during all break-times (indoor and outdoor) (*P* = .865, *ES* = .005) and outdoor-only lunch-times (*P* = .880, *ES* = .005). See Appendix 20 for the average duration of school day, physical education, break- and lunch-times in the participating schools.

Table 6.5. Mean (SD) minutes of MVPA during segments of the school day at baseline, mid- and end-intervention in the intervention and control groups

Segment	Group	Baseline	Mid-intervention	End-intervention	p-Value	ES
Break-time Indoors and outdoors	Intervention (n=32)	1.5 (.9)	1.6 (.9)	1.7 (1)	.865	.005
	Control (n=24)	2 (.6)	2.3 (1.2)	2.4 (1)		
Outdoors only	Intervention (n=32)	1.5 (.8)	1.6 (.9)	2 (.9)	.023*	.133
	Control (n=24)	2.2 (.8)	2.8 (.9)	2.4 (1)		
Lunch-time Indoors and outdoors	Intervention (n=32)	4 (2.4)	5 (3.4)	3.5 (2)	.017*	.142
	Control (n=24)	4.4 (4)	4.5 (1.2)	4.6 (1.4)		
Outdoors only	Intervention (n=32)	4.2 (2.4)	4.9 (3.5)	4.4 (2.3)	.880	.005
	Control (n=24)	4.4 (4)	5.2 (1.4)	4.9 (1.4)		
Physical education	Intervention (n=15)	5.6 (2.6)	3.2 (1)	2.6 (2)	.000*	.475
	Control (n=19)	4.1 (4.3)	16.8 (18.5)	4 (2.9)		

*Significant difference in the change in the proportion of time spent in MVPA between groups

6.3.5 Psychosocial factors related to physical activity

Intervention and control groups' baseline, mid- and end-intervention scores for enjoyment were considered high as they were greater than 4 (indicating that most children answered "disagree" or "disagree a lot" to negative feelings during physical activity) (Eather et al., 2013b). Scores for perceived social support were also high among the intervention and control groups at baseline, mid- and end-intervention as they were greater than 5, the mid-point of the scale. These variables for groups at baseline, mid- and end-intervention are presented in Table 6.6. Mann Whitney U tests indicated that there were no significant differences for scores of enjoyment (P = .526) or perceived social support (P = .710) for physical activity between the intervention and control groups at baseline. Mixed ANOVA tests revealed that there was 1) no intervention effect on the players' perceived social support for physical activity (P = .292, ES = .015) and 2) there was a significant decline in the players' physical activity enjoyment scores from baseline to end-intervention (P = .04, ES = .038) and mid-intervention to end-intervention in comparison to the control group (P = .02, ES = .032).

Table 6.6. Mean (SD) scores of enjoyment and perceived social support for the intervention and control groups at baseline, mid- and end-intervention

Psychosocial factor of PA	Group	Baseline	Mid-intervention	End-intervention	p-Value	ES
Enjoyment	Intervention (n=104)	4.6 (.5)	4.5 (.7)	4.2 (.9)	.04*	.038
	Control (n=66)	4.5 (.6)	4.5 (.6)	4.5 (.6)		
Social support	Intervention (n=104)	7.4 (2.8)	6.8 (3.2)	6.6 (3.6)	.292	.015
	Control (n=66)	7.1 (3.1)	7.2 (3.1)	7.0 (3.7)		

*Significant difference in the change in scores between groups

6.3.6 Players' and leaders' experience of the lunch-time intervention

The intervention was implemented in two stages, allowing the researcher to evaluate and refine the intervention at mid-point based on the players' and leaders' feedback and suggestions. Participants' feedback differed at mid- and end-intervention. Three main themes identified in the data set are presented: friendships with participants enhance the physical activity experience, involvement of players in decision-making, and leaders were challenged to manage play and players. The changes made to the intervention at mid-intervention are detailed within each theme as there was a direct link between the themes identified and the intervention modifications. Each theme is illustrated using examples from the participants' drawings, writings and comments from the focus group discussions.

6.3.6.1 Friendships with participants enhance the physical activity experience

The presence or absence of friends in the zones had a large influence on whether the players and leaders had a good experience with the intervention. At baseline, players and leaders were randomly assigned to a group for the zone activities. The players' and leaders' experience of these groupings, when and why changes were made to the groupings after mid-intervention are outlined below.

6.3.6.1.1 Players' experience of the zone groupings

A dominant pattern noted across three of the four schools was that players valued getting to know their classmates better when they weren't grouped with their close friends. For example, "I like meeting new people like that I don't really talk to a lot, like I don't really talk a lot to [name of player] and like [name of player]" (player, school 4, mid-intervention). After mid-intervention in one school, the researcher provided different zone groupings each week for the players in response to their requests to regularly change their zone groups to get to know other girls in their class better. For example, "I love the activities already but if I met new people I would have even more fun because I love making new friends" (player, school 3, mid-intervention).

In contrast to the schools described above the players in one school that were not friendly with all of their classmates were unhappy to not be grouped with their close friends in the

zones at baseline. For example, “I have my friend [name of player] and she’s not in my zone and she got really upset …because she couldn’t be with me” (player 3, school 1, mid-intervention). The players’ responses in this school illustrated their lack of enjoyment in playing the games when they were not grouped with their friends “I didn’t want to play the games because we weren’t in the same game as [name of player]” (player 1, school 1, mid-intervention). Some players in this school did not get along therefore did not want to be grouped together. For instance: “she doesn’t like being with [name of player] because whenever she’s with [name of player] they always get into fights and they start crying” (player, school 1, mid-intervention). After mid-intervention, when the researcher grouped the players in this school with their friends they enjoyed playing the games, “I love playing in the zone with my friends” (player, school 1, end-intervention). In summary, the players valued being with friends in some cases and making new friends in other instances.

6.3.6.1.2 Leaders’ experience of the zone groupings

The researcher randomly partnered leaders at baseline. Most leaders in the two smaller schools, that contained only one class group of fifth class students, were happy to be randomly assigned to a partner as they were friends with all of their classmates “well, all of us in the class are all kind of friends with each other anyway so it didn’t really matter who we were with” (leader, school 3, end-intervention). Another reason these leaders enjoyed being randomly allocated a partner is that they got to know their classmates better, “because some people are, they’re always like with their friends so like you can’t really get to know them …so it’s good to get to know other people in your class as well” (leader, school 4, mid-intervention). In contrast, the majority of leaders in the two larger schools were unhappy that they did not spend lunch-time with their friends. A reason that the leaders in these schools were concerned about being with their friends at lunch-time in contrast to the leaders in the other schools may be that they were not as friendly with the girls in their class due to the larger school and class sizes. The following conversation shows that the main reason that eight of the leaders in one of these schools stopped leading at mid-intervention was that they did not spend lunch-time with their friends:

> Leader 5: I didn’t hate it [the intervention] at all
>
> Leader 4: I just missed being with my friends
>
> Leader 1: Ya that was the big one
>
> All: Ya
>
> Leader 1: Because [name of teacher] would ask us did you enjoy it and we’d say ya and then our friends would be talking about what they did outside at lunch and you were kind of like “aww”
>
> (School 1, leaders that stopped leading after mid-intervention)

The majority of leaders in these two larger schools missed playing with their friends when they were leading on alternative weeks "you know you kind of miss playing a big game of catch or something when there's not your best friends like your really good friends you know in the Playground Pals in that week" (leader, school 2, mid-intervention). The leader depicted in Figure 6.9 is sad as she was not partnered with a close friend from baseline to mid-intervention.

Figure 6.9. Leader sad when she was not partnered with a close friend (leader, school 1, mid-point)

After mid-intervention, the researcher asked the teachers in the larger schools to group the leaders with their friends, "she [teacher] asked us and who do you want to be with and if we didn't really mind we could just be with anybody" (leader, school 1, end-intervention). Figure 6.10 shows the leaders smiling when they were able to lead with their friend after mid-intervention.

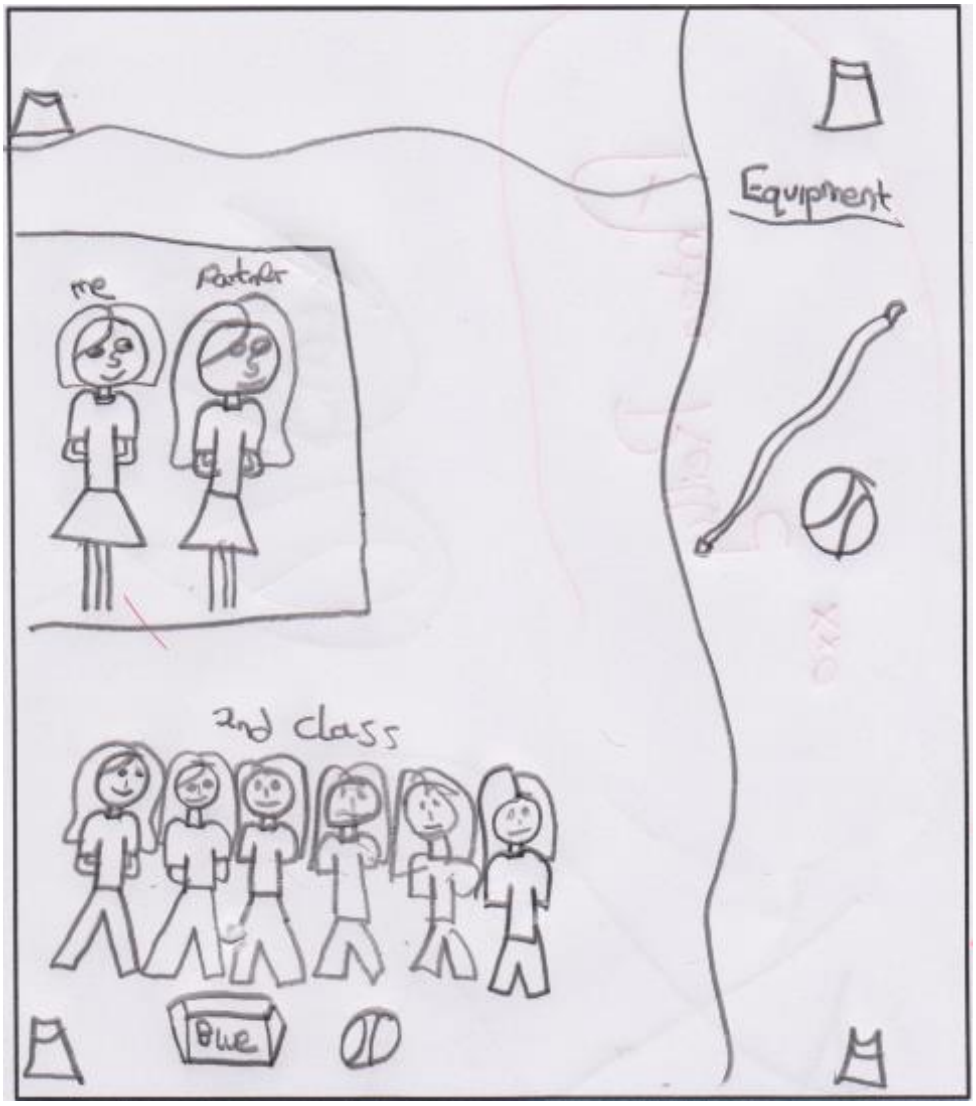


Figure 6.10. Leaders smiling when grouped with friend (leader, school 1, end-intervention)

The leaders in the two smaller schools enjoyed being randomly allocated a partner and getting to know their partners better as they were friendly with all of their classmates. In contrast, the leaders in the two larger schools wanted to spend lunch-times with their close friends, thus preferred to be partnered with their close friends than randomly allocated a partner.

Overall, friendship was a key factor in the participants' experiences as players or leaders and significantly impacted on their enjoyment of the intervention. Some players and leaders made better friends with their classmates through the randomly allocated groups. Other players and leaders did not get along with some classmates, therefore preferred to be grouped with their close friends in the zones. The relationship between the players and

leaders was largely dependent on the leaders' style of leading and is outlined in the following theme.

6.3.6.2 Involvement of players in decision-making

The manner in which the leaders implemented the activities and provided rewards had an impact on the players' enjoyment of the intervention. The leaders' style of leading was broadly categorised as mostly democratic or autocratic. The players' experience of the leaders implementing the activities with these types of leadership styles and the changes made at mid-intervention are outlined below.

Some leaders were democratic when implementing the activities by allowing the players to choose the games. Players enjoyed the activities when they had choices, for example:

> The good leaders were, just sometimes they just let you do what you want for about 10 minutes and me and [name of player] were playing a game for 10 minutes and it was really fun and then they brang us in and let us pick our own games, they didn't just say we're going to pick this game because some girls didn't like that game (player, school 2, end-intervention).

Players disliked the activities when some of the leaders were autocratic and they did not have a say in choosing the games, "I don't like playing the games because we have to play what the fifth class say" (player, school 1, mid-intervention). Additionally, the players did not have fun when they did not have opportunities to make changes to the games. For example, if the game was too short; "when we're playing other games we're only allowed have one person on and then it's onto a different game and then it's not fun now because we don't get barely any time to play the game" (player, school 3, end-intervention). Leaders that led with an autocratic style also shouted at the players to get them to play the games, for example, "she shouts a lot… she blows her whistle and goes like 'you have to listen to us, you can't do that, you can't do this" (player, school 3, mid-intervention). This autocratic style of leading made the players afraid of the leaders, for example:

> "But it made us feel like we had to do it now or else we get in big trouble and scared us in that way because we didn't want to get in trouble at the same time" (player, school 2, end-intervention).

The players used the adjective 'mean' to describe the leaders that led the activities with an autocratic style. Figure 6.11 shows the players as sad and describes the leaders as 'mean' for not allowing them to choose the game.

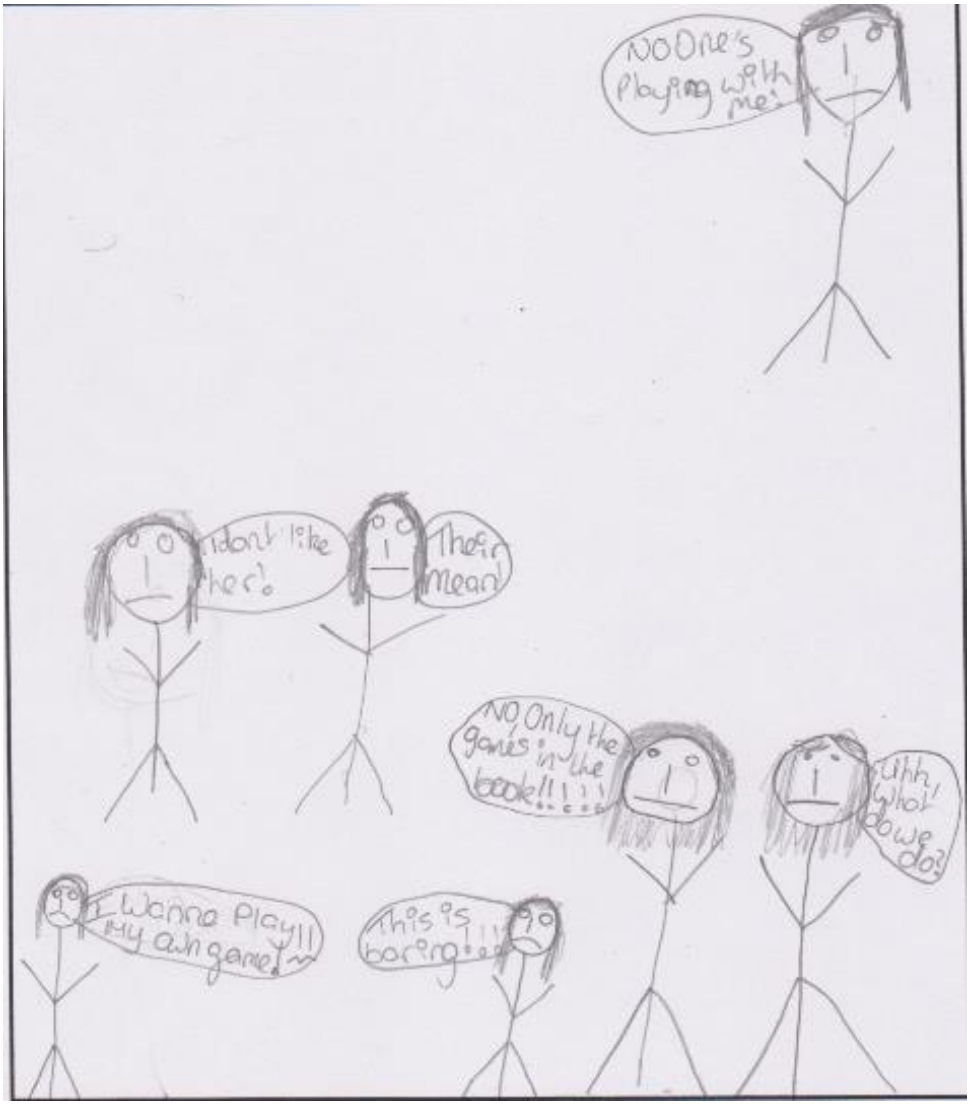


Figure 6.11. Drawing of leaders with an autocratic style of leading (leader, school 2, mid-intervention)

Some players protested against the leaders' autocratic style of leading by sitting out of the games, pretending to be sick or running away from the zones. For instance "they [three players] kept running away at lunch-times …they didn't want to play the games" (player, school 1, end-intervention). The players did not listen to the leaders when they did not want to play the games the leaders chose. The following conversation shows the players did not listen to the leaders when they picked games the players knew already or found boring:

> Researcher: Do second class always listen to fifth class when they're leading?
>
> All: No
>
> Researcher: And why might that be do you think?

Player 2: They pick out boring games all the time, the games we already know how to play

(Player, school 2, mid-intervention)

When the players did not listen to the leaders the players played fewer games in the zones. For example: "if they're playing ball and we say kind of like keep it low and then most groups will keep it low but then there's other groups that ignore you and just throw it up really high and then the groups that would keep it low they can play bomb for longer because they're not doing it like too high" (leader, school 2, mid-intervention). The players explained that they enjoyed playing the games they learnt during the lunch-time peer-led sessions for example: "I like the skipping ropes and I like the games where you do Mr Fox and Hot Potato" (player, school 3, mid-intervention). The players really enjoyed playing games they had not played before. For example, the leaders explained that "they [the players] love new games" (leader, school 4, mid-intervention). The players' enjoyment of the games were also evident when leaders saw the players play the games that they had learnt in the zones at other times of the school day, for example: "I saw them telling their friends about Frost and Sunshine and they were playing Frost and Sunshine on the Friday that we were all off" (leader, school 2, midpoint). Players also spoke about playing the games they learnt from the leaders after school. For example:

Player 2: Sometimes me and my Dad play the games that we'd do with the activities

Researcher: Do you play the lunch-time games at home?

Player 2: Ya, with my Dad

(Player, school 3, mid-intervention).

At mid-intervention, players and leaders requested to learn more games, for example: "I would like different games" (player, school 3, midpoint) and "we need more games" (leader, school 4, midpoint). Based on these requests to learn new games, the researcher held a second training session for the leaders. Overall, the players enjoyed the zone activities except when leaders led with an autocratic style. The players made further suggestions at mid-intervention in an attempt to solve the issue with leaders not listening to their perspectives which are outlined below.

Players wanted to change their leaders when they led with an autocratic style. In response to the players describing one leader in particular as 'mean', the researcher re-assigned the leaders in one school to lead a different second class cohort after mid-intervention by

generating a new player timetable that listed the names of the leaders that led the other 2nd class group up to mid-intervention. When the players played the activities with the new leaders they felt that they were able to do more activity "I think we'd be more likely to do activity with the leaders that we have now because they're really nice and [name of leader] used to be really bossy to us" (player, school 1, end-intervention). Players in other schools suggested selecting leaders from second or sixth class as they thought that girls from these classes would be more democratic when leading than the fifth class leaders. For example one player explained that leaders from second class would:

> If I was the leader and if I was thinking, I'd think of a couple of games and then I'd do a vote and then whoever had the hands up for the most thing then we'd play that whole game (girl, school 3, mid-intervention).

Similar to this idea, the researcher attempted to stimulate more democracy in the zones of one school by organising an initiative that allowed one player per zone to act as a leader each lunch-time. This initiative was implemented in one school only as it was the leaders in this school that suggested and designed the initiative they named *Playground Pal of the Day:*

> If we took the high vis or whatever, the bibs and said OK if you're good in this game you can be the leader and then give them the bib and they'll have the chance at being and they'll see the bib and they'll be like oh I've the special bib on, the special bib or whatever (leader, school 2, mid-intervention).

However, the way in which the leaders distributed the rewards of *Playground Pal of the Day*, stickers or certificates motivated or demotivated the players. The players in the school that held the *Playground Pal of the Day* initiative did not like when the leaders awarded the *Playground Pal of the Day* title at the beginning of the lunch-time. For example:

> They could pick it at the end, instead of at the start because then they know who's paying most attention because at the very start they wouldn't be doing anything and they just pick a random person (player, school 2, end-intervention).

During the mid-intervention focus groups, the leaders in one school suggested distributing certificates to one player in each zone each lunch-time and the leaders in another school proposed giving stickers to the players to encourage good behaviour. For example "if they're good we should give them stickers" (leader, school 4, mid-intervention). In response to these suggestions, the researcher organised the leaders in one school to award one player per zone each lunch-time with good behaviour certificates. During the end-intervention focus groups in this school, participants explained that the players did not like that only one player in each zone received a certificate. For example "we only brought out

one certificate, me and [name of leader] but then we gave it to one player and then everyone else got a bit upset because they didn't get one" (leader, school 1, end-intervention). In another school, the researcher provided various stickers for the leaders to distribute to all of the players in the zones at the end of each lunch-time to reward good behaviour. The stickers reward was successful at encouraging players to behave well as all players received the reward. For example:

> They were actually really good when they knew that they were getting the stickers, the first few weeks they didn't know, the first half they didn't really know what are we going to get now but then when they kind of got it they were like "were we good today?", "let's be good today so we can get a sticker" (leader, school 4, end-intervention).

These findings show rewards encouraged good behaviour when every player received an award at the end of lunch-time. Overall, the players enjoyed the activities when the leaders were democratic by allowing them to choose and manage the game. In addition to game and reward management, the leaders had to deal with the management of the equipment in the zones, other children in the yard, the players and the zone space. These zone management issues for the leaders are outlined in the following theme.

6.3.6.3 Leaders were challenged to manage play and players

Leaders' issues with organising the players for activities, preventing other children in the yard from entering the zones, space restrictions, and equipment management had a negative effect on the players' and leaders' enjoyment of the intervention. At mid-intervention, most players and leaders stated that the space restrictions in some zones made it difficult to play the games: my least favourite is the white zone… some girls like skipping around the place and moving around and they don't have enough room to do it (leader, school 1, mid-intervention). At mid-intervention, the researcher increased the size of the zones in the two schools where they were problematic and reassigned the ball and skipping zones to the larger zone areas in another school. The players and leaders acknowledged that the increase in zone size after mid-intervention made it easier to play the games: "when the green zone was over there we didn't know it was hard to skip but then when we moved out to the yard it was better and they got more time to skip" (leader, school 2, end-intervention).

Many players and leaders reported that children from other classes not involved in the intervention disrupted the zone activities by entering the zones, taking the equipment or joining the games. For instance: "Some girls come into, around part of it come into the group … and interfere a bit" (leader, school 1, mid-intervention). In an attempt to reduce the number of other children entering the zones, at mid-intervention, the researcher relocated the zones in three schools. In response to a suggestion from the leaders in one

school, the researcher provided the leaders with a sign to indicate to other children that these play areas were for the zone activities (see Appendix 21). However, the players and leaders reported that the sign did not keep the other children out of the zones, "we even made these signs but they still wouldn't listen" (player, school 2, end-intervention). One school did not have issues with other children entering the zones as the zones were situated in a separate area to the yard not used by the other children in the school.

Leaders were late commencing the games in the zones due to their difficulties with managing the equipment. A common pattern across the schools was that the leaders took equipment that was not assigned to their zones which delayed the commencement of the games due to spending time searching for the equipment. Furthermore, some leaders did not return the equipment correctly after lunch-time. For instance:

> People take your stuff coz they just grab everything and then you just say the lily pads thing, everyone was taking them and didn't need them and then there was skipping ropes gone and you had to tangle them all up and then the girls were waiting outside for you but that was because people were throwing them back in after they got them so (leader, school 1, leaders that stopped leading after mid-intervention).

In an attempt to alleviate the issue of leaders using unassigned equipment in the zones, the researcher allocated additional equipment to each zone in line with the equipment requested by the leaders and players. The players stated that they participated in more activities after mid-intervention because the leaders brought out more equipment to the zones, "they took out more equipment so we could actually play more so, instead of bringing out one basketball and two hula hoops they brought out three hula hoops and two basketballs" (player, school 1, end-intervention).

Organising the players and explaining the games were common difficulties for the leaders. The main issue with the management of players occurred when some players did not remember the zones they were to attend for that lunch-time. The following conversation shows the difficulties with organising the players considerably reduced the time spent playing the games:

> Leader 1: It takes a bit of time checking their names
>
> Leader 3: Ya it takes a few, it takes like 5 minutes to get them all together and then explain the game and then get straight into the activities

Leader 2: Ya it takes 10 minutes altogether just to get ready and then by that we only have like 7 minutes left

(School 4, mid-intervention)

Not all fifth class participants were suitable leaders as some gave poor explanations and demonstrations of the games which considerably reduced the time players participated in the zone activities. The following conversation among the players at end-intervention illustrates that the leaders sometimes spent too long explaining how to play the games:

Player 1: They just tell us what to do and then we only they take so long

Player 2: Explaining it because when we get it we're doing it right

Player 1: By the time they're finished it's

Player 2: Time to line up

(School 3, end-intervention)

Leaders had difficulties managing the equipment, zone space, other children in the yard and the players in the zones. These management issues reduced the amount of time the players engaged in the zone activities.

6.4 Discussion

The main purpose of the study was to determine the impact of a peer-led lunch-time intervention on second class primary school girls' daily MVPA. The second class girls' MVPA within segments of the school day, enjoyment, perceived social support for physical activity participation and experiences of the intervention will be discussed to provide insights into their response to this intervention and influence on MVPA. The leaders' experience of their involvement in the intervention will be discussed to capture their feelings on participating in the peer-led lunch-time intervention. The main finding was that participation in the peer-led lunch-time intervention significantly increased the players' daily MVPA in comparison to the control group, indicating the effectiveness of the programme.

6.4.1 Impact of the intervention on MVPA

Engagement in the peer-led lunch-time intervention significantly increased the players' daily MVPA in comparison to the control group. This study identifies the specific contribution student leaders can make to 7-8 year old girls' daily MVPA by leading structured lunch-time activities. This evidence warrants that students are trained to become physical activity leaders for younger girls at lunch-times in primary schools to maximise this physical activity opportunity. Previous studies showed structured lunch-time activities led by teachers (Huberty et al., 2011) or researchers (Howe et al., 2012) significantly increased 8-11 year old American children's school day MVPA. The present study shows older students can replace the role of the teachers and researchers in these previous studies by leading the structured lunch-time activities and significantly increasing girls' daily MVPA. It is plausible that

student leaders may present a more viable option for leading the lunch-time activities than researchers or teachers in the long-term, as researchers are generally only available for the duration of the intervention and teachers are under increased pressure to improve student academic achievement scores (Mahar et al., 2006), thus may not be available to lead lunch-time activities. Overall, the present study shows structured lunch-time activities led by older children in the school is an effective strategy to increase girls' daily MVPA.

The mean overall increase in the players' daily MVPA was less than one minute. The players' daily MVPA (49.6 minutes) and perceived social support scores (7.4) at baseline were high which indicates the girls participated in high amounts of physical activity each day and believed they were supported by their peers and teachers prior to participating in the intervention. Therefore, a one minute increase in daily MVPA from baseline to end-intervention modestly contributed towards meeting the daily MVPA guideline (World Health Organisation, 2010) in this already active sample. One potential reason the players only increased their daily MVPA by less than one minute may be that the high levels of daily MVPA and perceived social support scores at baseline created a 'ceiling effect' (Corder et al., 2008) that limited the scope of the intervention to improve their daily MVPA. Another consideration is that the intervention may have helped reduce the decline in physical activity that begins in early adolescence (Biddle et al., 2014). A longitudinal accelerometer-measured study of American children's physical activity aged nine to 15 years found a linear rate of decline of 37.7 minutes of MVPA per day per year beginning at nine years of age (Bradley et al., 2011). Thus the peer-led lunch-time programme may be seen as an important strategy to reduce age-related decreases in children's physical activity.

The rise in daily MVPA among the intervention group may be explained by the significant increases in their outdoor-only break-time MVPA from baseline to end-intervention and after school MVPA from baseline to mid-intervention in comparison to the control group. The intervention group increased their time spent in MVPA by 0.5 minutes while the control group decreased their MVPA by 0.2 minutes during outdoor-only break-times from baseline to end-intervention. Similarly, the intervention group accumulated 1.1 more minutes of MVPA after school while the control group decreased their MVPA levels at this time by 9.3 minutes from baseline to mid-intervention. Although the intervention did not target outdoor-only break-time or after school MVPA, findings from the thematic analysis suggest participation in the intervention may have led to increases in MVPA during these segments of the day. The findings show the players enjoyed playing the games they learnt in the zones as they played them during outdoor-only break-times and after school. Similarly, a previous study noted that boys played the modified soccer and football games they learnt during physical education during their discretionary lunch-times (Beighle et al., 2006). While this study (Beighle et al., 2006) was not based on learning games in a lunch-time

intervention, the students transferred their learning of games in physical education to their discretionary lunch-times similar to the way the girls in the present study played the intervention games during their discretionary outdoor-only break-times and after school. It is a novel idea that the children played the intervention lunch-time activities during other discretionary times of the day. However, previous single component lunch-time interventions did not contain data to determine this finding as they examined lunch-time MVPA but not MVPA within segments of the day nor included student voice in their evaluations (Stratton and Mullan, 2005, Engelen et al., 2013b, Verstraete et al., 2006, Ridgers et al., 2007b, Ridgers et al., 2010, Blaes et al., 2013, Lopes et al., 2009, Howe et al., 2012, Huberty et al., 2011, Larson et al., 2014). The present study shows the players played the games they learnt in the zones during outdoor-only break-times and after school which helped increase the players' overall daily MVPA.

While the thematic findings show the players enjoyed the lunch-time activities, the findings from the questionnaire show the players' enjoyment of physical activity significantly declined from baseline to end-intervention in comparison to the control group. The decline in the players' enjoyment scores may be due to the autocratic leadership style of some leaders in the zones. The leaders that led with an autocratic leadership style controlled the game selection and completion however research shows allowing children choice in activity selection is vital to activity enjoyment (Weiss, 1991). In addition, the players in the present study outlined in the focus groups that there were 'mean' leaders, whom they were afraid, that shouted at the players and threatened repercussions if they did not follow their instructions. This style of leadership does not promote positive social interactions between students, thus does not foster a supportive environment for physical activity among primary school children (Lubans et al., 2012). The thematic findings in the present study indicate the players reacted negatively to an autocratic style of leadership by not listening to the leaders, sitting out of the games, pretending to be sick or running away from the zones. This response to an autocratic leadership style in the present study was reflected in the findings of a review of UK children's and adults' reasons for participation and non-participation in sport and physical activity (Allender et al., 2006). This report found girls were willing to be active however only on their own terms in a safe non-threatening environment (Allender et al., 2006). The findings in the present study suggest some leaders warrant further guidance on creating a supportive environment to foster activity enjoyment.

It is surprising that there was no difference between the players' and control group's outdoor-only lunch-time MVPA from baseline to end-intervention as each previous structured lunch-time activity intervention reported significant increases in lunch-time MVPA (Scruggs et al., 2003, Howe et al., 2012, Huberty et al., 2011). Outdoor-only lunch-time MVPA for the intervention group in the present study at baseline, mid- and end-

intervention were 1.5(.8), 1.6(.9) and 2(.9) minutes. Corresponding values for the control group were 2.2(.8), 2.8(.9) and 2.4(1). The lack of change in the players' lunch-time MVPA in the present study may be partly due to the decline in the players' enjoyment scores as previous research found enjoyment of physical activity was strongly correlated with nine year old Dutch girls' physical activity (Remmers et al., 2015). The findings that some leaders did not implement the intervention as planned as they instead led sedentary games in the zones may further explain the lack of change in the players' lunch-time MVPA. A review of research that described the activities primary school boys and girls engage in during lunch-times found girls tend to mainly play sedentary, language-orientated games during this segment of the day (Riley and Jones, 2007). It is thus plausible that the girls' familiarity with playing sedentary games at lunch-times may have led to them to lead sedentary games in the zones. The issue of leaders implementing sedentary games warrants particular attention in future primary school peer-led lunch-time programmes.

6.4.2 Leaders' experience of the peer-led lunch-time intervention

The leaders' involvement in the intervention was essential as their role was to implement the lunch-time activities for the players. The leaders' experience of the intervention was evaluated as the factors that influenced the leaders' actions in the zones had an impact on the players' physical activity experience in the zones. The thematic findings show the leaders valued being with friends while leading, be it either leading with their close friends or developing new friendships. While the leaders in the two smaller schools enjoyed developing new friendships, the leaders in the two larger schools were generally unhappy to spend lunch-times without their close friends from baseline to mid-intervention. The unhappiness between the leaders in the two larger schools may have contributed to the lack of change in the players' lunch-time MVPA as a previous study of a peer-led physical education programme for secondary school girls found teamwork between leaders declined as the intervention progressed due to some leaders wanted the opportunity to lead with their friends (Jenkinson et al., 2012). Perhaps the teamwork between the unsatisfied partner groupings also declined from baseline to mid-intervention, resulting in these leaders putting less effort into leading the lunch-time activities over time and contributing to the lack of change in the players' lunch-time MVPA. The creation of suitable partner groupings to develop or maintain friendships is warranted in future peer-led lunch-time programmes.

The thematic analysis also indicated the leaders were challenged with preventing other children in the yard from entering the zones. The commencement of the activities was delayed sometimes as other children in the yard took the equipment. On occasion, the zone activities were disrupted due to other children entering the zones or joining the games. These delays and disruptions to the zone activities may further explain the lack of change in the players' lunch-time MVPA. The issue of other children entering the zones and disturbing the zone activities is a novel finding and specific to this structured peer-led lunch-time

intervention design as the zones were located within the second class yards for supervision purposes. Previous structured lunch-time interventions (Huberty et al., 2011, Howe et al., 2012) did not report an issue with other children entering the zones as the teachers in these interventions led the activities thus extra supervision of these zones when in yards or field areas not frequently used during lunch-times was not required. The only primary school intervention that contained a peer-led lunch-time activities component did not describe the location for these activities or issues with this setting (Eather et al., 2011). The practical implications of locating the zones within the yard described in the present study would be of interest when implementing peer-led lunch-time activities in primary schools in the future.

6.4.3 Strengths and limitations

117 rather than 66 participants were required to meet the power calculation in the present study to account for the clustered nature of the sample. However, only 56 participants were included in the final accelerometer data analysis. As the required sample size to meet the power calculation was not met, the findings in the present study are preliminary and should not be used to generalise to the national population of 7-8 year old girls. Also of note is that more 7-8 year old girls in the present study included in the final accelerometer data analysis were of normal weight (77%) compared to the nine year olds reported in the nationally representative Growing Up in Ireland study (70%) (Williams et al., 2009) further indicating the sample in the present study is not representative of 7-8 year old girls nationwide.

The main strength of the present study is that it is the first study to identify the specific contribution of the peer-led lunch-time intervention on 7-8 year old girls' daily MVPA. Previous peer-led lunch-time interventions were incorporated within multicomponent approaches (Eather et al., 2013a, Peralta et al., 2009, Lubans et al., 2011), thus making it difficult to determine the specific contribution of the lunch-time component to their overall physical activity (Naylor and McKay, 2009). A second strength of the present study is that MVPA was measured for the entire day. Many school based interventions only measured physical activity during school hours, which leaves the debate open to whether children would sustain the increased school day activity after school or compensate after school in response to school day activity (Kriemler et al., 2011). A third strength of the present study is that measurement of MVPA through accelerometers allowed for analysis of specific segments of the school day (Dollman et al., 2009). A fourth strength was the use of qualitative data as it provided a more comprehensive account of participants' physical activity engagement while participating in the lunch-time intervention (Bryman, 2006). The qualitative data helped to explain the findings generated by the quantitative data (Bryman, 2006). For example, the lack of change in the players' lunch-time MVPA from baseline to end-intervention in comparison to the control group was partly explained by a finding identified in the thematic analysis that some leaders led sedentary games in the zones. A

fifth strength was following the Consolidated Standards of Reporting Trials (CONSORT) (Schulz et al., 2010) and the Transparent Reporting of Evaluations with Nonrandomised Designs (Des Jarlais et al., 2004) guidelines as this ensured an adequate description was provided for transparency and replication purposes. Very few studies follow these guidelines which makes it difficult to determine the effectiveness of studies and include them in future systematic reviews (Salmon et al., 2007).

6.5 Conclusion

The present study is the first that shows structured lunch-time activities led by older students in primary schools is an effective strategy to increase girls' daily MVPA. The players played the zone activities during outdoor-only break-times and after school which led to significant increases in MVPA during these segments of the day and their daily MVPA in comparison to the control group. Interestingly, there was no change in the players' lunch-time MVPA in comparison to the control group but may be explained by the significant decline in the players' enjoyment scores, unhappiness between some leader partnerships, an autocratic leadership style of some leaders in the zones, some leaders not implementing the intervention as planned by instead leading sedentary games in the zones and other children entering the zones. Further research is necessary to determine the effectiveness of a peer-led lunch-time intervention on girls' daily MVPA with a sample size that is appropriately powered. Based on the findings of this study, one practical recommendation for increasing daily MVPA levels is that students could be trained to lead structured activities for girls at lunch-times in primary schools. Within peer-led lunch-time programmes, partner groupings should be formed that develop or maintain friendships, positive social interactions between students should be promoted and the leading of sedentary games should be checked and corrected. Ideally, the activity zones would be located in yards that are separate to other children not participating in the programme, however this would require extra yard supervision.

Chapter 7. General Discussion

This general discussion chapter examines the main physical activity themes identified in this thesis. The studies described in chapters 3-6 provide details on primary school children's physical activity at various times of the day with and without participation in a physical activity intervention. While the findings of each chapter were discussed individually, this chapter aims to combine the main results from chapters 3-6, examine the overall conclusions of this thesis and make suggestions for future research.

The most important finding of this thesis is that primary school girls significantly increased their daily MVPA by participating in a peer-led lunch-time intervention in comparison to the control group. It is thus recommended that school authorities and staff consider implementing peer-led lunch-time activities to help primary school girls increase their daily MVPA. This study, described in chapter 6, was novel as three previous studies evaluated the impact of peer-led lunch-time interventions on primary (Eather et al., 2013a) and secondary school (Peralta et al., 2009, Lubans et al., 2011) children's physical activity, yet these studies did not target primary school girls' physical activity specifically. A physical activity intervention created specifically for primary school girls was warranted as girls are particularly at risk of inactivity (Camacho-Minano et al., 2011) and are generally less active than boys (Morgan et al., 2003, Tudor-Locke et al., 2006, Brusseau et al., 2011, Nettlefold et al., 2011, Salmon et al., 2008, Mota et al., 2003). The pronounced difference between boys' and girls' participation in physical activity was also echoed throughout the findings in chapters 3 and 4 in this thesis. In these studies girls were significantly less active than boys during the entire day, school day, physical education, class-, break- and lunch-times when not engaged in a physical activity initiative. The study described in chapter 6 makes a significant contribution to the literature as it is the first to specifically address the issue of girls' inactivity with a peer-led lunch-time intervention.

One aspect of the intervention, described in chapter 6, that may have led to the successful increase in participants' daily MVPA was engaging with the children who delivered and participated in the intervention. The leaders and players of the intervention informed the development of the intervention, suggested modifications to the intervention design at mid-intervention and provided an account of their experience of participating in the intervention by completing draw and write activities and engaging in focus group discussions. Engaging student voice was listed by Public Health England (2015) as one of the eight promising principles for practice on what works in schools to increase physical activity among children as it enhances children's ownership of physical activity delivery and ensures activities are appropriately tailored to their needs. In particular, it is recommended that participants' views are integrated early in the research process as it can help develop an acceptable and attractive intervention and increase the likelihood of a successful trial and intervention

sustainability (Van Sluijs and Kriemler, 2016). To date, there are few existing health interventions that are influenced by student engagement prior to the implementation of the main trial (O' Cathain et al., 2013). The national physical activity plan and the ASF national whole-school initiative highlight the importance of student voice in the provision and promotion of physical activity (Department of Health & Department of Transport Tourism and Sport, 2016). One target of the National Physical Activity Plan is to include children in the development and implementation of programmes in which they are involved (Department of Health & Department of Transport Tourism and Sport, 2016) and one of the requirements of the national ASF initiative is to involve the children in the decision making process regarding the provision and promotion of physical activity by including them in the ASF school committee. The development of the peer-led lunch-time intervention, as outlined in chapter 5, was informed by primary school girls and is implemented by student leaders, therefore fulfilling the National Physical Activity Plan target and ASF requirement should schools include it as part of the ASF initiative.

Analysis of participants' MVPA during segments of the day and the draw and write and focus group data in chapter 6 provide further insights into girls' physical activity patterns as they engaged in the peer-led lunch-time intervention. Firstly, the players' significant daily MVPA increases after participating in the peer-led lunch-time intervention may be attributed to the significant increases in outdoor break-times and after school MVPA in comparison to the control group. Secondly, analysis of the draw and write and focus group data indicated that the players played the games they learnt in the zones during these segments of the day and may have led to the significant increases in MVPA. It is a positive finding that the girls enjoyed the games so much that they played the games after lunch-times as enjoyment of physical activity leads to regular participation in physical activity (Rowe et al., 2007). Furthermore, it is promising that the girls engaged in more after school activity during the intervention as the number of children playing outdoors near their homes on roads and footpaths has decreased from 75% to 15% between the years 1973 and 2006 (Play England and Sustrans, 2008). These findings suggest this peer-led lunch-time intervention may stimulate girls to engage in physical activity during break-times and after school which is important for encouraging girls to accumulate MVPA throughout the day.

One limitation of the study presented in chapter 6 is that there was no follow-up measurement of MVPA after the intervention had concluded, which means there is no indication whether the positive daily MVPA gained during the implementation of the intervention was sustained after the eight-week period. Similarly, two systematic reviews identified only a small number of studies that measured outcomes beyond the end of the intervention (Dobbins et al., 2013, Lai et al., 2014). Dobbins et al. (2013) and Lai et al. (2014) suggest that long-term measures of interventions that show short-term effects are

conducted to determine whether the behaviour change had some level of sustainability. Furthermore, Van Sluijs and Kriemler (2016) recommend that the sustainability of interventions of good methodological quality, regardless of evidence of short-term effects, are examined to improve the level of evidence produced by future research. A future study is thus warranted to determine the impact of the peer-led lunch-time intervention on primary school girls' daily MVPA beyond the end of the intervention.

The accelerometer-measured MVPA data in the present thesis can also make a significant contribution to the literature. The findings in relation to the objectively-measured physical activity reported in the present thesis have the potential to make an important contribution to the tracking and surveillance of national physical activity levels. Previous researchers have used a model called the Report Card on Physical Activity for Children and Youth to compile and assess the national evidence on physical activity among children and adolescents (Harrington et al., 2014a, Standage et al., 2014, Reilly et al., 2014, Liukkonen et al., 2014, Prista et al., 2014, Draper et al., 2014, Akinroye et al., 2014, Wachira et al., 2014, Ocansey et al., 2014, Gray et al., 2014, Dentro et al., 2014, Gonzalez et al., 2014, Rodriguez et al., 2014, Schranz et al., 2014, Maddison et al., 2014). This model uses the familiar academic letter grade approach (i.e., A, B, C, D, F) (Colley et al., 2012) to report the national physical activity levels, thus allowing the findings to be translated internationally with ease (Colley et al., 2012, Harrington et al., 2014b). A D minus grade was awarded to the overall physical activity levels category in the Irish Report Card on Physical Activity for Children and Youth (Harrington et al., 2014b) based on the findings that only 12-43% of 7-18 year old children met the daily physical activity guideline between the years 2009 and 2013 (Woods et al., 2010, Griffiths et al., 2013b, Williams et al., 2009, Central Survey Unit, 2011, Kelly et al., 2012). The inclusion of the MVPA findings described in chapters 4 and 6 in the next Report Card on Physical Activity for Children and Youth would provide more details on 6-12 year old Irish children's daily MVPA during the years 2012 and 2014.

Children's usual daily MVPA levels, without participating in an intervention, were recorded in chapters 4 and 6. The benefits of analysing children's usual MVPA levels are that it highlights physical activity opportunities for children, trends in physical activity and times when there is low physical activity. The 6-12 year old children and 7-8 year old girls in chapters 4 and 6 respectively were highly active at baseline when compared to the recommended 60 minutes of MVPA daily (World Health Organisation, 2010) as an average of 52.9 and 54.7 minutes of MVPA per day were recorded at baseline in these studies. Similar to the high levels of daily MVPA accumulated by the 6-12 year old Irish participants in chapters 4 and 6, Northern Irish, Scottish, Welsh and English children aged 7-8 years accumulated an average of 60.1 minutes of daily MVPA (Griffiths et al., 2013b). It is a positive finding that the children in the studies described in chapters 4 and 6 were highly

active at baseline as physical activity among primary school children is associated with numerous health outcomes (Chalkley et al., 2015). In contrast, previously published Irish accelerometer-measured findings indicate that 9-12 year old Irish primary school children have low levels of MVPA as nine year old children only accumulated between 20.2 and 33.7 minutes of MVPA daily (Murtagh and McKee, 2013) and 19% of 10-12 year old children met the daily MVPA guideline (Woods et al., 2010). Studies show that children's physical activity begins to decline from the age of seven years (Basterfield et al., 2011) and continues to decrease during adolescence (Dumith et al., 2011). This decline in physical activity with age may explain the differences between the MVPA findings in the present thesis and these published studies (Woods et al., 2010, Murtagh and McKee, 2013) as the majority of the participants (93 of the 117 participants) in chapters 4 and 6 were aged 6-8 years whereas the children in the published Irish studies were aged 9-12 years (Murtagh and McKee, 2013, Woods et al., 2010). Interventions are thus warranted to maintain the high levels of physical activity evident among young children and prevent the decline in physical activity as they increase in age.

The findings in chapters 3 and 4 provide information that can help researchers design school-based interventions to improve primary school children's physical activity. The participants in these studies had low levels of MVPA during physical education, class-, break- and lunch-time which suggest stimuli during these segments of the school day may be beneficial to increase their MVPA levels. The study described in chapter 3 revealed children spend the longest duration of the school day in class-time, yet spend the lowest percentage of the school day in MVPA during this segment. This finding suggests there is an opportunity to increase children's MVPA during class-time perhaps by activating the curriculum with programmes like Take 10! (Stewart et al., 2004) or providing class-time activity breaks for lesson transitions using initiatives such as Bizzy Breaks! (Murtagh et al., 2013). Physical education, break and lunch-times are generally the only time children can be regularly physically active during the school day (Kobel et al., 2015). The Department of Education and Science (1999a) advocates that break- and lunch-times are held for 10 and 30 minutes daily respectively and physical education is scheduled for 60 minutes weekly. Chapters 3 and 4 show the potential of promoting children's physical activity during these segments of the school day. Approximately 20-30% of each of these segments were spent in MVPA whereas it is recommended that MVPA is accumulated for 40% of break- and lunch-times (Ridgers et al., 2005) and 50% of physical education (US Department of Health and Human Services, 2000). To contribute to children's daily MVPA, strategies to increase MVPA during physical education, break- and lunch-times are warranted possibly by planning and delivering physical education with MVPA goals in mind (Fairclough and Stratton, 2005) or providing structured activity breaks during break- and lunch-times (Howe et al., 2012, Scruggs et al., 2003, Huberty et al., 2011).

A whole-school approach uses all of the school-based physical activity opportunities available including physical education, break- and lunch-times to develop physically educated students (American Alliance for Health Physical Education and Dance, 2013). However, few studies show the impact of whole-school interventions on children's physical activity. The study outlined in chapter 4 conducts the first analysis of primary school children's physical activity in an Irish whole-school initiative. The findings of this study show children's participation in the ASF did not significantly change their daily MVPA in comparison to the control group. It is plausible that a "ceiling effect" caused by high baseline MVPA levels may have prevented the change in daily MVPA (Corder et al., 2008). A ceiling effect occurs when many of the scores on a variable are at or approaching the maximum possible score (Ary et al., 2013, Cramer and Howitt, 2004). The majority of participants in the study described in chapter 4 were at or near achieving 60 minutes of MVPA at baseline. The high levels of daily MVPA among participants at baseline may have been due to their young age as previous research found similar aged children (6-11 years) were also highly active (Van Sluijs et al., 2008, Troiano et al., 2008, Riddoch et al., 2004, Owen et al., 2009, Kolle et al., 2010). Another potential reason the participants in chapter 4 had high levels of daily MVPA may be that the cohort was not representative of Irish primary school children nationally. Only two ASF rural primary schools that applied to participate in the research and two rural primary schools matched for school type and location took part in the study. The cohort in this study thus was not representative of Irish primary school children as these schools were not randomly selected and the sampling bias was not reduced (Salazar et al., 2015). In addition the children in chapter 4 are not representative of Irish primary school children nationally as they were considerably more active than the 19% of 10-12 year old Irish children who were active for at least 60 minutes of MVPA each day (Woods et al., 2010). As participants described in chapter 4 had high levels of daily MVPA at baseline, it is plausible that a ceiling effect may have prevented the ASF initiative from significantly increasing their daily MVPA in comparison to the control group. Without acknowledging the possibility of a ceiling effect in the study outlined in chapter 4, a questionable conclusion that the ASF had no effect on children's daily MVPA would have been made (Cramer and Howitt, 2004). As the participating schools in the study described in chapter 4 were not representative of primary schools nationally, a cluster randomised controlled trial is warranted to enable generalisations to be made regarding the impact of the ASF initiative on Irish primary school children's daily MVPA.

In conclusion, this thesis contributes to the literature on children's physical activity as it outlines the development and evaluation of an intervention that successfully increased primary school girls' daily MVPA, it provides objective measurements of Irish children's MVPA levels that can be used for the tracking and surveillance of national physical activity

levels, it identifies opportunities for physical activity promotion in the school setting and an evaluation of the impact of a whole-school initiative on primary school children's daily MVPA. The most important contribution this thesis provides to the existing evidence base is the presentation of the findings on the development and evaluation of a peer-led lunch-time intervention. This study was the first to examine primary school girls' MVPA in such a type of intervention. One of the main strengths of this intervention was that the participants' views were engaged early in the process and throughout the implementation of the intervention. While the intervention demonstrated success at increasing girls' daily MVPA there was no follow-up MVPA measurements after the intervention had concluded. Further research is thus warranted to determine whether the increases in daily MVPA during the intervention are sustainable when participation in the intervention has ended. This thesis identifies the potential the school setting holds to promote physical activity among children. Schools hold a captive audience of many children from different backgrounds and the continued promotion of physical activity within this setting is warranted.

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Appendices

Appendix 1: MIREC study approval for study described in chapter 3

Mary Immaculate Research Ethics Committee

MIREC-4: MIREC Chair Decision Form

1	Title of Research Project
An evaluation of primary school children's physical activity (PA) during the segmented school day.	

2	Applicant
Name	Deirdre Hegarty
Department / Centre / Other	Arts Education and Physical Education
Position	Research postgraduate student

3	Decision of MIREC Chair
	Ethical clearance through MIREC is required
	Ethical clearance through MIREC is not required and therefore the researcher need take no further action in this regard
x	Ethical clearance is required and granted. Referral to MIREC is not necessary
	Ethical clearance is required but the full MIREC process is not. Ethical clearance is therefore granted if required for external funding applications and the researcher need take no further action in this regard.
	Insufficient information provided by applicant

4	Reason(s) for Decision

All ethical issues have been addressed; the Department in question, and the supervisor has considerable experience in this kind of study.

One suggestion – not binding – is that parents and schools be offered a short summary of the class-level data rather than simply being given access to a report on request. The focus of the study is of interest to parents and schools.

5	Declaration	
Name (Print)		Anne Looney
		MIREC Chair
Signature		
		MIREC Chair
Date		06/02/2012

Appendix 2: Anthropometry protocol adapted from Lohman's (1988) Anthropometric Standardization Reference Manual

Procedure for measuring height:

1. Remove shoes, items in pockets and head gear (if it affects recording of height).
2. Stand on 'footprints', heels together and touching backstop.
3. Hang arms freely by side with palms facing the thighs.
4. Stand with a straight back and shoulder blades and buttocks touching backboard.
5. Look straight ahead (make sure head and eye are in line/horizontal).
6. Headboard moves down with enough pressure to compress the hair down to touch the head.
7. Record to nearest mm.
8. Measure twice.

Procedure for measuring weight:

1. Remove shoes, jewellery and items in pockets.
2. Stand on scale with both feet fully on weighing platform and weight equally distributed between feet.
3. Hang arms freely by side with palms facing the thighs.
4. Look straight ahead and stand as still as possible.
5. Measure in kg to the nearest 0.1kg and record on data sheet.
6. Measure twice.

Appendix 3: Samples improvements primary schools implemented to achieve the ASF as detailed on the activeschoolflag.ie website

See http://activeschoolflag.ie/index.php/sample-improvements/ for further details.

Sample physical education improvements

Planning and curriculum

- The school now has an overall PE timetable ensuring that every class has 1 hour of timetabled PE per week. Free time slots are also shown on the timetable allowing teachers to make use of the hall for discretionary time.
- The school now teaches PE as 2 x 30 minute classes as opposed to in a 1 hour block, thus allowing pupils to be active on two separate occasions during the week.
- Staff Survey – At the start of the ASF process we carried out a staff survey. This revealed hidden talents amongst the teaching and resource staff. As a result we have commenced a system of team teaching, sharing our skills across the PE strands. This has strengthened our delivery of the PE curriculum considerably.
- Playground Game of the Week – Teachers decide upon a different playground game every two weeks which they teach as part of their PE lesson. Pupils are encouraged to play this game with their friends during their break times. Classrooms with windows onto the yard will have diagrams and instructions about how to play the Game of the Week.
- The PE yearly plan is now on display in every classroom ensuring that pupils know what strand will be taught every month. The Seven Key Messages of the PE curriculum are displayed side by side with it.
- As a staff we agreed upon certain specified months to teach certain PE strands. We felt it would help if classes were doing the same thing at the same time, particularly for sharing resources and setting out equipment. We set November aside for Dance, February for Gymnastics and May for Outdoor Adventure. This seemed to work quite well and ensured that all classes covered 5 different PE strands.

Resources

- The PE storage area has been re-organised to make it a more user-friendly space. All boxes are clearly labelled. The ASF committee are responsible for keeping it tidy and ensuring that all equipment is returned to its' correct place.
- The school carried out a PE equipment audit disposed of broken items and sourced new equipment based on the suggestions of staff members and ASF committee. All staff members have a copy of the inventory and know where each piece of equipment and resource is located.
- Dancin' Time an Irish/Folk dance resource pack for primary teachers was sourced and photocopied. Music to accompany dances in this pack were uploaded to the shared server.
- An Active Schools folder has been created on the teachers' server containing the PSSI lesson plans, Primary PE Glance Cards, lesson plan ideas, links to online interactive videos, Bizzy Breaks by the Irish Heart Foundation, yoga poses for kids and a sports programme called Fit Kids. This is constantly being updated.
- Playground specific equipment has been purchased and is now stored in an area convenient to the yard. Senior pupils have been assigned the responsibility for its maintenance, distribution

and collection. An equipment map for the yard has been designed and attached to the storage box so that the children know where to place the equipment before the break begins.

- There has been significant investment in sports equipment for the pupils to use at their break times, including a table tennis table to cater for wet day activities. The equipment focussed on enabling pupils to develop individual pursuits e.g. quality skipping ropes, balance balls, hockey sticks.
- The learning support team came together to establish a rainbow room and ball room for children with special needs. A new prefab was put in to cater for this new resource. The children are timetabled to use the rooms on a weekly basis with the support of their LS teacher and/or SNA.
- Goalposts have been painted onto a wall in the yard as a new yard activity and new footballs have been purchased specifically for this.

Sample physical activity improvements

Physical activity during break-times

- Prior to the ASF we had a 'no running' policy. We removed this rule for a trial period allowing children to run more freely in the yard. This has been a great success and we have changed our policy as a result.
- The school organised a skipping workshop for all classes. Skipping is actively promoted during break times. Older pupils act as Skipping Leaders for the younger classes and the school sets Skipping Challenges for pupils that pupils work towards achieving.
- At second break the senior girls felt like they needed their own space to play sport so they were allowed access, under supervision, to the gym two days a week at lunch.
- Playground zones have been introduced to ensure that juniors to 2nd have the space and equipment to engage in in specific activities (bean bag throws, parachute games etc.). Senior pupils were selected as 'Play Leaders' to organise the equipment and to lead the younger pupils in activity. Bibs were purchased to identify the play leaders.
- Feel Good Fridays – We now play dance music in yard over the intercom system every Friday. Older pupils lead younger pupils in routines. This has proven extremely successful with pupils that were not games orientated.
- Football Free Fridays – The school introduced Football Free Fridays. Every Friday, no footballs are allowed in the yard. This gives each pupil a chance to feel safer, by not being in danger of getting hit by a football, and also a chance to try out new activities. Hula hoops, skipping ropes, SAQ ladders and hurdles, space hoppers, and javelins were brought out in order to give the children real variety in their activities. A skipping challenge and, later, a keepy-uppy challenge were put in place. This was a huge success. Older classes are involved in the supervision and collection of resources.
- On rainy days all teachers do an activity in their classroom to get their children moving. All teachers have a Go Noodle account so that they can access a wide variety of activities on their interactive white board including Zumba, yoga, athletics in the classroom and coordination activities. Each class picks a character and the more active they are the more their character grows. This has proven to be a massive success so much so that teachers often use it, not only on the days when children cannot get outdoors to play but also, as a transition between lessons or at the end of a day.

- On wet days, the Active Team (under supervision) lead classes in classroom based physical activity during their lunch breaks. This includes aerobics, dance, stretches etc. This initiative has replaced the watching of DVDs.

Physical activity throughout the school day

- An activity log is completed by children for random two week blocks, throughout the year. They record all activity they participated in, each evening, and attempt to do something active each day. Prizes are awarded for children who make an effort to be active each day, and those who show improvements in physical activity.
- Super Troopers – Our school has signed up for the Laya Healthcare Super Troopers programme where every child receives a physical activity homework journal and completes exercises and activities each night with family and friends as homework.
- The school uses loud speakers in the hall or outdoor in the yard (weather dependent) during Wake Up Shake Up time every morning to encourage all pupils to be more active through dance and this has proved extremely successful. This is led by 6th class pupils.
- Between subject transitions children engage in 2 min exercises to improve their concentration, balance, posture, flexibility etc. It also is very inclusive of all children. For rote learning the children march, skip, walk and hop while saying aloud their tables and rhymes.
- Run Around Europe – The ASF committee set up an initiative called the Run around Europe. The aim of this was to see how far we could travel, as a school, from Dublin through Europe. Prizes were given out when certain targets were met. We ensured that all prizes would be active based (eg: active homework).
- As part of daily homework pupils are now assigned ten minutes of physical activity.
- As a school we have incorporated physical activity as part of our positive behaviour plan. Any student who is spotted behaving well on yard or around the school grounds or helping younger children etc. is rewarded with a 'PE Stick'. Pupils pick a PE stick out of a box in the office to find out their active reward. eg: 10 minutes extra PE for their class. Treats can be used immediately or the class can let them build up and use at a later date. In this way 'Sweets as Treats' has been eliminated from our school and replaced by a system that rewards children with extra physical activity. Children now view physical activity as something that is very positive.
- The ASF committee organised the Most Active Class award to celebrate physical activity in the school. A trophy was purchased and is awarded to the most active class at each assembly.

Physical activity throughout the school year

- The ASF committee organised Super Sporty Skills for assemblies. Two classes select individuals /groups to display a sports skill at assembly eg: dance, gymnastics, hula hooping, ball skills, juggling etc.
- DEAR Time – We have introduced DEAR Time (Drop Everything and Run) and it has been a big success. As a quick active break from lessons children Drop Everything And Run in the nearest yard to them. This is a non-competitive activity where children run a lap or two at their own pace. Classes try to do DEAR Time at least once a day and keep a record of how many times they did it that week on a laminate on their door ('Scores on Doors'). It was the responsibility of the ASF committee to tally scores every week and pick a winner from the junior end and senior end

each week. The winners were announced at that week's assembly and the prize is a free slot in the PE hall that day where a circuit of PE activities is set up for them.

- Maths Week – The pupils in 5th & 6th class designed maths trails for Infants during Maths Week and assisted them complete the trails.
- Santa's Bootcamp – At Christmas, the ASF Committee led a Santa's Bootcamp in the school yard in the morning prior to school starting. We invited parents and a great many stayed when dropping off their children to participate. Parents, staff and pupils followed the ASF team members through a series of exercises.

Extra-curricular activities

- The girls wanted more sports to take part in so we introduced camogie, football, basketball and handball opportunities for the girls from 4th class upwards. Our older girls are noticeably more active and also partaking in more sports/activities outside of school.
- Our matches against other schools are arranged in a Go-Games format where it is non-competitive and inclusive to all players.
- Active Hour – The school has introduced Active Hour as part of the extra- curricular programme for 1st class children every Thursday. The emphasis is on fun and participation. 3 different activities will be offered each week alternating between field and yard games.
- An after-school Irish club has been established which places emphasis on games and activities through the medium of Irish. Children play games and activities using Irish words and phrase and learn action songs and poems through Irish.

Active travel

- All pupils were given high visibility jackets in September of this year. The ASF committee carried out an active travel survey which confirmed greater numbers walking and cycling to school.
- Children get stamps for active travel – one homework pass for every 20 stamps.
- Pupils take a short walk around perimeter of school twice daily (weather permitting) to reach maximum target of 1,000 steps extra per person per day.
- Active Challenge – Each child has been given an activity sheet. Each day they try to do a number of laps and the teacher signs their sheet. Once the children have completed 20 laps they get an active homework pass.

Sample partnership improvements

Working with pupils

- 5th/6th class pupils told us that they were becoming bored of swimming. We decided to introduce 4 weeks of kayaking instead. The response was excellent and it will feature on next year's plan for PE also.
- Classes were surveyed about their favourite aspects of PE/extracurricular programmes and asked to suggest new activities that they would like to partake in. The results were displayed on the ASF notice board.
- ASF committee members, with the help of a teacher, were responsible for creating active homework for each class grouping during Active School Week.
- ASF committee have been chalking out playground markings every week on the playgrounds.

- We now give achievement stickers to pupils who excel or make a great effort during timetabled PE classes. Children now feel that Physical Education is as important as the other academic areas and therefore they put more effort into the class.
- We now have a Sports Book of Achievements which is passed around every class every Monday to record sporting achievements outside school. These are then read out over intercom by principal each Monday afternoon.

Working with parents

- The Active School committee gave a presentation to new parents at the open night to explain what the AS process is about and to give a brief description of the physical activities the children can avail of during school and after school hours.
- The Parents' Association now organise our annual Fun/Sports day.
- During our Skipathon event this year we had a Teacher/Parents category that proved very successful. We hope to introduce a 'Skip Off' competition Parents/Teachers vs. Pupils next year.

Working with the local community

- A member of the local tennis club organised a workshop in our school where all classes got the opportunity to take part and get a taste of what the local tennis club had to offer.
- The school organised a bicycle and helmet safety check with the help of the local bicycle shop owner.
- The children spent A Day in the Community engaging in various types of sports or activities within the community. Children were introduced to facilities within the community that they may not have realised were available to them. As a result many of them joined new clubs.
- The whole school community completed a 5km walk in our local wood. We did this to promote this amenity as a possible family activity. Children completed a Fun Mud Run on a local farm.

Working with National Agencies

- The ASF coordinator attended a workshop run by the Health Promotion Department of the HSE titled Get Your School Walking.
- A Buntús Refresher course was provided by the Local Sports Partnership for the whole staff.
- The school contacted the Irish Wheelchair Association and a representative came to the school to speak with the pupils and to raise their awareness. The representative brought a variety of wheelchairs so that the children could experience what it would be like to take part in activities in wheelchairs. He also recommended an activity book specialising in activities and games for children with physical difficulties.
- We liaised with a traveling nurse for the visually impaired. She made two visits during the year so far to suggest ways in which we can provide the visually impaired child with opportunities to engage in with the curriculum. Among these suggestions were: yellow markings to be placed around the perimeter of the manholes and a line along steps. It was advised that the child should be accompanied by an SNA during PE lessons.

Appendix 4: The TREND checklist (version 1.0) for reporting a trial with a non-randomised design (Des Jarlais et al., 2004)

Topic and item number	Checklist item	Checklist
Title and abstract		
1a	Information on how units were allocated to interventions	☑ Title
1b	Structured abstract recommended	N/A
1c	Information on target population or study sample	☑ Title
Introduction		
2a	Scientific background and explanation of rationale	☑4.1
Background:		
3a	Theories used in designing behavioural interventions	N/A
Methods		
Participants:		
4a	Eligibility criteria for participants, including criteria at different levels in recruitment/sampling plan (e.g., cities, clinics, subjects)	☑ 4.2.3
4b	Method of recruitment (e.g., referral, self-selection), including the sampling method if a systematic sampling plan was implemented	☑ 4.2.2
4c	Recruitment setting	☑ 4.2.2
4d	Settings and locations where the data were collected	☑ 4.2.2
Interventions:		
5a	Details of the interventions intended for each study condition and how and when they were actually administered (content, delivery method, unit of delivery, deliverer, setting)	☑ 4.2.1
5b	Exposure quantity and duration	☑ 4.2.1
5c	Time span	☑ 4.2.1
5d	Activities to increase compliance or adherence	☑ 4.2.5
Objectives:		
6a	Specific objectives and hypotheses	☑ 4.1
Outcomes:		
7a	Clearly defined primary and secondary outcome measures	☑ 4.2.1
7b	Methods used to collect data and any methods used to enhance the quality of measurements	☑ 4.2.4, 4.2.5, 4.2.6
7c	Information on validated instruments such as psychometric and biometric properties	☑ 4.2.4, 4.2.5, 4.2.6

Sample size:		
7a	How sample size was determined	☑ 4.2.2
Assignment method		
8a	Unit of assignment	☑ 4.2.2
8b	Method used to assign units to study conditions	☑ 4.2.2
8c	Inclusion of aspects employed to help minimise potential bias induced due to non-randomisation	☑ 4.2.2
Blinding:		
9a	Whether or not participants, those administering the interventions, and those assessing the outcomes were blinded to study condition assignment	☑ 4.2.2
Unit of analysis		
10a	Description of the smallest unit that is being analysed to assess intervention effects	☑ 4.2.1, 4.2.5
10b	If the unit of analysis differs from the unit of assignment, the analytical method used to account for this	N/A
Statistical methods:		
12a	Statistical methods used to compare study groups for primary outcomes	☑ 4.2.7
12b	Statistical methods used for additional analyses, such as subgroup analyses and adjusted analysis	☑ 4.2.7
12c	Methods for imputing missing data, if used	N/A
12d	Statistical software or programs used	☑ 4.2.7
Results		
Participant flow:		
13a	Flow of participants through each stage of the study Enrolment: the numbers of participants screened for eligibility, found to be eligible or not eligible, declined to be enrolled, and enrolled in the study Assignment: the numbers of participants assigned to a study condition Allocation and intervention exposure: the number of participants assigned to each study condition and the number of participants who received each intervention Follow-up: the number of participants who completed the follow-up or did not complete the follow-up (i.e., lost to follow-up), by study condition Analysis: the number of participants included in or excluded from the main analysis, by study condition Description of protocol deviations from study as planned, along with reasons	☑ 4.2.3

Recruitment:		
14a	Dates defining the periods of recruitment and follow-up	☑ 4.2.2
Baseline data:		
15a	Baseline demographic and clinical characteristics of participants in each study condition	☑ Tables 4.1, 4.2, 4.3, 4.4
15b	Baseline characteristics for each study condition relevant to specific disease prevention research	
15c	Baseline comparisons of those lost to follow-up and those retained, overall and by study condition	
15d	Comparison between study population at baseline and target population of interest	
Baseline equivalence		
16a	Data on study group equivalence at baseline and statistical methods used to control for baseline differences	N/A
Numbers analysed:		
16	Number of participants (denominator) included in each analysis and whether the analysis for each study condition, particularly when the denominators change for different outcomes; statement of the results in absolute numbers when feasible Indication of whether the analysis strategy was "intention to treat" or, if not, description of how non-compliers were treated in the analyses	Tables 4.1-4.5
Outcomes and estimation:		
17a	For each primary and secondary outcome, a summary of results for each study condition, and the estimated effect size and a confidence interval to indicate the precision	☑ 4.3.2-4.3.5
17b	Inclusion of null and negative findings Inclusion of results from testing pre-specified causal pathways through which the intervention was intended to operate, if any	
Ancillary analyses:		
18	Summary of other analyses performed, including subgroup or restricted analyses, indicating which are pre-specified or exploratory	N/A
Adverse events:		
19	Summary of all important adverse events or unintended effects in each study condition (including summary measures, effect size estimates, and confidence intervals)	N/A
Discussion Interpretation:		

20a	Interpretation of the results, taking into account study hypotheses, sources of potential bias, imprecision of measures, multiplicative analyses, and other limitations or weaknesses of the study	☑ 4.4
20b	Discussion of results taking into account the mechanism by which the intervention was intended to work (causal pathways) or alternative mechanisms or explanations	
20c	Discussion of the success of and barriers to implementing the intervention, fidelity of implementation	
20d	Discussion of research, programmatic, or policy implications	
Generalisability:		
21	Generalizability (external validity) of the trial findings, taking into account the study population, the characteristics of the intervention, length of follow-up, incentives, compliance rates, specific sites/settings involved in the study, and other contextual issues	☑ 4.4.4
Overall evidence:		
22	General interpretation of the results in the context of current evidence and current theory	☑ 4.4

Appendix 5: Teacher log sheet

School _____ Teacher _____ Class _____

Thursday	**Break time** was from _____to _____.	Did the children go outside at break time (circle):	YES	NO
	Lunchtime was from _____ to_____.	Did the children go outside at lunchtime (circle):	YES	NO
	PE was from _____ to _____.	Did the children go outside for PE (circle):	YES	NO
Friday	**Break time** was from _____to _____.	Did the children go outside at break time (circle):	YES	NO
	Lunchtime was from _____ to_____.	Did the children go outside at lunchtime (circle):	YES	NO
	PE was from _____ to _____.	Did the children go outside for PE (circle):	YES	NO
Monday	**Break time** was from _____to _____.	Did the children go outside at break time (circle):	YES	NO
	Lunchtime was from _____ to_____.	Did the children go outside at lunchtime (circle):	YES	NO
	PE was from _____ to _____.	Did the children go outside for PE (circle):	YES	NO
Tuesday	**Break time** was from _____to _____.	Did the children go outside at break time (circle):	YES	NO
	Lunchtime was from _____ to_____.	Did the children go outside at lunchtime (circle):	YES	NO
	PE was from _____ to _____.	Did the children go outside for PE (circle):	YES	NO
Wednesday	**Break time** was from _____to _____.	Did the children go outside at break time (circle):	YES	NO
	Lunchtime was from _____ to_____.	Did the children go outside at lunchtime (circle):	YES	NO
	PE was from _____ to _____.	Did the children go outside for PE (circle):	YES	NO

Appendix 6: Questionnaire utilised in chapter 4, adapted from the Fife Active questionnaire (Rowe and Murtagh, 2012)

Coláiste Mhuire gan Smál
Mary Immaculate College

ID Number: _____

1. What is the name of your school? _____

2. How old are you? (tick √ the correct box)

9 years old ☐ 10 years old ☐ 11 years old ☐ 12 years old ☐

3. What class are you in? (tick √ the correct box)

4th class ☐ 5th class ☐ 6th class ☐

4. Are you a boy or a girl? (tick √ the correct box)

Boy ☐ Girl ☐

Motivators, benefits and obstacles to being physically active

Physical activity means any activity that makes your heart beat faster and makes you get out of breath some of the time. Some examples are running, walking quickly, cycling, dancing, swimming and football.

5. Circle one box for each line to show how true it is for you.
"For me, physical activity..."

Is fun	Very true	Quite true	Not very true	Not at all true
Helps me cope with stress	Very true	Quite true	Not very true	Not at all true

Helps me make new friends	Very true	Quite true	Not very true	Not at all true
Makes me healthy	Very true	Quite true	Not very true	Not at all true
Gives me more energy	Very true	Quite true	Not very true	Not at all true
Helps me keep in shape	Very true	Quite true	Not very true	Not at all true
Makes me look and feel better	Very true	Quite true	Not very true	Not at all true
Makes me stronger	Very true	Quite true	Not very true	Not at all true

6. Circle one box for each line to show how true it is for you. "I could do physical activity even if…"

I was tired	Very true	Quite true	Not very true	Not at all true
I had other things I wanted to do	Very true	Quite true	Not very true	Not at all true
I had to do it on my own	Very true	Quite true	Not very true	Not at all true
I had a bad day at school	Very true	Quite true	Not very true	Not at all true
I was feeling lazy	Very true	Quite true	Not very true	Not at all true
I was not very good at it	Very true	Quite true	Not very true	Not at all true

I was sore from physical activity the day before	Very true	Quite true	Not very true	Not at all true
I was not in the mood	Very true	Quite true	Not very true	Not at all true

7. Circle one box for each line to show how true it is for you. Reasons why I am not always physically active?

I don't have enough time	Very true	Quite true	Not very true	Not at all true
It is difficult to get to places	Very true	Quite true	Not very true	Not at all true
I am not very interested	Very true	Quite true	Not very true	Not at all true
I would rather do other things	Very true	Quite true	Not very true	Not at all true
I am not very good at physical activity	Very true	Quite true	Not very true	Not at all true
I do not have the right clothing or equipment	Very true	Quite true	Not very true	Not at all true
The weather is often too bad	Very true	Quite true	Not very true	Not at all true
I have too much homework to do	Very true	Quite true	Not very true	Not at all true

Appendix 7: ASF group's improvements to school physical activity provision in chapter 4

The improvements made to physical education, break- and lunch-times as detailed on the ASF school application form are outlined below.

Segment of school day	ASF Group	Improvements	Completion date
Physical education	ASF1	• PE separate lesson to GAA coaching	June 2013
		• More dance during winter months	February 2013
		• Athletics taught to all classes	June 2013
		• PE curriculum closely integrated with other subjects within the primary school curriculum.	June 2013
		• Ideas for activity related homework shared with staff	May 2013
		• Improved resources to enable teaching of Outdoor and Adventure lessons	January 2013
		• Increased awareness of seven key messages of the PE curriculum	November 2012
		• Glance Cards as a resource for teachers	May 2013
	ASF2	• Covering Dance Strand more comprehensively	March 2013
		• More inclusive lessons	March 2013
		• Covering each strand using Glance Cards	Ongoing
		• 3rd and 6th class attending swimming lessons	Ongoing
Break- and lunch-times	ASF1	• Play equipment brought out for break- and lunch-times (e.g. hurdles, skipping ropes, hoops)	March 2013
		• The number of children skipping and using hoops increased	May 2013
		• Better access to sports shed	September 2012
		• Play hurling during lunch-times	May 2013
		• Special Needs Assistants (SNAs) encourage children to play	October 2012
	ASF2	• Basketball League for 4th-6th class	December 2012
		• Hockey League for 1st-3rd class	December 2012
		• Senior classes set up simple games for Infant classes	February 2013
		• More equipment bought for break-time activities (basketballs, hoops, two new basketball rings)	Ongoing

Appendix 8: MIREC study approval for study described in chapters 5 and 6

Mary Immaculate Research Ethics Committee

MIREC-4: MIREC Chair Decision Form

1	Title of Research Project
An evaluation of a peer-led lunch-time physical activity intervention for primary school girls	

2	Applicant
Name	Deirdre Hegarty
Department / Centre / Other	Education - Arts Education and Physical Education
Position	Research postgraduate student

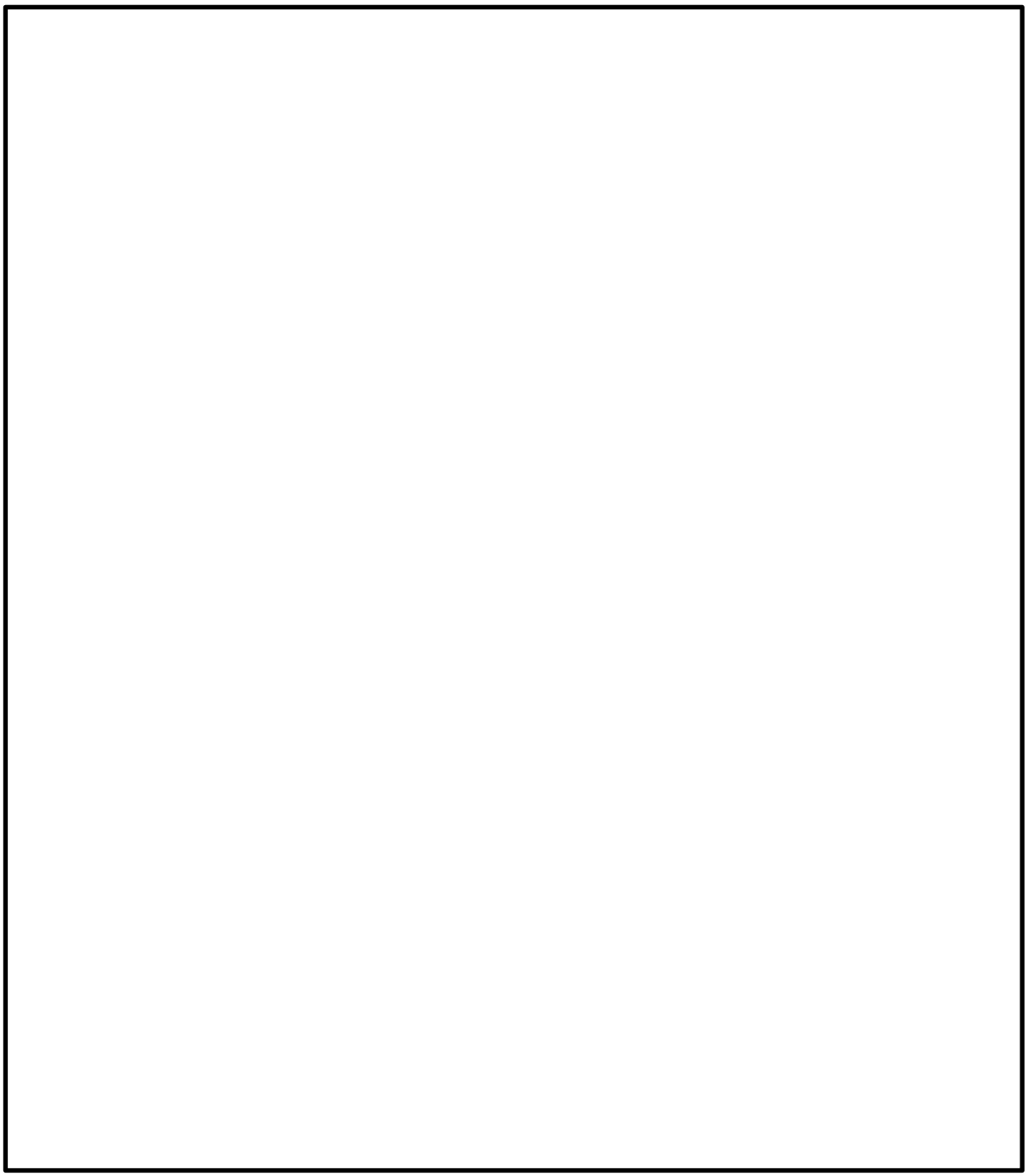
3	Decision of MIREC Chair
	Ethical clearance through MIREC is required
	Ethical clearance through MIREC is not required and therefore the researcher need take no further action in this regard
X	Ethical clearance is required and granted. Referral to MIREC is not necessary
	Ethical clearance is required but the full MIREC process is not. Ethical clearance is therefore granted if required for external funding applications and the researcher need take no further action in this regard.
	Insufficient information provided by applicant / Amendments required

4	Reason(s) for Decision
Ethical considerations have been addressed in the application.	

5	Declaration
Name (Print)	Áine Lawlor *MIREC Chair*
Signature	 *MIREC Chair*
Date	26/11/2013

Appendix 9: Second class draw and write activity

Draw a picture of yourself in the playground at lunch-time.



Write words/a sentence that describes the picture you drew.

_____

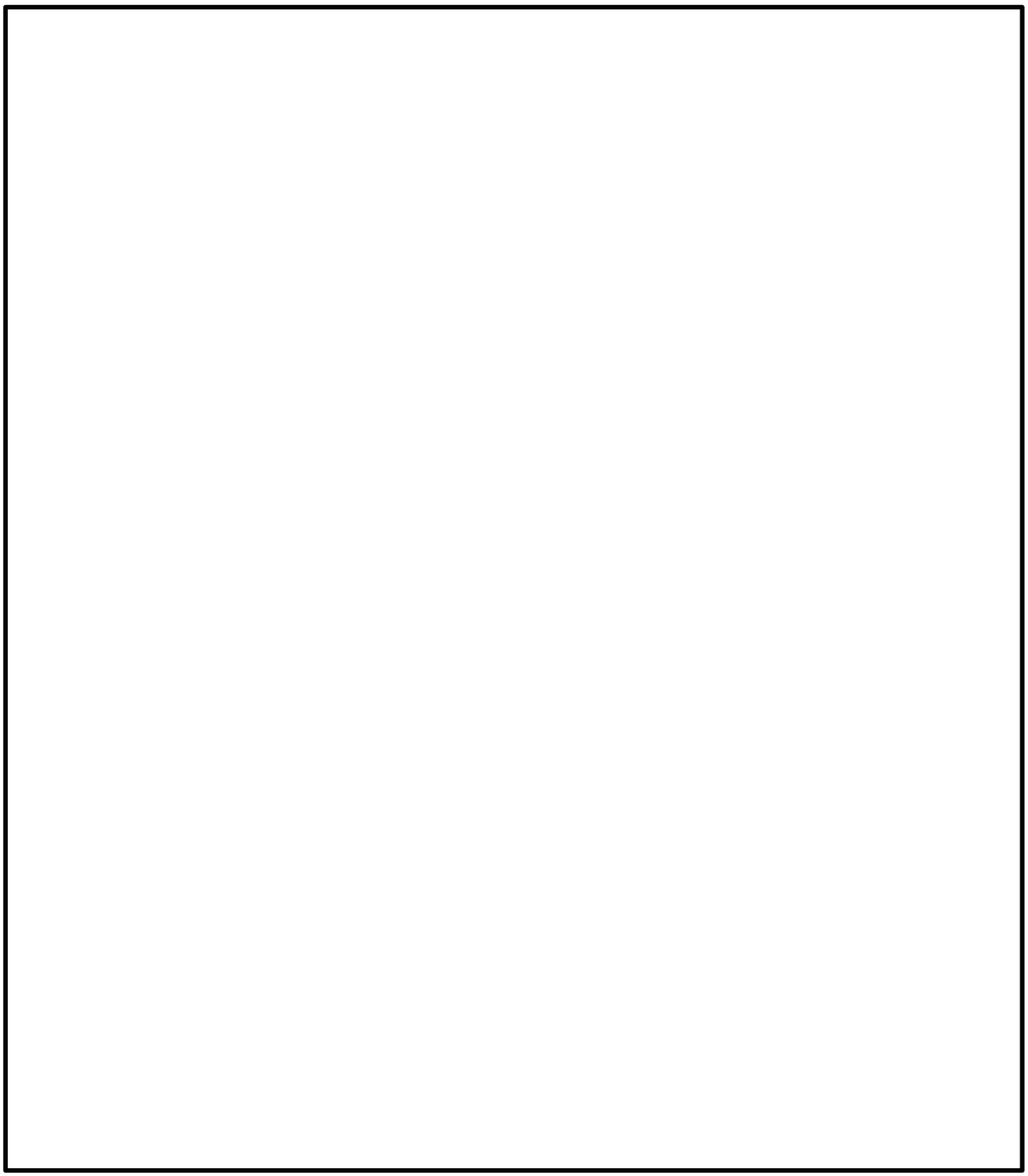
_____

_____

_____

Appendix 10: Fifth class draw and write activity

Draw a picture of yourself leading activities in the playground at lunch-time.



Write a sentence that describes the picture you drew.

_____

_____

_____

_____

Appendix 11: CONSORT 2010 checklist of information to include when reporting a cluster randomised trial (Campbell et al., 2012)

Topic and item number	Checklist item	Checklist
Title and abstract		
1a	Identification as a cluster randomised trial in the title	☑ Title
1b	Structured summary of trial design, methods, results and conclusions	N/A
Introduction		
Background and objectives:		
2a	Scientific background and explanation of rationale Rationale for using a cluster design	☑ 6.2.1
2b	Specific objectives or hypotheses Whether objectives pertain to the cluster level, the individual participant level, or both	☑ 6.1
Methods		
Trial design:		
3a	Description of trial design (such as parallel, factorial) including allocation ratio Definition of cluster and description of how the design features apply to the clusters	☑ 6.2.1
3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	N/A
Participants:		
4a	Eligibility criteria for participants Eligibility criteria for clusters	☑ 6.2.3
4b	Settings and locations where the data were collected	
Interventions:		
5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered Whether interventions pertain to the cluster level, the individual participant level, or both	☑ 6.2.2
Outcomes:		
6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed Whether outcome measures pertain to the cluster level, the individual participant level,	☑ 6.2.5

	or both	
6b	Any changes to trial outcomes after the trial commenced, with reasons	N/A
Sample size:		
7a	How sample size was determined Method of calculation, number of cluster(s) (and whether equal or unequal cluster sizes are assumed), cluster size, a coefficient of intracluster correlation (ICC or k), and an indication of its uncertainty	☑ 6.2.3
7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation Sequence generation:		
8a	Method used to generate the random allocation sequence	☑ 6.2.3
8b	Type of randomisation; details of any restriction (such as blocking and block size) Details of stratification or matching if used	
Allocation concealment mechanism:		
9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned Specification that allocation was based on clusters rather than individuals and whether allocation concealment (if any) was at the cluster level, the individual participant level, or both	☑ 6.2.3
Implementation:		
10a	Who generated the random allocation sequence, who enrolled clusters, and who assigned clusters to Interventions	☑ 6.2.3
10b	Mechanism by which individual participants were included in clusters for the purposes of the trial (such as complete enumeration, random sampling)	
10c	From whom consent was sought (representatives of the cluster, or individual cluster members, or both) and whether consent was sought before or after randomisation	
Blinding:		
11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	N/A
11b	If relevant, description of the similarity of interventions	N/A
Statistical methods:		

12a	Statistical methods used to compare groups for primary and secondary outcomes How clustering was taken into account	☑ 6.2.6
12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	
Results		
Participant flow (a diagram is strongly recommended):		
13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome For each group, the numbers of clusters that were randomly assigned, received intended treatment, and were analysed for the primary outcome	☑ 6.3.1
13b	For each group, losses and exclusions after randomisation, together with reasons For each group, losses and exclusions for both clusters and individual cluster members	
Recruitment:		
14a	Dates defining the periods of recruitment and follow-up	☑ 6.2.2
14b	Why the trial ended or was stopped	
Baseline data:		
15	A table showing baseline demographic and clinical characteristics for each group	Tables 6.2-6.6
	Baseline characteristics for the individual and cluster levels as applicable for each group	☑ 6.3.2
Numbers analysed:		
16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups For each group, number of clusters included in each analysis	☑ 6.3.2
Outcomes and estimation:		
17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval) Results at the individual or cluster level as applicable and a coefficient of intra-cluster correlation (ICC or k) for each primary outcome	☑ 6.3.3-5
17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	N/A
Ancillary analyses:		
18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	N/A
Harms:		
19	All-important harms or unintended effects in each group	N/A

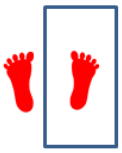
Discussion		
Limitations:		
20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	☑ 6.4.3
Generalisability:		
21	Generalisability (external validity, applicability) of the trial findings Generalisability to clusters and/or individual participants (as relevant)	☑ 6.4.3
Interpretation:		
22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	☑ 6.4
Other information		
Registration:		
23	Registration number and name of trial registry	N/A
Protocol:		
24	Where the full trial protocol can be accessed, if available	N/A
Funding:		
25	Sources of funding and other support (such as supply of drugs), role of funders	N/A

Appendix 12: Sample activity cards for Chinese skipping sequences

The 10s Chinese Jump Rope Challenge

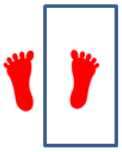
Level 1: Enders put rope around ankles and feet shoulder width apart.
Level 2: Enders put rope around ankles and feet together.
Level 3: Enders put rope around ankles and feet far apart.
Level 4: Enders put rope around knees and feet shoulder width apart.

- **10**



- **20**

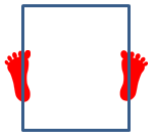
- **30**



- **40**

- **50**

- **60**



(underneath rope)

- **70**

- **80**

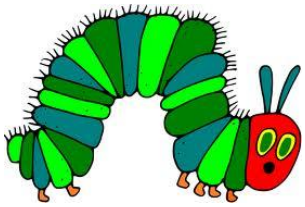
- **90**

- **100**

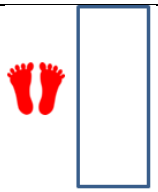
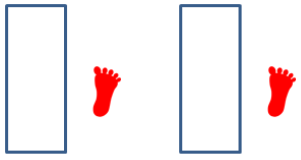
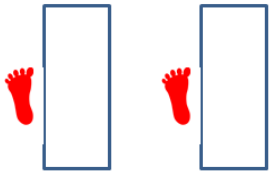
(on rope)

YouTube video: http://www.youtube.com/watch?v=H48DTWOlmw0

Caterpillar



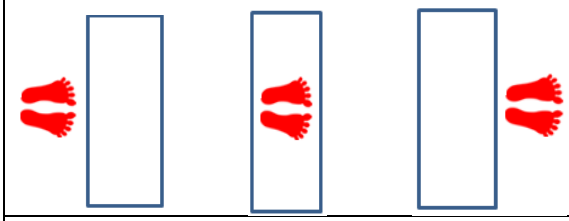
Up to 3 jumpers can do the sequence at same time, one behind the other:

• Stand side on, outside ropes	
• Hop on right leg inside ropes	
• Hop on left leg inside ropes	
• Hop on right leg outside ropes x 2	
• Hop on left leg inside ropes	
• Hop on right leg inside ropes	
• Hop on left leg outside ropes x 2	

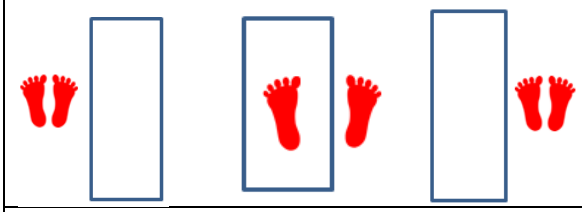
YouTube video: http://www.youtube.com/watch?v=NAVv_pqo9M8&list=PLD77B42F15C70D7FF

Can you jump……..

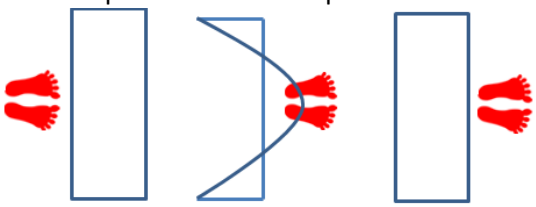
- Into the centre and out again?



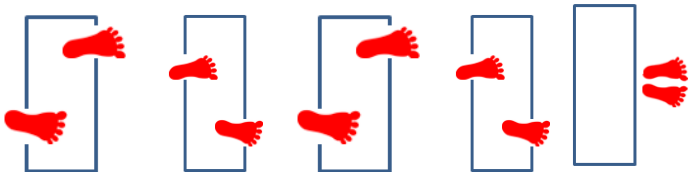
- And straddle over the furthest rope?



- And pull the nearest rope over the furthest rope?



- On the 2 ropes and switch legs 4 times?

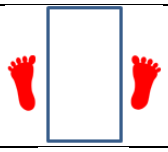
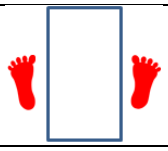
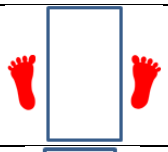


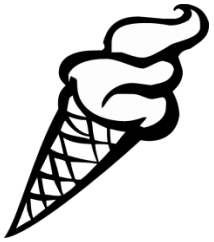
YouTube video: http://www.youtube.com/watch?v=4qrYQ_FOgZw

Ice Cream Cone

To make the ice cream cone shape: One ender puts the rope around one ankle and the other ender puts the rope around both legs.

Sequence for jumper:

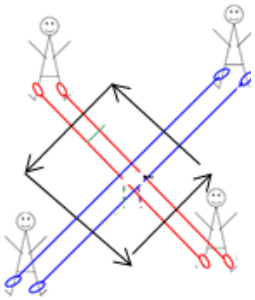
• In	
• Out	
• In	
• Out	
• In	
• Out	
• On	



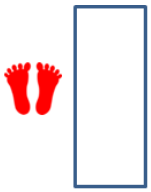
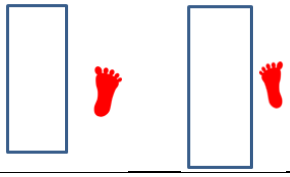
YouTube video: http://www.youtube.com/watch?v=LgFyQGWsgmc

The Box

Jumpers line up one behind the other outside on set of ropes. Start and end at one corner of the box shape and move in an anticlockwise direction:



Jumper sequence:

1) Stand side on, outside ropes 	2) Step on right leg inside ropes 
3) Step on left leg inside ropes 	4) Step on right, then left leg outside ropes 
• Repeat above until the jumpers reach end of the ropes. The jumpers then return to where they started and line up again to repeat the sequence.	

YouTube video: http://www.youtube.com/watch?v=NAVv_pqo9M8&list=PLD77B42F15C70D7FF

The Ladder

Enders: Two or three pairs of Enders line up side by side to form the ladder.

Jumpers line up one behind the other.

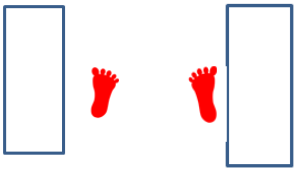
Jumper sequence:

- Stand side on, outside ropes

- Step on right leg inside ropes

- Step on left leg inside ropes

- Step on right, then leg outside ropes



- Repeat above until the jumpers reach end of the ropes. The jumpers then return to where they started and line up again to repeat the sequence.

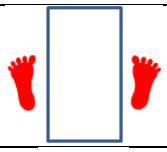
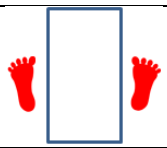
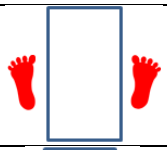
Variation: Two jumpers may begin at the same time and face each other as they 'climb the ladder'.

YouTube video: http://www.youtube.com/watch?v=NAVv_pqo9M8&list=PLD77B42F15C70D7FF

The Scissors Chinese Jump Rope Challenge

Enders put the rope around their ankles and put one leg in front of the other. Enders jump and switch legs so that they land with the other leg in front. This movement is like a scissors. Repeat this scissors action until the jumper has finished the sequence.

Sequence for jumper:

• In	
• Out	
• In	
• Out	
• In	
• Out	
• On	

YouTube video: http://www.youtube.com/watch?v=0vl8sjP3ezg

Appendix 13: Formulae used to account for clustered sample (Killip, 2004)

Design effect formula:

1 + intra-cluster correlation (number of participants per cluster – 1)

1 + 0.04 (8.25 - 1)

1 + 0.04 (7.25)

1 + 0.29

1.29

Effective sample size formula:

(number of participants per cluster)(number of clusters) / design effect

(8.25)(8)/1.29

66/1.29

51.2

51

Appendix 14: Poster displayed in the classroom to remind participants to wear accelerometer

Appendix 15: Questionnaire utilised in chapter 6 derived from PACES and the Child and Adolescent Trial for Cardiovascular Health surveys

COLÁISTE MHUIRE GAN SMÁL – OLLSCOIL LUIMNIGH | MARY IMMACULATE COLLEGE – UNIVERSITY OF LIMERICK

ID NUMBER:_____

1. What is the name of your school? _____

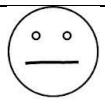
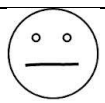
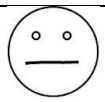
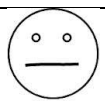
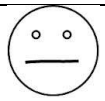
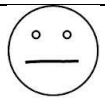
2. How old are you? (tick √ the correct box)

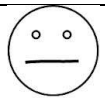
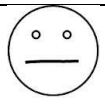
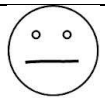
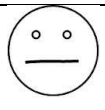
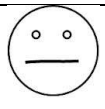
7 years ☐ 8 years ☐ 9 years ☐

PHYSICAL ACTIVITY means any activity that makes your heart beat faster and makes you get out of breath some of the time. Some examples are running, walking quickly, cycling, dancing, swimming and football.

3. When I am physically active…

(**Circle the face** that best shows how you feel for each of the statements)

	Disagree a lot	Disagree	Unsure	Agree	Agree a lot
I enjoy it					
I feel bored					
I dislike it					
I find it pleasurable					
It's no fun at all					
It gives me energy					
It makes me sad					

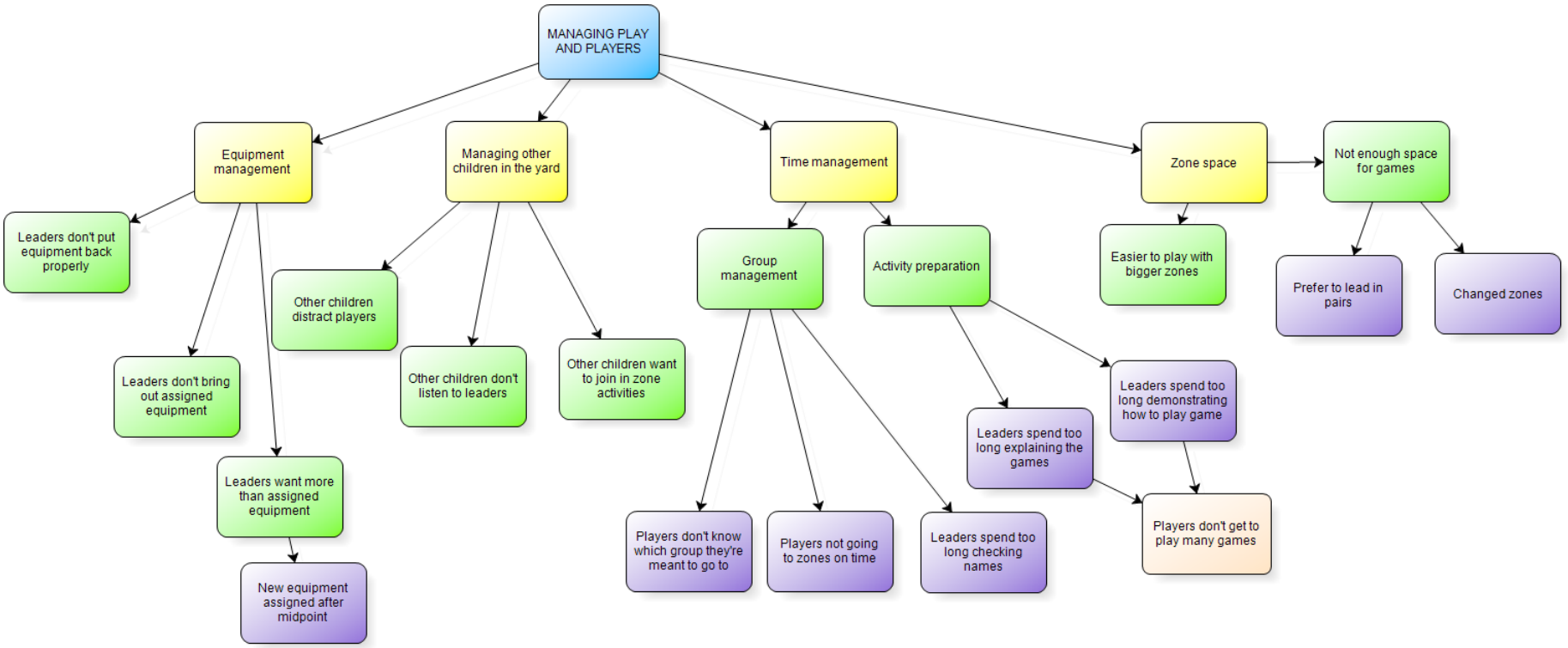
	Disagree a lot	Disagree	Unsure	Agree	Agree a lot
It's very pleasant					
My body feels good					
I get something out of it					
It's very exciting					
It frustrates me					
It's not at all interesting					
It gives me a strong feeling of success					
It feels good					
I feel as though I would rather be doing something else					

Appendix 16: Steps used to conduct the log transformation of the MVPA data

The six steps outlined below were followed to conduct the log transformation of the MVPA data within the statistical package for the social sciences (IBM SPSS Statistics version 21, US).

1. Click ‘transform’, ‘compute variable’
2. Type a label for the transformed data within the ‘target variable’ section
3. Select the data to be transformed and click the arrow pointing towards the ‘numeric expression’ section to transfer it to this location
4. Select ‘arithmetic’ within the ‘function group’ list
5. Select ‘Lg10’ within the ‘functions and special variables’ list
6. Click ‘OK’

Appendix 17: Organisation of the theme piles within the *Managing Play and Players* theme



Appendix 18: Narrative that describes the interesting aspects of the compiled data extracts in the *Other Children Coming into Zones* sub-theme

Theme: LEADERS WERE CHALLENGED TO MANAGE PLAY AND PLAYERS			
Sub-theme	Sub-theme piles	Recurring ideas	Implications
• Managing other children in the yard	• Other children distract players	• Players become annoyed • Leaders find it difficult to lead • Players don't like it when other children enter the zones • Players afraid they'll hit other children with equipment	• Disrupts play • Bad experience for leaders and players
	• Other children don't listen to leaders	• Other children don't listen to leaders because they're not teachers	• Other children don't respect leaders • Bad experience for leaders
	• Other children want to join in zone activities	• Leaders tell other children they can't play • Leaders let other children play • Leaders don't like telling other children they can't play • Other children sad because they can't play in the zones	• Players don't get to play when other children join in the games • Bad experience for leaders and players

Appendix 19: Description of the three main themes

Theme title	Sub-themes	Description of theme
Friendships with participants enhance the physical activity experience	• Happy grouped with friends • Unhappy without friends • Make new friends	Grouped with friends in the zones had a positive effect on the players' and leaders' enjoyment of the intervention. When players were randomly grouped they were either unhappy or made better friends with other students in their class. Leaders that had close friends leading on alternative weeks were lonely in their own yard as they were not able to play with their friends.
Involvement of players in decision-making	• Game selection and management • Use of rewards	Leaders that implemented the games with a democratic style of leadership had a positive effect on the players' and leaders' enjoyment of the intervention. Players described the leaders as 'mean' when they lead the activities with an autocratic style. The players preferred playing the activities when the leaders were democratic in choosing the games and deciding when to change the game. Players made up excuses to not play when leaders were autocratic with game selection. Rewards motivated or demotivated the players, dependant on how the system was operated.
Leaders were challenged to manage play and players	• Managing other children in yard • Managing zone space • Managing players • Equipment management	Poor leader management of play in the zones had a negative effect on the players' and leaders' enjoyment of the intervention. Other children in the yard disrupted the zone activities by coming into the zones, taking the equipment or joining in the games. Space restrictions in the zones made it difficult to play the games. Time was lost for playing in the zones when the leaders spent too long collecting the equipment from the equipment room, finding the players for the zones and explaining the games to the players.

Appendix 20: Minutes allocated to school day, break-time, lunch-time and physical education at baseline, mid- and end-intervention in the study described in chapter 6

The school day consisted of 340 ± 14.1 minutes (range 320-370 minutes). Physical education was scheduled between once and three times per week from baseline to end-intervention. A maximum of two break-/lunch-times were held indoors among intervention and control groups at baseline, mid- and end-intervention due to bad weather. The table outlined below displays the minutes allocated to physical education, break- and lunch-times from baseline to end-intervention.

Mean (SD) and range of minutes allocated to break-time, lunch-time and physical education school day segments at baseline, mid- and end-intervention.

Segment		Baseline	Mid-intervention	End-intervention
		Mean ± SD, range	Mean ± SD, range	Mean ± SD, range
Break-time	All	11.8 ± 4, 5-15	11.4 ± 3.2, 5-15	12.2 ± 3.9, 5-30
	Intervention	12.1 ± 3.9, 5-15	10.7 ± 3.5, 5-15	10.7 ± 3.5, 5-15
	Control	11.3 ± 4.8, 5-15	12.5 ± 2.9, 10-15	14.8 ± 3.7, 10-19
Lunch-time	All	23.6 ± 8.7, 15-40	25.2 ± 10.2, 15-40	25.2 ± 10.2, 15-40
	Intervention	23.6 ± 8.0, 15-30	25 ± 11.2, 15-40	25 ± 11.2, 15-40
	Control	23.8 ± 11.1, 15-40	25.5 ± 9.7, 20-40	25.5 ± 9.7, 20-40
Physical education	All	38.2 ± 43, 0-110	63.2 ± 37.4, 0-130	53.6 ± 20.7, 35-85
	Intervention	18.6 ± 25.3, 0-60	69.3 ± 29.9, 55-130	50.7 ± 20.9, 20-80
	Control	72.5 ± 49.2, 0-110	52.5 ± 51.2, 0-120	58.8 ± 22.5, 30-85

Appendix 21: Sign for zones after the mid-intervention review in chapter 6

Only 2nd and 5th class in these zones for Playground Pals