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Does a Step Back Approach to the Implementation of Project Spraoi Affect the Health and Fundamental Movement Skill Proficiency of Irish Children?

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Does a step back approach to the implementation of Project Spraoi affect the health and fundamental movement skill proficiency of Irish children?

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Author’s Declaration

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Abstract

Title: Does a step back approach to the implementation of Project Spraoi affect the health and fundamental movement skill proficiency of Irish children?

Background: Project Spraoi is an intervention which attempts to positively influence the overall health of Irish primary school children. Previous iterations of Project Spraoi have been labour intensive with an Energiser working with a maximum of two schools to deliver the intervention. The purpose of this research was to evaluate the effectiveness of the intervention on fundamental movement skills (FMS), and markers of health of Irish primary school children using a step back approach. The step back approach entailed reduced Enegiser contact with greater school autonomy

Methods: A 26 week Project Spraoi FMS and physical activity intervention was evaluated among children aged 5-7-years (1st and 2nd class) and 9-11-years (5th and 6th class) from 4 Cork primary schools during the 2016/17 academic school year. Participating schools had been supported in the implementation of the Project Spraoi intervention on the previous year. Data was collected from 284 children in intervention schools (n = 4) and 304 children in control schools (n = 3) at pre- and post-intervention. The Test of Gross Motor Development-2 (Urlich, 2000) was used to measure FMS proficiency. Height and mass were measured and subsequently body mass index (BMI) was calculated. Cardiorespiratory fitness (CRF) was measured using the 550m run/walk. Physical activity and sedentary behaviour was measured via accelerometry. Process evaluation tools used were questionnaires and physical activity logbooks in order to identify the barriers and facilitators and dose of the project.

Results: There were significant positive intervention effects for object control and total FMS scores among both age groups. For locomotor skills, significant positive intervention effects were found among the older age cohort only ($p<.01$; large effect size). Among the older cohort positive findings were found for waist circumference in the intervention group relative to control ($P<.01$; large effect size). No group time interactions were found for BMI, CRF and physical activity. Process evaluation findings revealed an increase in teacher's level of confidence to take physical activity sessions from baseline to follow up. Physical activity log book data revealed that while in school in approximately 15 minutes per day was allocated for physically active pursuits.

Conclusion: The Project Spraoi intervention using a step back approach was found to have positive impact on FMS levels. Furthermore, the findings from process evaluation indicate a positive impact on habitual physical activity and development of a health promoting culture within the school. This provides support for FMS and physical activity interventions in Irish primary school settings.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

BMI	Body Mass Index
CIT	Cork Institute of Technology
CRF	Cardiorespiratory Fitness
CSPPA	Children's Sports Participation and Physical Activity Study
DXA	Dual Energy X-Ray Absorptiometry
EU	European Union
IOTF	International Obesity Taskforce
LPA	Light Physical Activity
METS	Metabolic Equivalents
MPA	Moderate Physical Activity
MVPA	Moderate to Vigorous Physical Activity
NCD's	Non Communicable Diseases
PA	Physical Activity
RE-AIM	Reach, Effectiveness, Adaptation, Implementation and Maintenance
SB	Sedentary Behaviour
SPSS	Statistical Package For Social Studies
SMS	Short Message Service
VPA	Vigorous Physical Activity
WHO	World Health Organisation
WHtR	Waist to Height Ratio
WC	Waist Circumference

Appendices

Chapter 1:

Introduction

1.1 Introduction

Obesity is reported as the most common childhood disorder in Europe (Webber *et al.* 2014). In 2011, 22% of Irish children aged between 5 and 12 years old were classed as overweight or obese (WHO 2011). Furthermore, the World Health Organisation has recently predicted that Ireland will have the highest prevalence of people overweight or obese in Europe by the year 2030 (Webber *et al.* 2015). It has been claimed that there is a high correlation obesity at childhood and adulthood (Herman *et al.* 2009), therefore primary prevention strategies are recommended. Obesity has also been found to have extensive economic repercussions. In 2009 it was estimated that the cost attributed to overweight and obesity in the Republic of Ireland was €1.13 billion (SafeFood 2012).

Regular physical activity (PA) has been positively associated with markers of health and lower levels of overweight or obesity among children (Berkey *et al.* 2000). Additionally, regular PA has proven not only to enhance cardiorespiratory and musculoskeletal fitness but also enhance a child's emotional, social and cognitive well-being (Davis *et al.* 2011). Worryingly, in Ireland, a mere 25% of children (31% boys, 18% girls) were found to partake in PA on a daily basis (WHO 2011) with over 50% of Irish children not meeting the daily PA requirements (Harrington 2016). When compared to international counterparts, Irish children have low levels of PA, high levels of sedentary behaviour (SB) and have poor habitual healthy eating habits (Webber *et al.* 2012; Tremblay, 2014). In addition, 'The Growing up in Ireland Study' examined the pattern of overweight and obesity among nine-year-old children; it was found that among boys, high levels of SB and low levels of physical exercise were both associated with a higher risk of overweight and obesity (Layte *et al.* 2011).

Fundamental movement skills (FMS) are basic observable patterns of movement that facilitate participation in PA and sport (Gallahue & Ozmun 2006). FMS are the foundation upon which more complex, sport-specific skills are based and have been referred to as the 'ABCs of movement' (Robinson 011). These are categorised into three subcategories: locomotor, object-control and stability skills (Gallahue & Ozmun 2006). Locomotor skills are those that involve moving the body from one place to another (e.g. running, jumping and leaping) while object-control skills are those that involve the manipulation of an object such as a bat or a ball (e.g. catching, throwing and striking). Stability skills are movements that are neither locomotive nor manipulative (e.g. balancing and twisting) (Gallahue *et al.* 2012). To date, limited research has examined the FMS levels of Irish primary school children, with results from one published study reporting low levels relative to norms and international counterparts (Bolger *et al.* 2018). Given the strong positive relationship that exists between FMS and PA (Fisher *et al.* 2005; Robinson *et al.* 2015)**,** the development of FMS has the potential to improve PA. levels in children, in addition to developing their health-related fitness and perceived competence, whilst decreasing the prevalence of overweight and obesity (Fisher *et al.* 2005; Robinson *et al.* 2015).

Cardiorespiratory fitness (CRF) is the ability of the body's circulatory and respiratory systems to supply fuel and oxygen during sustained PA. It is a good indicator of how much PA you routinely perform (Ortega *et al.* 2008). Cardiorespiratory fitness is a powerful marker of health among children (Boddy *et al*. 2012; Ortega *et al*. 2008) with studies demonstrating that low CRF is associated with obesity, high blood pressure and metabolic syndrome (cluster of metabolic conditions that can lead to heart disease) in young people (Janssen & Leblanc 2010). There is evidence that school-based initiatives that target increased fitness can improve child health (Carrel *et al.* 2005; Kovacs *et al.* 2009). Furthermore, CRF during childhood can predict a healthier cardiovascular profile in adulthood (Dwyer *et al.* 2009; Hruby et al. 2012; Twisk *et al.* 2002) with recent evidence indicating levels of CRF to be declining globally (Boddy *et al.* 2012; Sandercock *et al.* 2010; Tomkinson & Olds 2007). Factors implicated in this decline are increased body mass (Sandercock *et al*. 2010), decreased PA and increased time spent in SB (Aggio *et al.* 2012). Although there is a lack of Irish data, one study has reported that one in four Irish primary school children has a low level of fitness, is overweight or obese and has elevated blood pressure (Woods *et al*. 2010).

The prevention of childhood obesity is of high priority (WHO 2015). Therefore, school-based strategies aimed at increasing regular PA, improving FMS and CRF levels are warranted and have the potential to positively impact on markers of health.

1.2 Aims and Hypotheses

1. To evaluate the effectiveness of a Project Spraoi intervention using a step back design on markers of health (BMI, waist circumference, cardiorespiratory fitness and physical activity) among primary school children.

   HØ: There will be no significant difference in markers of health among primary school children following a Project Spraoi intervention which adopted a step back approach.

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2. To evaluate the effectiveness of a Project Spraoi intervention using a step back design on Fundamental Movement Skills among primary school children.

   HØ: There will be no significant difference in Fundamental Movement Skills among primary school children following a Project Spraoi intervention which adopted a step back approach.

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3. To conduct a process evaluation of the implementation of Project Spraoi to assess (i) teacher level of adherence and engagement in the project and (ii) teacher perceived barriers and facilitators pre- and post-intervention.

   HØ: There will be no increase in the delivery of physical activity sessions among participating teachers and no change in barriers/ facilitators will be identified to the Project Spraoi intervention using a step back approach.

1.3 Project Spraoi and the Current Research

This research was carried out as part of Project Spraoi which is a primary school based health promotion based in Cork Institute of Technology (CIT) within the Department of Sport Leisure and Childhood Studies. A staff member within the Department of Sport Leisure and Childhood Studies in CIT, had previously worked on a similar project in New Zealand titled Project Energize (PENZ). This link was central in the origins of Project Spraoi. Hence, Project Spraoi is based on the New Zealand health promotion intervention, PENZ. The project aims to enhance the overall health and well-being of primary school children (Rush *et al.* 2011). PENZ has reported positive impacts on levels of overweight and obesity, physical fitness and nutritional behaviour among NZ children (Rush *et al.* 2011; Rush *et al.* 2012; Rush *et al*. 2014). Similarly, Project Spraoi aims to enhance the overall health and well-being of Irish primary school children.

Project Spraoi commenced in Ireland in 2013 and is coordinated by a team of researchers from Cork Institute of Technology. Since its origin, the intervention has been delivered to 11 primary schools in Cork city and county. The school-based delivery of Project Spraoi is carried out by trained members of the Project Spraoi research team, known as 'Energisers'. Energisers deliver the project to schools by acting as agents of change in the school settings. Energisers work by supporting school staff members to promote PA and healthy eating among the students. Energisers do this in numerous different ways including:

- modelling PA sessions (e.g. sessions that focus on CRF, FMS and maximum participation)
- setting up whole-school PA initiatives
- providing PA resources (e.g. equipment, games manuals and so on.)
- forming links between the school and PA providers in the local community (e.g. with local sports clubs, universities for the use of facilities)
- aiding in the development of PA and healthy eating policies
- providing healthy eating promotional material (e.g. fridge magnets, dietary information sheets)
- organising healthy eating parent information evenings or simply being available to talk to or answer any questions teachers may have in relation to PA and nutrition

Project Spraoi is a research-driven initiative in that each Energiser is actively engaged in a postgraduate study in a specific health-related area. To date, the focus of the postgraduate studies has been to evaluate the impact of Project Spraoi on: (i) PA levels, (ii) (FMS) proficiency, (iii) nutritional intake, (iv) markers of health, (v) SB levels and (vi) process evaluation analysis.

Key baseline findings from Phase 1 of Project Spraoi were:

- A total of 16% of 6-year-old boys (n=175) and 19.8% of 6-year-old girls (n=156) were overweight or obese. The same study also found that among 10-year-old children, 17.9% of boys and 24.3% of girls were overweight or obese (O'Leary 2018).
- Irish children aged between 6 and 10 years of age show low FMS proficiency levels (Bolger *et al.* 2015) compared to international literature (Bakhtiar *et al.* 2014; Cohen *et al.* 2014; Spessato *et al*. 2013; van Beurden *et al.* 2002).
- The intake of fruit and vegetables, fibre, calcium and iron were poor which is consistent with their international counterparts (Merrotsy 2018).
- Children spent 8.5±1.18 of waking hours in sedentary patterns which is consistent with international data (Murphy 2017).
- Almost three quarters (74.1%) of 6-year-olds and 57.6% (N=264) of 10-year-olds were classified as having low CRF (O'Leary 2018).

These findings highlighted the need for an intervention to improve the health of Irish children.

The key findings from the Project Spraoi intervention to date include (Phase 1):

- The difference between the intervention and control groups from pre to post-intervention increased significantly for BMI (p<0.01, large effect sizes) following the Project Spraoi intervention (O'Leary *et al*. 2018).
- The Project Spraoi intervention group had significantly greater FMS proficiency levels (p<.0001) relative to the control group (Bolger *et al*. 2018).
- A significant decrease in the Project Spraoi intervention groups' overall screen time was found (6-year-olds: -32.59 minutes ± 0.10, p =.03; 10-year-olds: -44.97 minutes ±25.48 p =.02). (Murphy 2018).

- Moderate to vigorous physical activity (MVPA) was found to have increased in both intervention and control groups, but the statistical analysis did not show any group effect (O'Leary 2018).

This research formed phase 2 of the Project Spraoi intervention delivery. The 1st phase collected baseline findings and assessed the impact of the intervention with one Energiser assigned a maximum of two schools. Phase 2 (this study) assessed the impact of the intervention findings based on a step back approach. The focus of this research was to build on previous iterations of the project in schools where the project had been delivered. Further to this, the aim of the study was to assess the effectiveness of the intervention with a larger number of schools using a step back approach. This step back approach was structured with school personnel receiving less direct contact from the Energiser and thereby adopting a more proactive role in the delivery of the project. Therefore the current research aimed to design, implement and evaluate a school-based PA intervention across four intervention schools with reduced Energiser contact and increased school autonomy. Figure 1.1 shows a flowchart of how Project Spraoi differs from stage 1 to stage 2 and further highlights the progression of the programme from stage 1 to stage 2.

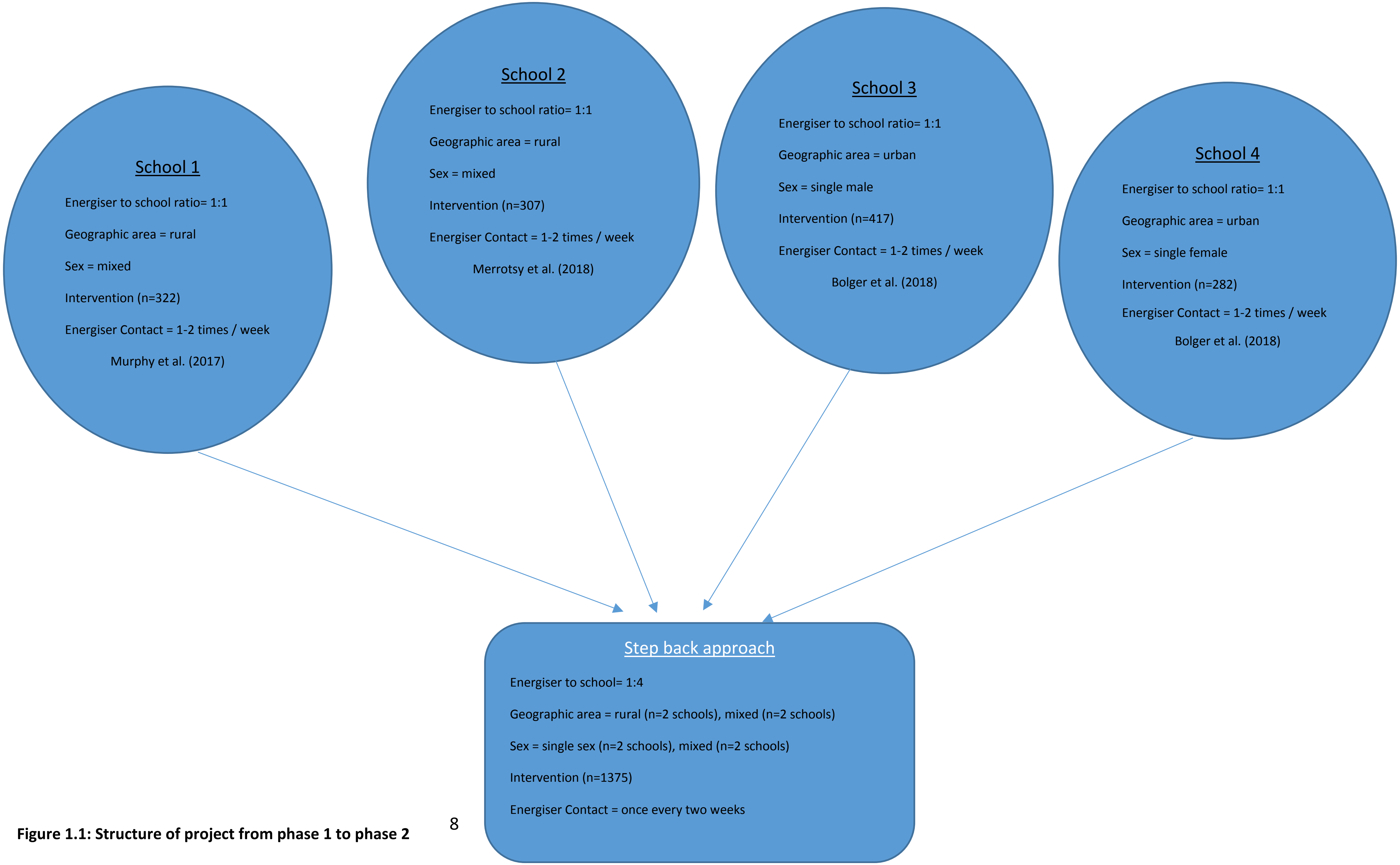

Figure 1.1: Structure of project from phase 1 to phase 2

Chapter 2:

Literature Review

2.1 Overview of Literature Review

This literature review will specifically focus on FMS and the following markers of health body mass index (BMI), waist circumference (WC), CRF and PA. These variables were chosen for review as previous iterations of the Project Spraoi intervention utilised these variables to evaluate their research. Therefore, as this is a follow on study, the same variables were used to assess the effectiveness of the intervention and to enable the assessment of trends over time.

This literature review is divided into five main sections. Section 2.2, 2.3 and 2.4 provide an overview of markers of health (body mass index (BMI), waist circumference (WC), CRF and PA), how each marker of health is assessed and current trends among children. Section 2.5 provides an overview of fundamental movement skills, how FMS are assessed, the benefits of high FMS proficiency and the current levels of FMS proficiency among youth. Section 2.6 reviews school-based health promotion interventions and recommendations for effective interventions. Finally, section 2.7 reviews process evaluation protocols.

2.2 Overweight and Obesity

2.2.1 Definition of Overweight and Obesity

Overweight and obesity are defined as the accumulation of abnormal or excessive amounts of adipose tissue (body fat) that is strongly associated with adverse health outcomes (WHO, 2017; Sahoo *et al.* 2015). Abnormal or excess adipose tissue arise from an energy (calorie) imbalance, whereby energy (calorie) intake exceeds energy (calorie) expenditure (Sahoo *et al*. 2015) and therefore is strongly related to dietary, PA and SB (WHO, 2002; Lobstein *et al*. 2004).

2.2.2 Classification of Overweight and Obesity

Body mass index is an approximate measure of whether someone is over, normal or underweight calculated by dividing their weight in kilograms by the square of their height in meters (Sahoo *et al.* 2015). BMI values are age-independent and are categorised by cut-points to define BMI status, these are based on the same method at different ages (Kuczmarski *et al*. 2002). As BMI varies with age and sex (Lobstein *et al*. 2004), different cut-points (based on different reference populations) have been recommended to classify children into BMI categories (Cole *et al*. 2000; Cole, Freeman, & Preece, 1995; Kuczmarski, 2000; Must, Dallal, & Dietz, 1991; Rolland-Cachera *et al*. 1991; WHO, 1995).

Numerous age and sex-specific BMI cut-points have been developed for use among children (Cole *et al*. 1995; Cole *et al*. 2000; Must *et al*. 1991; Rolland-Cachera *et al*. 1991; WHO, 1995). There is no consensus on which set of cut-points should be used to determine overweight and obesity among children (Sahoo *et al.* 2015), making it difficult to compare findings across research (Lobstein *et al.* 2004; Martin-Calvo *et al*. 2016). Cut-points have been developed from reference populations from the U.S. by Must *et al*. (1991) and more recently by the Center for Disease Control and Prevention (Kuczmarski 2000). Other cut-points have been developed from reference populations from the UK (Cole *et al*. 1995) and France (Rolland-Cachera et al. 1991) while cut-points from international reference populations have been developed by the World Health Organisation (WHO) (de Onis *et al*. 2007) and the International Obesity Taskforce (IOTF) (Cole & Lobstein 2012).

In the United States, the Center for Disease Control and Prevention (CDC) developed cut-points to classify overweight/obesity amongst children and adolescents. Their data was based on BMI for age growth charts from 1977 to 2000 (Kuczmarski *et al.* 2002). CDC defines overweight as a BMI at or above the 85th percentile and lower than the 95th percentile for children of the same age and gender from relative populations. Obesity is defined as a BMI at or above the 95th percentile for children and teens of the same age and sex (Kuczmarski *et al*. 2002). BMI for age weight status categories and the corresponding percentiles are shown in the following table.

Table 2.1: BMI for age weight status categories and the corresponding percentiles (Kuczmarski *et al*. 2002)

Weight Status Category	**Percentile Range**
Underweight	Less than the 5th percentile
Normal or Healthy Weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obese	95th percentile or greater

Further to the CDC's categorisation of childhood body mass, researchers suggest that it is possible to identify an individual's status relative to the reference population the individual would match and allow for comparison with children of similar age and gender. Figure 1 highlights the BMI percentiles for boys aged 2 -20 years based on CDC cut-points.

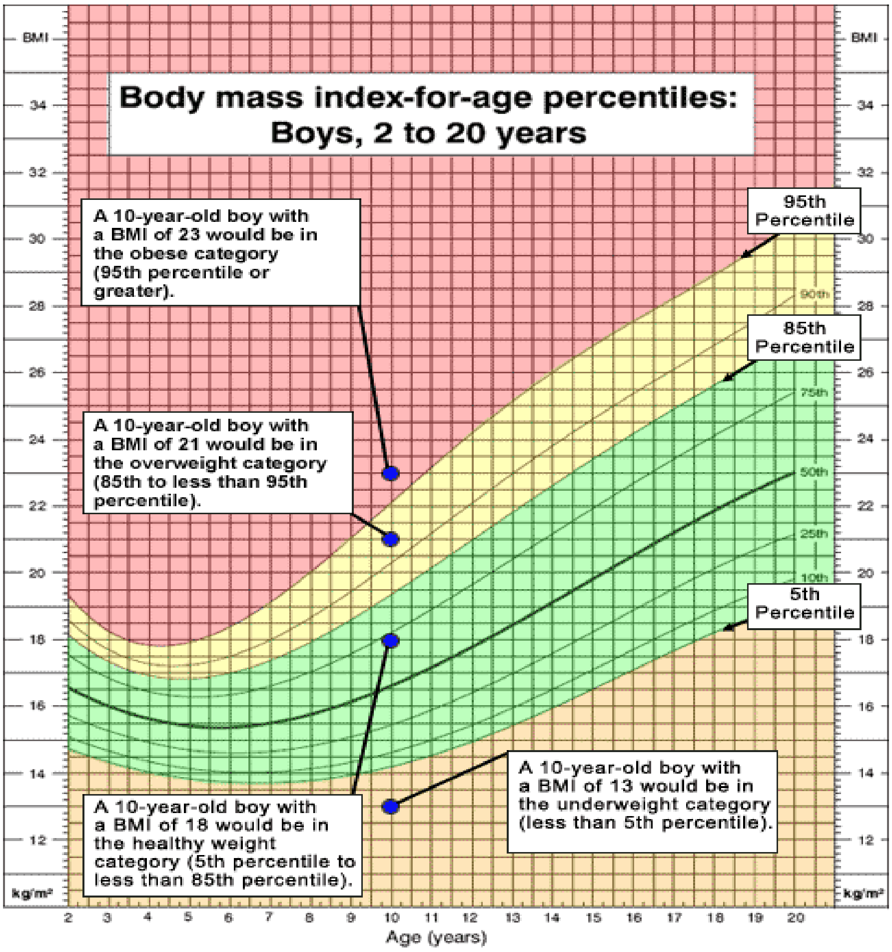

Figure 2.1: CDC BMI percentiles (Boys). The above example explains how some sample BMI numbers would be interpreted for a ten year old boy (CDC, 2014)

The WHO (1995) defines overweight and obesity as BMI values greater than 1 and 2 standard deviations from the mean of the reference population, respectively. The reference population used for the WHO cut-points was drawn from a combination of (i) the 1977 National Center for Health Statistics/WHO Growth reference (1-24 years) (WHO 1995) and (ii) data from pre-school children under the age of 5 taken from the WHO Child Growth Standards. The International Obesity Task Force cut-points for children aged 2-18 years are based on representative data from the United States, Great Britain, Brazil, China, Holland

and Singapore and are linked with the IOTF's adult BMI cut-point values for overweight (i.e. 25 kg/ m2) and obesity (i.e. 30 kg/m^2) (Cole & Lobstein 2012).

Findings from studies that have used different cut-points cannot accurately be compared. O'Neill *et al*. (2007), estimated the prevalence of overweight and obesity in 5-12 year old Irish children (N=596) using IOTF (Cole et al. 2000), CDC (Kuczmarski 2000) and British BMI cut-points 1990 (Cole *et al*. 1995), found the prevalence of overweight ranged from 10.5-15.3% among boys and 11.6-19.6% among girls. Moreover, the prevalence of obesity ranged from 4.1-9.2% among boys and 9.3-14.3% among girls, depending on what cut-points were used (Deurenberg, Yap, & Van-Staveren, 1998; Deurenberg, 2001; Ellis, 1997; Reilly, 2002). As no age and sex specific BMI cut-points have been developed from an Irish reference population, O'Neill *et al*. (2007) suggest that the British 1990 cut-points of Cole *et al*. (1995) may be the most appropriate for use among Irish children. However, despite these suggestions, the IOTF cut-points have been widely used in previous studies to determine the BMI-based weight status of Irish youth and so perhaps it may be more appropriate to use the IOTF cut-points to allow comparisons to be made between these studies and also to identify trends in the data.

2.2.3 Measuring Mass

When measuring mass within youth populations, maturational changes as they grow must be taken into consideration (Krebs *et al*. 2007). Hence, developing one simple index of measurement for mass is a complex process. Further to this, the current lack of agreement makes comparisons between studies difficult to conduct. However, Livingston, (2001) states that for population screening, anthropometric measures such as skinfold measurements and BMI (weight kg/ height m2), remain the most feasible and practical methods of measuring mass. However, Cooper (2013) identifies a limitation with BMI stating that BMI as a measure of mass, is a weaker marker of health as it does not differentiate between lean and fat body mass.

The main advantages of the BMI measure are that it is quick, compatible for testing large groups, and non-invasive method used as an index of relative adiposity. BMI is limited in that it may not be a sensitive measure of adiposity in people of extreme sizes (e.g. very short or tall individuals or those with an unusual distribution of body fat). A further limitation to BMI is that it cannot distinguish between fat and fat-free mass, and thus often incorrectly categorises individuals with large fat-free masse**s** (McCarthy & Ashwell 2006)**.**

2.2.4 Waist Circumference

Waist circumference to height ratio (WHtR) is an alternative way of measuring body mass. This is a measure of abdominal adiposity (Ashwell *et al.* 1996; Roriz *et al*. 2014). The WHtR is a measure of the distribution of body fat (Savva *et al*. 2000). Higher values of WHtR indicate higher risk of obesity-related cardiovascular diseases; it is correlated with abdominal obesity (Ashwell *et al*. 1996). It should be noted that a number of different protocols have been used to measure WC (Mason & Katzmarzyk, 2009; Sant'Anna et al. 2009). A limitation of WC is that different authors have different methodological protocols to measure this variable. This results in difficulty comparing research studies. In a study by Coppinger *et al*. (2016), WC was measured as the smallest circumference around the abdominal region between the lower costal (10^{th} rib) border and the top of the iliac crest. In contrast, Brambilla *et al*. (2013) reported that WHtR (with WC at the highest point of the iliac crest) is a better predictor of body fat percentage, trunk fat percentage and fat mass index measured using Dual Energy X-Ray Absorptiometry (DXA) (which uses a very small dose of ionizing radiation to produce pictures of the inside of the body to measure bone, muscle and adipose density) than both WC and BMI among children. A study by Swainson *et al*. (2017) supports the methods utilised by Coppinger *et al*. (2016) as the best predictor of measuring total body fat.

The use of WHtR as a measure of adiposity has been encouraged for children as WC and height are simple and cheap to measure, with results highly reproducible given the ease at which the bony landmarks required for measurement can be located (McCarthy & Ashwell, 2006).

2.2.5 Negative Health Consequences Associated with Overweight and Obese Children

There is strong evidence that indicates childhood obesity is strongly associated with chronic disease (e.g. asthma, tooth decay and so on.) (Wing *et al*. 2003; Goran *et al.* 2003; Ford *et al*. 2005), cardiovascular ill-health (e.g., high blood pressure) (Freedman *et al.* 2008), and mental health risk factors (e.g. low self-esteem) (Griffiths *et al*. 2010; Singh *et al*. 2014). The impact of overweight and obesity during childhood may result in lifelong health implications (e.g., diabetes, cardiovascular disease hypertension and so on.), which has been found to manifest into lifetime morbidity and subsequently premature mortality (Kones, 2011; Ruiz *et al*. 2009; Trasande *et al*. 2009). Many chronic diseases that become clinical manifest during adulthood but are influenced by lifestyle habits established during the childhood and adolescent years (Faigenbaum *et al*. 2012). This suggests that the promotion of healthy habits early in life may prevent the development of such risk factors and unintended pathological processes later in life.

2.2.6 Obesity Trends among Children

Global age-standardised rates of obesity have increased from 0.7% in 1975 to 5.6% in 2016 in girls, and from 0.9% in 1975 to 7.8% in 2016 in boys (WHO, 2017). Further to this, it has been reported that the number of overweight/obese infants and young children (aged 0 to 5 years) increased from 32 million globally in 1990 to 44 million by 2012 (WHO, 2014). If such trends continue, the WHO estimates that the number of overweight or obese children will increase to 70 million by 2025 (WHO, 2014). Recently it has been found that in total, 124 million children and adolescents around the world had a BMI that categorised them as obese. A further 213 million fell into the "overweight" range (Amini *et al.* 2015).

2.2.7 Levels of Obesity among Irish Children

In 2009 it was stated that the number of obese Irish children was set to increase annually by 10,000 (Layte and McCrory 2011). Bell-Serrat, (2017) states that the prevalence of obesity is reaching a plateau among Irish children. However, Keane *et al*. (2014) state that the plateau is unacceptably high. The longitudinal Growing Up in Ireland study confirmed that 30% and 22% of 9-year old girls and boys respectively are overweight (ESRI, 2016).

2.2.8 Trends of Obesity among Irish Children

Since 1990, in Ireland, trends are showing a two-fold decrease in the number of children aged between 8-12 years being categorised as having a normal body mass and an increase in those being categorised as overweight or obese over a 15 year period (1990 -2005) (O'Neill *et al.* 2006). Furthermore, a systematic review of trends and prevalence found that overweight/obesity from 16 Irish studies from 2002 – 2012 found a slight decrease in obesity rates throughout (Keane *et al*. 2014). However, the author stresses caution when interpreting the results, and states the current plateau is still at a worryingly high level of overweight/obesity amongst Irish children (Keane *et al*. 2014).

2.2.9 Financial Costs of Obesity in Ireland

Further to negative health outcomes and reduced quality of life, obesity poses a considerable economic burden on the economy and health care systems (Withrow *et al*. 2011). It has been reported that individuals with obesity have medical costs about 30% higher than people with normal weight (Withrow *et al.* 2011).

In Ireland, the Department of Health, (2013) state that obesity has clinical, social and financial challenges associated with it that could have a detrimental legacy lasting decades. O'Sullivan *et al*. (2005) suggest that its cost can be broken into direct (preventative, diagnostic and medical treatments) and indirect (loss of life, pain, loss of independence and loss of leisure time) factors. The toll of such factors is borne by the individuals, their families, the health services and society as a whole.

In 2009, it was estimated that the overall economic cost of obesity (both childhood and adulthood) was €1.13 billion to the economy (Safe food 2012). This report also outlined that the treatment for overweight and obesity combined represented 2.7% of total health expenditures for Ireland.

2.3 Physical Activity

2.3.1 Definition of Physical Activity

Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure (Ortega *et al.* 2007). This energy expenditure can be measured in kilocalories (kcal), which is the amount of energy/kcal required to accomplish an activity. The total amount of caloric expenditure associated with PA is determined by the amount of muscle mass producing bodily movements and the intensity, duration, and frequency of muscular contractions (Taylor *et al*. 1978). Caspersen *et al*. (1985) suggest that PA in daily life can be categorized into occupational, sports, conditioning, household, or other activities. They further suggest that everyone performs PA in order to sustain life; however, the amount is largely subject to what the individual is exposed to in daily life and hence may vary considerably from person to person as well as for a given person over time (Caspersen *et al*. 1985). The authors differentiate physical activity from exercise, by stating that exercise is a subset of PA, which is planned, structured, and repetitive and have as a final or an intermediate objective the improvement or maintenance of PA (Caspersen *et al*. 1985).

2.3.2 Classification of Physical Activity

Physical activity can be categorised by intensities (WHO, 2010). Intensity refers to the rate at which the activity is being performed or the magnitude of the effort required to perform an activity or exercise which is categorised by metabolic equivalents (MET). MET, is a physiological measure expressing the energy cost of physical activities and is defined as the ratio of metabolic rate (and therefore the rate of energy consumption) during a specific PA (WHO, 2010). PA is typically classified as light moderate or vigorous intensity activity. Examples of activities which can be classified as moderate and vigorous are provided in Table 2 (Webber 2014).

Table 2.2: Examples of moderate to vigorous activity. Metabolic Equivalents (MET) is the ratio of a person's working metabolic rate relative to their resting metabolic rate (Webber, 2014)

Moderate-Intensity Physical Activity (Approximately 3 – 6 MET's) Requires a moderate amount of effort and noticeably accelerates the heart rate.	**Vigorous-Intensity Physical Activity (Approximately >6 Mets)** Requires a large amount of effort and causes rapid breathing and a substantial increase in heart rate.
Examples of moderate intensity exercise include:	Examples of vigorous intensity exercise include:
• Brisk walking	• Running
• Dancing	• Walking/climbing briskly up a hill
• Gardening	• Fast cycling
• Housework and domestic chores	• Aerobics
• Traditional hunting and gathering	• Fast swimming
• Active involvement in games and sports with children / walking domestic animals	• Competitive sports and games (e.g. Traditional Games, Football, Volleyball, Hockey, Basketball)
• General building tasks (e.g. roofing, thatching, painting)	• Heavy shovelling or digging
• Carrying/moving moderate loads (<20kg)	• Carrying/moving heavy loads (>20kg)

Physical inactivity is said to be the fourth leading cause of mortality (Kohl *et al.* 2012). To combat this, it is recommended that children aged 5-17 years engage in at least 60 minutes of moderate to vigorous physical activity (MVPA) every day (Healthy Ireland, 2016; WHO, 2017). It is further recommended that most of this exercise should be aerobic and of a vigorous nature, conducted in conjunction with muscle and bone building exercises (WHO, 2017). However, Barnett *et al*. (2015) refute this by stating the majority of youth exercise should be focused on the acquisition of optimising technical movement patterns (FMS) rather than focusing on aerobic fitness.

2.3.3 Measuring Physical Activity of Children

Measuring habitual PA patterns in children is challenging with methodological difficulties due to the sporadic nature of their activity (Bailey *et al*. 1995). Bailey *et al*. (1995) also suggest that children engage in very short bursts of intense PA interspersed with varying levels of low to moderate activity. Livingston *et al*. (2013) found that children tend to have more multi-dimensional patterns than adults, which heightens the complexity of measuring their activity.

Techniques for measuring PA can be classified as either objective (e.g. heart rate monitors) or subjective (self-reported) (Livingstone *et al*. 2003). The most commonly used method in epidemiological studies is objective measures (Trost *et al.* 2002). While self-reported tools such as questionnaires PA logbooks are used to capture the perceptions of what PA has been engaged in, objective measures assess the actual quantity (and often the intensity) of the activity (Kang *et al*. 2016). The major difficulty with self-reported tools include item interpretation, recall and social desirability (Loprinzi & Cardinal, 2011). Instrumental movement devices such as pedometers and accelerometers, while still having their own limitations, can avoid the problems associated with self-report and have become more commonly used in recent times (Cain *et al*. 2013). Pedometers estimate the number of steps taken but are limited in their inability to measure intensity of activity (Goran, 1998). Accelerometers, on the other hand, measure the frequency and magnitude of the body's acceleration during movement and can be used to estimate PA intensity. As a result, accelerometers have become one of the measures of choice for assessing children's PA (Loprinzi & Cardinal, 2011).

Further to this, and relative to the objective measures, Riddoch *et al.* (2004) suggest that accelerometers are the most efficient method for recording and providing a valid analysis of children's PA due to the aforementioned sporadic nature of children's movement.

Accelerometers measure bodily movements using piezoelectrical acceleration sensors which contain a piezoelectrical element and seismic mass housed in an enclosure. When the sensor undergoes acceleration, the seismic mass causes the piezoelectrical element to experience deformation. These changes cause a variable output voltage to be generated which is proportional to the acceleration applied; these values are stored for analysis (Freedson *et al*. 1998).

Accelerometers are one of the most widely used tools in PA research, in particular, research relative to children's PA (Trost *et al.* 2005). They are relatively small, lightweight monitors (typically worn at the hip) that record movement (Loprinzi & Cardinal 2011; Pate 1993). Activity counts per time-interval or epoch refer to the amount of time recorded, summed and stored (Sherar *et al*. 2011). Epoch length has been shown to influence the quantification of children's PA in terms of the duration of time spent in various intensities (Aibar & Chanal, 2015; Banda *et al*. 2016). Due to the sporadic nature of children's activity, which may only last for a few seconds (Ward *et al.* 2005), long epochs (e.g. > 1 min) lack relevance to children's movement patterns and may underestimate time spent at higher intensities (Banda *et al*. 2016). A study by Vale *et al*. (2009) which compared a 5-second epoch and a 60-second epoch amongst 2-5 year old children (N=59), reported a significant (62%) difference in MVPA between the 5-second epoch (26.46 ± 9.64 minutes in MVPA) and the 60 second epoch (10.05 ± 8.43 minutes) ($p<0.01$). Further to this, McClain *et al*. (2008) found that a 5-second epoch was the most accurate for measuring children's activity when compared to longer epochs of 10, 15, 20 and 30 seconds. Time in minutes per day of PA and the various time spent in the different intensity zones is recorded and calculated based on intensity cut-points (Banda *et al*. 2016).

Actigraph accelerometers are widely used in the field of research, Table 2.3 highlights that the five most commonly used ActiGraph (non-invasive method of monitoring human rest/activity cycles) cut-points developed specifically for use among youth are those of Evenson *et al*. (2008), Freedson *et al*. (2005), Mattocks *et al*. (2007), Puyau *et al*. (2002) and Treuth *et al*. (2004). Such recordings, allow the researcher to quantify the duration, frequency, intensity and activity performed by the wearer using counts per minute (cpm) (Woods *et al*. 2010). The cut-points correspond to predefined intensity levels developed by Loprinzi and Cardinal, (2011). In a comparative study of 5 commonly used cut-points, Trost *et al*. (2011) used VO2 max as the criteria measure during 12 activities (Trost *et al*. 2011). Cut-points developed by Evenson *et al*. (2008) were found to be the most accurate in classifying PA across all intensities of activity among children (Trost *et al*. 2011).

Two commonly used models of the accelerometer are the ActiGraph GT3X and the ActiGraph GT3X+. Both of these devices are tri-axial (i.e. measure activity in the vertical, medio-lateral and antero-posterior axes), digitise acceleration output by a 12-bit analogue-to-digital converter and store this data for subsequent analysis. Triaxial Accelerometers (such as those designed by Actigraph) consist of three orthogonal accelerometer units and provide an output for each plane as well as a composite measure (Rowlands 2007).

Table 2.3: Physical activity cut-points for children (Evenson *et al*. 2018)

Cut-points	LPA (cpm)	MPA(cpm)	VPA (cpm)
Evenson *et al*. (2008)	101-2295	2296-4011	>4012
Freedson *et al*. (2005)	150-499	500-3999	>4000
Mattocks *et al*. (2007)	101-3580	3581-6129	>6130
Puyau et al. (2002)	800-3199	3200-8199	>8200
Treuth et al. (2004)	100-2999	3000-5200	>5201

cpm=counts per minute, **LPA**=light physical activity, **MPA**=moderate physical activity, **VPA**=vigorous physical activity

ActiGraph accelerometers have previously been used in large studies such as the European Heart Study (Riddoch *et al.* 2004) and the US National Health and Nutrition Examination Survey (Troiano *et al*. 2008). However, there is a lack of standardisation regarding accelerometer usage, which outcome measures are used and how outcome measures are interpreted (Rowlands and Eston 2007). This lack of agreement limits the comparability between studies and the accumulation of knowledge relating to children's activity patterns (Rowlands and Eston 2007).

There are many challenges/disadvantages associated with ActiGraph accelerometers and accelerometers in general, with Sirard and Slater, (2009) stating that adherence issues surface when children forget to wear the administered accelerometer. Furthermore, another disadvantage associated with ActiGraph accelerometers is that they cannot be worn in in water – therefore aquatic activities cannot be recorded (Troutman *et al*. 1999). It is advised during a field-based accelerometer research project, that children wear the monitors during all waking hours (except when bathing or swimming) over a set number of days. Belton *et al*. (2013) state that one of the greatest difficulties is getting children to comply with accelerometer based research conditions.

To get a valid and clear representation of children's habitual PA while at the same time limiting the burden to the participant the number of days of monitoring needs to be considered (Loprinzi & Cardinal 2011). It has been suggested that 7 days of monitoring, including week and weekend days, can provide reliable estimates of usual PA among children (R= 0.86-0.87), (Trost *et al*. 2000). This 7-day recommendation emerged from a population-based sample which included 7-10-year-old children (N=92) from the USA and also revealed that 4-5 days of monitoring is necessary to achieve a reliability of 0.80 (Trost *et al.* 2000).

If an accelerometer is not being worn, data will be recorded as strings of consecutive zero counts per minute which indicate that the accelerometer has been removed, this is a very similar recording to SB. To distinguish between non-wear time and SB Cain *et al*. (2013), state that 10 and 20 minutes periods of consecutive zeros were the most commonly applied to 'non-wear time' in PA research among youth.

2.3.4 Physical Activity and Health

Physical activity is associated with many physical, psychological and mental health benefits among children (Janssen & LeBlanc, 2010; Public Health England, 2017; Strong *et al*. 2005) including enhanced cardiovascular health, CRF, academic performance (Haapala *et al*. 2016). It is also inversely related to adiposity (Ekelund *et al*. 2004; Patel & Talati, 2016; Rennie *et al*. 2005; Ruiz, Rizzo, *et al*. 2006), anxiety and depression. Janssen and LeBlanc (2010) who reviewed the relationship between PA and health, reported that the more PA one participates in, the greater the health benefits, and highlighted that aerobic-based activity was associated with the greatest health benefits (with the exception of bone health for which weight bearing activities were optimal).

2.3.5 Levels of Physical Activity

Research has reported that PA levels are declining worldwide, with declines of 32.2% and 20.2% being observed in the United States and the United Kingdom between the 1960's and 2000 (Ng and Popkin 2012). While such data trends are derived from adult populations, similar trends have been observed in youth populations (Fuller *et al*. 2016; Woods *et al.* 2010).

The PA Report Card is a method of collating and analysing data relative to children's activity levels in a particular country and allows for comparisons to be made between regions (Gray *et al*. 2014). As seen in fig 3, it is graded on a scale of A – F. In 2014, in a cross-border initiative involving both the Republic of Ireland and Northern Ireland, Harrington *et al*. (2014) joined 14 other countries in launching their first Report Card. Overall, in 2014 Ireland received a 'D minus' in its first report card. In 2016, following a similar analysis, this was upgraded to a 'D' (Harrington *et al*. 2016), which shows slight improvement but stills suggest that large improvements are required. Further to this, The Growing up in Ireland Study also found that only 51% of 9-year olds exercise greater than four times a week, with girls having significantly lower rates of exercise than boys (ESRI, 2016).

Figure 2.2: Physical Activity Report Cards, International Grading System

These findings are in agreement with the Health Behaviours in School Children reports 2006 and 2010 which revealed that over half of Irish primary school children did not achieve the recommended levels of daily PA (Nic Gabhainn et al. 2007, Kelly et al. 2012). In conjunction, Nic Gabhainn et al. (2007) reported lower levels of PA among older adolescents (15-17 years) compared to younger children (10-11 years), indicating a drop off in PA with age.

There is limited research that has collected valid and reliable accelerometer-based data among Irish children. One study in Cork that used accelerometers to collect data among a cohort of children found that only 22% of 8-11-year-olds (N=830) met the PA guidelines (Keane *et al.* 2014). Further to this, O'Leary *et al*. (2018) found that participants achieving the 60 minute MVPA guideline (Department of Health and Children & Health Services Executive, 2009) increased significantly for both age cohorts and groups over the intervention period, with the exception of the 6-year-old intervention group (53.5 to 62.2%, p=0.219). In subjective reports, Layte and McCrory (2011) state that one in four children (25%) engaged in 60 minutes of (MVPA) for each of the last 7 seven days, while 4% of children did not meet this criterion on any of the last 7 days. In this research subjects were 9-year-old children who were asked to report on their participation in PA from the previous 7 days (Layte and McCrory 2011).

2.3.6 Physical Activity Recommendations

Global health recommendations state that children and adolescents should accumulate 60 minutes or more of MVPA daily (Department of Health and Children, 2009). Contrary to this, older recommendations such as the American College of Sports Medicine (ACSM) recommended that children and adolescents should engage 20 to 30 minutes of vigorous daily PA (Simons-Morton *et al,* 1988). Further to this, Brockman *et al.* (2009) recommend 15–20 min of daily vigorous PA to reduce sedentary time and in turn help fight youth overweight and obesity. Interestingly, Australian and Canadian authorities recommend young children (1-4 years) participate in PA of any intensity (light, moderate, vigorous) for 3 hours per day, building up to 60 minutes of moderate to vigorous exercise by 5 years (Cliff and Janssen, 2011, Tremblay *et al*. 2012). In addition to enhancing cardiorespiratory and musculoskeletal fitness, relevant studies state that regular PA has the potential to increase a child's emotional, social and cognitive well-being (Davis *et al*. 2011; Ortega *et al*. 2008).

2.3.7 Sedentary Behaviour

High levels of SB in developed countries have been reported, with research indicating that children spend two-thirds of waking hours sedentary (WHO, 2011). Further to this, Carson *et al*. (2011) found that almost 3,000 (50.8%) Canadian children and youth between 6-19-year-olds, spend 7 hours of waking in sedentary patterns. Similar findings were reported by The Canadian Health Measure Survey, accelerometer data from 1608 participants, 6-19-year-olds from March 2007- February 2009. Colley *et al*. (2011) through their analysis of this data found that Canadian children and youth spend an average of 8.6 hours per day, or 62% of their waking hours, being sedentary. Children aged between 6 -10 were reported spending 7.4 hours per day sedentary (Colley *et al*. 2011). Similar findings were reported in the U.S. where children and youth spend an average of 6-8 hours per day being sedentary (Matthews *et al*. 2004). All studies show an increase in time spent sedentary with age. Similar levels of SB were found in the UK, Steele *et al*. (2010) objectively measured levels of SB amongst 1568, and children aged 9-10 and found that children spent 7 hours per day sedentary.

Irish primary school children are presenting with similar results. The Children's Sports and Physical Activity Study (CSPPA)) found that Irish primary school children spend 6 hours in school-based SB and an additional 2.6 hours in after school SB, with homework found to account for 30 mins of SB per day (Woods *et al.* 2010). Furthermore, while 100% of primary school children met the 2-hour screen limit for one day a week it decreased dramatically to 30% for three days and 0% for seven days a week. Further to this, research from the WHO (2011) has shown that current levels of SB in children are consistently high in the developed world.

Similarly to measuring PA the development of accelerometers as an objective measure has enabled researchers to measure SB (Pate *et al*. 2008). The use of cut-points to determine SB is widely used in SB research to date (Owen *et al.* 2010) with the majority using thresholds of less than 50 or 100 counts per minute (Pate *et al.* 2008). However, Ward *et al*. (2005) recommended further research in order to determine the best cut-points for SB among children and adults. Currently, no universally agreed cut-points are in use to classify sedentary, light and MVPA. This results in difficulties in comparing accelerometer based research (Kim *et al*. 2012). A further limitation to using accelerometers to measure SB is their inability to detect changing posture, therefore difficulties occur when determining between standing and sitting.

2.4 Cardiorespiratory Fitness

2.4.1 Cardiorespiratory Fitness Definition

Cardiorespiratory fitness (CRF) is a health-related component of physical fitness and has been widely defined. The American College of Sports Medicine, (1998) describe it as the ability of the circulatory, respiratory, and muscular systems to supply oxygen during sustained PA. While Hayes *et a.l* (2013) state that CRF refers to the ability to perform large muscle, dynamic, moderate to high intensity, PA for a prolonged period, and depends on the integrity of the cardiovascular, respiratory, and skeletal muscle systems. The most universally used definition is that of Armstrong & Welsman, (2007) where it is stated that it is the ability to transport oxygen to muscles and use this oxygen to generate energy during exercise. Cardiorespiratory fitness is usually expressed in METs or maximal oxygen uptake (VO_2 max), which essentially is the maximal oxygen consumption (VO_2max/VO_2peak) or the highest rate at which one can consume oxygen. Cardiorespiratory fitness is not only a sensitive and reliable measure of habitual PA (Church *et al*. 2007; Jackson *et al.* 2009; Wang *et al*. 2010), but also a relatively low-cost and useful health indicator for patients in clinical practice (Gibbons *et al.* 2002; Gulati *et al.* 2005; Myers *et al*. 2002). Further to this, CRF is an important marker of health among children (Mesa *et al*. 2006; Ruiz, Ortega, *et al*. 2006), so much so that it has been suggested that CRF testing should be included in health monitoring systems at a very early age (Mesa *et al.* 2006; Ruiz, Ortega, *et al.* 2006; Sandercock, Voss, M, 2010)**.**

2.4.2 Measuring Cardiorespiratory Fitness

The most widely used indicator of CRF is the volume of oxygen that is consumed at maximal physical exertion (V02max). Cardiorespiratory fitness can be objectively and accurately measured through laboratory tests such as treadmill run or cycle tests to exhaustion, however, due to a number of disadvantages including high cost, the necessity of sophisticated and expensive equipment, availability of trained technicians and time constraints (Hamlin *et al*. 2014), these tests are impractical in population-based field studies and for applied use (Hamlin *et al*. 2014). For studies such as this, field tests that are commonly used in this regard include the 20-metre shuttle run test, the Progressive Aerobic Cardiovascular Endurance Run (PACER) and the 550m walk/run test. Hamlin *et al.* (2014) conducted a study to determine the relationship between two field tests of CRF (20 m Maximal Multistage Shuttle Run [20-MST], 550 m distance run [550-m]) and direct measurement of VO2max after adjustment for body fatness and maturity levels. Fifty-three participants (25 boys, 28 girls, age 10.6 ± 1.2 y, mean ± SD) performed in random order, the 20-MST and 550-m run followed by a progressive treadmill test to exhaustion. Pearson correlation coefficient analysis revealed that the participants' performance in the 20-MST and 550-m run were highly correlated to VO2max. Hamlin *et al*. (2014) concluded that both the 20-MST and the 550-m distance run are valid field tests of CRF in 8– 13-year-old children.

The 20-metre shuttle run test (20m SRT) is one of the most common field tests of CRF(Armstrong & Welsman, 2007; Batista *et al*. 2017). Subjects run back and forth on a 20 m course and must touch the 20 m line, at the same time a sound signal is emitted from a pre-recorded tape. The frequency of the sound signals is increased 0.5 km h-1 each minute from a starting speed of 8.5 km h-1. When the subject can no longer follow the pace, the last stage number announced is used to predict maximal oxygen uptake (VO2max) (Léger & Lambert, 1982). Bearing in mind, that technical efficiency of running is relative to age and that the two-minute stages were "boring" for children (Astrand, 1952; Daniels *et al.* 1978; Davies, 1980; MacDougall *et al*. 1983; Pate, 1981; Silverman & Anderson, 1972), a 1 minute staged version was developed (Léger *et al.* 1984). This newly designed version which begins at 8.5 km/hr and increases by 0.5 km/hr every minute, has been found to be a valid and reliable assessment of CRF (Hamlin *et al*. 2014; Léger *et al.* 1988; van Mechelen *et al*. 1986). However, Astrand, (1952) suggests that the 20 m shuttle test is not an appropriate measure for children to the over-technical nature of the test.

The 550m walk/run test is commonly used to measure the CRF of children and adolescents (Hamlin *et al*. 2014). It requires subjects to complete a distance of 550m in the shortest time possible. Advantages of anaerobic test like the 550m walk/run include the ability to test a large number of children over a short time period with little equipment. It should be cautioned that results are likely to be influenced by motivation and environmental conditions such as wind, rain, temperature and conditions underfoot and so on. (Hamlin *et al*. 2014)**.**

2.4.3 Cardiorespiratory Fitness and Health

Cardiovascular disease (CVD) is the leading cause of death worldwide, accounting for more than 17.92 million deaths in 2015 alone (Roth *et al*. 2017). Such findings highlight the underlying need for interventions that promote heart health and oxygen uptake, thereby reducing the risk of overall chronic disease, and healthcare costs. Research has also found that high CRF has a protective effect on CVD risk factors among children (Anderssen *et al.* 2007; Eiberg *et al*. 2005; Eisenmann *et al*. 2005; Hurtig-Wennlöf *et al*. 2007; Twisk, Kemper, & van Mechelen 2000). Andersen *et al*. (2007) found that independent of country, age and sex, CRF has a strong negative association with CVD risk (i.e. the presence of more than one CVD risk factor) among children. International research among 9-year-olds found that those with low CRF (in the lowest quartile) were 13.2 times more likely to have a risk of CVD than those with high CRF(in the highest quartile) (Anderssen *et al*. 2007). Measures of CRF correlate negatively with BMI in children and it has been proposed that declining CRF in children may be mediated by increases in adiposity (Tomkins *et al*. 2003). More recently, the WHO, (2017) suggested that CVD is the most common non-communicable disease among children. Further to this, Ischemic heart disease was the leading cause of CVD globally in 2015, as well as in each world region, followed by stroke (Roth *et al.* 2017).

2.4.4 Cardiorespiratory Fitness Trends

It has been found by numerous researchers that CRF among children worldwide is declining (Tomkinson *et al.* 2003; Tomkinson & Olds 2007; Tremblay *et al*. 2010, Sandercock *et al*. 2010). Furthermore, *et al.* (2007) found that children's CRF is declining by 4.3% per decade globally. A meta-analysis compared the results of 55 reports international reports of the performance of children and adolescents aged 6–19 years who have used the 20m shuttle run test (20mSRT). All data were collected in the period 1981–2000 (Tomkins *et al*. 2003). Results from this meta-analysis suggest a continuous decline in the 20m shuttle run test performance of children and adolescents over the last 20 years. Further to this, Tomkins and Olde, (2007), in more recent years, found that there is a rapid decline in cardiorespiratory performance. The study took place from 1953 -2003 with 27 countries included, it was found that there was a global decline in CRF of 0.47% per annum among children, with declines of 0.63% per year observed in the latter part of the last century (the 1990s) (Tomkinson & Olds 2007).

In Ireland, O'Leary *et al*. (2018) found that a positive relationship between CRF, waist to height ratio (WHtR) and school socioeconomic status (socioeconomic status (SES) is an economic and sociological total measure of a person's economic and social position in relation to others, based on income, education, and occupation (ERSI 2018)) among Irish children has been shown. Among 6-year-old participants, it was found that as WHtR increases by 1 unit, run-time (CRF) increases by 8.24 units ($p<0.05$), as school status changes from middle/high to low socioeconomic status (O'Leary *et al.* 2018).

2.5 Fundamental Movement Skills

2.5.1 Fundamental Movement Skills (FMS) Definition

Fundamental movement skills (FMS) are basic observable patterns of movement upon which more complex, sport specific skills are based (Clark & Metcalf, 2002; Gallahue & Ozmun, 2006; Stodden *et al.* 2008). The Fundamental movement skills (FMS) (n=12) are divided into two subcategories, Locomotor skills (n=6) and Object control skills (n=6). Locomotor skills are those which involve the movement of the body from one place to another and include the run, jump, leap, hop, gallop and the slide. Object control skills are those which involve the manipulation of an object and include the catch, throw, roll, dribble, kick and strike.

2.5.2 The Importance of FMS

FMS have been viewed as the building blocks for sport-specific movement patterns, Deli *et al.* (2006) state that it be should be the focus of physical development programs for children from early childhood to develop gross motor skills. Previous research has indicated that FMS development is essential to ensure that correct movement patterns are mastered in safe and fun environments to ensure the efficient and effective performance of more complex sports movements at a later stage (Oliver *et al*. 2011). FMS development can facilitate greater participation in sporting and physical activities. For instance, by (i) directly transferring to a sports skill (e.g. the overhand throw transferring to the badminton overhead clear and javelin throw) (O'Keeffe *et al*. 2007), and (ii) underlying attributes of one skill e.g. dynamic balance, inter- and intra-muscular coordination, transferring to other skills required for sporting/physical activities e.g. hand-eye coordination developed during catching may facilitate the striking or control of a ball in hockey (Barnett, Stodden, *et al*. 2016). Further to this, Lloyd *et al*. (2012) state in the National Strength and Conditioning Association's youth physical development model that emphasis from physical education teachers, paediatric fitness specialists, and strength and conditioning coaches who train children should be placed on FMS development up to the onset of puberty, and subsequently, focus is given to sport specific skills (SSS) from adolescence onwards.

2.5.3 Measuring FMS

There is no gold standard for the assessment of FMS and a variety of measurement tools have been developed (Cools *et al.* 2009). FMS scoring tools vary in terms of whether they are a product or process-oriented tools (Cools *et al*. 2009). They may also vary in relation to how many skills are being evaluated, testing administration and scoring protocols (Cools *et al.* 2009). A product-oriented tool includes the Movement Assessment Battery for Children, 2nd edition (MABC-2) (Henderson *et al*. 2007). Examples of process-oriented tools include the Test of Gross Motor Development (TGMD) (Ulrich, 1985), Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000), Test of Gross Motor Development-3 (TGMD-3) (Ulrich, 2013), Get Skilled: Get Active (NSW Department of Education and Training, 2000), the Children's Activity and Movement in Preschool Study Motor Skills Protocol (CHAMPS) (Williams *et al*. 2009) and the 'FMS: A Manual for Classroom Teachers' assessment tool (Department of Education Victoria, 1996). Product-oriented FMS tools measure the outcome of the movement being assessed (e.g. the speed, distance, height, number of successful attempts) (Hands, 2002). Product-oriented assessment tools are reliable owing to their objective nature (Spray, 1987). However, they do not provide information regarding the technical movement pattern performed to produce the end result. Advantages associated with such tools is they can test large groups over a relatively short period of time and do not require the administrator to have a deep understanding of FMS (Hands & McIntyre 2015)**.**

Process-oriented FMS assessment tools involve observation and are concerned with the mechanical execution used to perform the skills (Ulrich 2013). Many process-oriented assessment tools involve the use of predefined performance criteria checklists (based on an expert performance of the skill) in which scores are awarded based on the presence or absence of such criteria across a number of test trials (e.g. a score of 1 is awarded if the criterion is observed and a score of 0 is awarded it is not). Benefits associated with this type of tool is that they provide information relating to the pattern of movement used to perform the skill and can identify specific components of a skill that requires practice. However, it should be noted that analysis when using such tools are subjective, which often makes it difficult to compare results between assessors.

The Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000), a revision of the original Test of Gross Motor Development (Ulrich 1985), is a criterion based process-oriented assessment tool. The TGMD-2 assesses 12 FMS; 6 locomotor (run, leap, hop, gallop, slide, horizontal jump) and 6 object-control (catch, overarm throw, underhand roll, kick, 2-handed strike and stationary dribble) skills. The test has been found to be valid and reliable for children aged 3-10 years (Ulrich 2000). Reliability coefficients (Cronbach's alpha) for the subsets of the TGMD-2, for 3-10-year-old children, ranged from 0.76 to 0.92, (Ulrich, 2000).

2.5.4 FMS and Health

Enhancing FMS proficiency has the potential to facilitate greater levels of PA in childhood, adolescence and adulthood (Breuer & Wicker 2009). Research suggests that children who are not exposed to environments to enhance PA and motor skill proficiency (e.g., catching, kicking, and hopping and so on.) tend to be less active in adolescence and are at increased risk of a sedentary lifestyle adulthood (Barnett *et al.* 2008; Barnett *et al*. 2009; Stodden *et al.* 2009). Stodden *et al*. (2008) state that motor competence has a spiralling effect in which FMS proficiency (along with higher perceived competence, higher PA levels and greater fitness levels) can help promote a healthy and active lifestyle. Systematic reviews have reported positive associations between FMS and PA, fitness (Cattuzzo *et al*. 2016; Lubans *et al*. and healthy weight status (Lubans *et al*. 2010). Research has also reported positive associations between FMS and perceived competence (LeGear *et al*. 2012), academic performance (Haapala, 2013) and enjoyment of PA (Salmon *et al*. 2008). Further to this, Cliff *et al*. (2012) state that the eventual decline and disinterest in sport and physical activity is a contemporary corollary of low motor skill proficiency, which starts even earlier in overweight children who perceive PA to be "discomforting" or "boring" (Lopes *et al*. 2012). This data indicates that an increase in body fat and low movement efficiency impedes the child's perceived confidence to meet PA guidelines (fig 2.3) (Logan *et al*. 2012).

Figure 2.3: *The adverse events that may result from lack of Fundamental Movement Skill development during childhood (Faigenbaum et al. 2012)*

2.5.5 Levels of FMS Worldwide

Recent studies indicate fewer FMS proficiency among the current generation of children when compared to their predecessors (Cliff *et al.* 2009; Spessato *et al*. 2013). In New-Zealand the FMS levels of 5-12 year old (N=701) children from 11 primary schools were assessed, it was found that in 10 of the 12 skills assessed less than 65% achieved mastery (exceptions being the run and slide). in agreement with this, Barnett *et al*. (2010) also reported less than 65% mastery (i.e. all components present/all but one component present) in all six skills assessed in their study (catch, kick, overhand throw, side gallop, vertical jump and hop) among 10 year old Australian children (N=276). Lower mastery levels were reported by

Bryant *et al.* (2014) among 6-11-year-old British children on assessment of their FMS using the Process Orient Checklist of the New South Wales 'Move It, Groove It' (NSW Department of Health 2003). Eight FMS (the sprint run, side gallop, hop, kick, catch, overarm throw, vertical jump and static balance) were assessed among this cohort, results suggest mastery levels did not exceed 35% and ranged from 3.3% (in the sprint run) to 33.5% (in balance).

2.5.6 FMS and Irish Youth

Currently, limited research exists pertaining to FMS proficiency levels of Irish youth. However, In a Cork based study, Bolger *et al*. (2018) found that older children achieved higher performance scores than their younger counterparts in both locomotor and object-control subsets, independent of sex. Participants (N=203) in the study were senior infants (n=l02, mean age: 6.0 ± 0.4 years) and fourth class children (n=I0I, mean age: 9.9 ± 0.4 years) children from 3 primary schools in Cork City and County. This trend is reflective of many studies worldwide (Booth *et al*. 1999; Bryant *et al*. 2014; Mitchell *et al*. 2013; Spessato *et al*. 2013) where it is reported that FMS proficiency increases with age.

Breslin *et al*. (2012) measured FMS proficiency of 7-8-year-old children (N=177) in Northern Ireland. A total of 10 FMS were assessed using an adapted model of two previously existing FMS assessment tools; the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks 1978) and the Movement Assessment Battery for Children (Henderson & Sugden 1992). The standing broad jump, jump-half turn, overarm throw, kick, the trapping of a ball, the catching of a ball, balance on one foot and the log roll were all assessed. While the mean and standard deviation scores were reported, the level of proficiency of each of the skills could not be determined to owe to the omission of the possible score ranges and the use of a novel assessment tool.

2.6 School-Based Interventions

The preceding sections of this literature review provide analysis relating to FMS and health markers of children. Based on this information it has been recommended that targeted interventions are necessary to improve the health of children (Amini *et al.* 2015) and schools have been identified as an important setting for such interventions (Wang *et al*. 2015) especially for promoting healthier lifestyle behaviours (Centre for Disease Control Prevention 2017). Countries such as Denmark and Finland have used this strategy (adapting/introducing new school-based PA policies) in an attempt to increase PA levels and/or reduce overweight/obesity. For example, in Denmark, since the 2014 primary schools are now required to deliver 45 minutes of mandatory PA every day (European Commission & WHO 2015). In Finland, reformed national policies that require schools to provide compulsory health education and PE to children are among those believed to have contributed to the country's stabilising overweight/obesity levels (WHO 2015).

2.6.1 Schools as Settings for Interventions (Health Habits Formed)

Schools allow for continuous, intensive contact with a large number of children. In addition, schools provide children with the opportunity to learn and provide support for regular PA and healthy eating, which in turn has the potential of establishing lifelong healthy behaviour patterns (Centre for Disease Control and Prevention 2011). Irish primary school children spend most of their 5-6 hour school day engaged in sedentary activities (e.g. reading, writing, and so on.) and thus the school day has huge potential to become more physically active (Belton *et al.* 2016; van Stralen *et al*. 2014). Further to this, physical education provides children with the opportunity to not only engage in PA (Kobel *et al*. 2017; McKenzie, & Lounsbery 2009; Scheerder *et al*. 2008; Ward *et al*. 2007), but also to learn skills that will allow them to be active outside of school and in later life (Green, 2008; Mitchell *et al*. 2013; van Beurden *et al*. 2003).

Some school-based obesity prevention programmes relative to reducing BMI among children (Goldberg *et al*. 2013; Kamath *et al*. 2008) have reported positive findings. Findings from a meta-analysis support this finding (Sobol-Goldberg *et al*. 2013). The author concluded that newer studies tended to be longer, more comprehensive and included parental involvement which could explain the positive findings (Sobol-Goldberg *et al*. 2013). In a meta-analysis of 19 school-based programmes by Gonzales-Suarez *et al*. (2009), it was concluded that school-based programmes were generally effective in decreasing the prevalence of overweight or obesity. However, in 7 other studies, no significant change for BMI was found (Gonzalez-Suarez *et al*. 2009). As a possible explanation, the author noted the small number of studies and the minimal duration time of these studies (Gonzalez-Suarez *et al.* 2009). Similar to previous studies the authors recommended longer duration programmes incorporating both PA and healthy eating components to effectively reduce obesity (Gonzalez-Suarez *et al*. 2009).

2.6.2 Recommendations for School-Based Interventions

While primary schools have been highlighted as important settings for intervention, reviews that have examined the effectiveness of interventions aiming to improve PA and prevent/reduce overweight/obesity among children highlight that those that are successful tend to be multi-component in nature (Amini *et al*. 2015; Dobbins *et al*. 2009; Kriemler *et al.* 2011; Salmon *et al*. 2007) and should include both schools and families (Heitzler *et al*. 2006; Salmon *et al*. 2007). Salmon *et al*(2007), in a systematic review of 76 studies reported that multi-component interventions that focused on physical education and included PA breaks or family-based and community strategies were most effective. Similarly, Kriemler *et al*. (2011) outlined that multi-component school-based interventions that involved PA or a paediatric exercise specialist appeared to be effective for increasing PA among children. Research also indicates that longer interventions are more effective for the alteration of BMI than shorter interventions (Back Giuliano Ide *et al*. 2005; Dobbins *et al*. 2009; Kavey *et al*. 2006; Williams *et al*. 2002). Further to this, a systematic review by Tompsett *et al*. (2017) reported that health promotion interventions have little impact on BMI status among primary school children. Moreover, Lai *et al.* (2014) suggest other factors may influence BMI such as nutrition and home health-related behaviours. While the focus of this study was on the school environment greater efforts may be needed to target these elements of children's lives.

As previously mentioned, with children spending a large proportion of their waking hours in school, Project Energize (New Zealand) suggest that children should engage in at least 20 minutes of MVPA during the school day (Rush *et al*. 2012) while others have recommended that children should spend at least 30 minutes of their school day engaged in MVPA (Nettlefold *et al*. 2011; Pate *et al*. 2006). As it has been found that children spend more time in MVPA on PE days than non-PE days (Kobel *et al.* 2017), it is not surprising that other researchers suggest that daily PE classes may be effective for optimising health in childhood

(Kemper, 2000; Marshall & Bouffard, 1997) and positively affecting long-term PA habits (Trudeau *et al.* 1999). Positive findings from Jarani *et al*. (2016) and Bolger *et al*. (2018) found significant improvements among the intervention groups in FMS proficiency following a 5-6 month FMS based intervention. Further to this, Brambilla *et al*. (2013) found the weight to height ratio improved following a primary school intervention programme that focused on enhancing PA levels by exposing children to 30 -60 minutes of PA per day.

Furthermore, it has also been found that components for effective interventions should include: (i) the development of PA and FMS development concurrently (Dudley, Okely, Pearson, & Cotton, 2011), (ii) classroom activity breaks (Murtagh, Mulvihill, & Markey, 2013; Naylor & McKay, 2009), (iii) making classroom lessons physically active (Kohl, Moore, & Sutton, 2001), (iv) the integration of home-based activities that encourage PA (Waters *et al.* 2011; Wechsler *et al*. 2004) and (v) continuous PE professional development for school staff (Dudley *et al*. 2011; Lonsdale *et al*. 2012; Morgan *et al*. 2013; Waters *et al*. 2011; Wechsler *et al*. 2004).

2.6.3 Delivery of School-Based Interventions

Delivery of school-based health promotion interventions may vary from intervention to intervention. Initiatives with similar aims to this study have implemented health promotion interventions that involve an exercise specialist implementing the programme on a weekly basis (Bolger *et al.* 2018), others have used an exercise specialist who coordinates 6–12 schools in close geographical location (Rush *et al*. 2016). While others, provide annual PA workshops for teachers with further online resources through the Active School Flag for example (Ni Chróinín, Murtagh & Bowles 2017).The author has not found any evidence of school-based interventions using a step back approach such as the one used in this study.

The intervention of Bolger *et al*. (2018) was primarily delivered by the 'Energiser' (exercise specialist) in one school. The intervention was multi-component and consisted of (i) the delivery of FMS based lessons (ii) the dissemination of FMS posters and FMS homework manuals (iii) professional development workshops and resources, (iv) an FMS activity break initiative and (v) other PA promoting initiatives (e.g. 'Stride for 5', 'Kilometre Challenge', 'PE Student of the Week', 'Paper Rush' and 'Active Agents'). In addition, teachers were encouraged to engage children in a minimum of 20 minutes of MVPA during every school day (other than those on which the FMS lessons were held). This intervention was found to be effective in improving all FMS variables i.e. locomotor skills, object control skills and total FMS proficiency, BMI and 550m run time (CRF) among the intervention cohorts (Bolger *et al.* 2018). Logan *et al*. (2017) state that stability skills are the underpinning skills of both object and control skills. Therefore, stability skills are subsumed in both object and control skills and can be evaluated through these skills (Logan *et al*. 2017)

Rush *et al*. (2016) with Project Energize (NZ), carried out a health promotion intervention that consisted of one Energizer coordinating 6–12 schools in close geographical location and a standard memorandum of understanding signed by the school and a representative of Project Energize. This memorandum explicitly states expectations of who, what and when activities would happen. A lead teacher is appointed as a point of contact for the assigned Energizer. The Energizer directs all school interactions, programmes and activities to do with nutrition and PA and is effectively the school go-to-person to ensure that nutrition and PA actions, policies and changes to practice within schools are aligned with the overall Project Energize goals (Rush *et al*. 2016). Findings from this approach, show positive findings with follow-up measures (by external staff) of children aged 5 (n=1926) and 10 (n=1426) years (692 intervention schools and 660 control schools) of a reduced accumulation of body fat in younger children, a reduced rate of rise in systolic blood pressure in older children, and in a substudy lower vitamin D insufficiency compared with children in control schools (Rush *et al.* 2016).

The Active School Flag is a national self-evaluation initiative which requires schools to plan and implement enhanced opportunities for PA. The Active School Flag (ASF) is awarded to schools that strive to achieve a physically educated and physically active school community. The process aims to get more schools, more active, more often (Ni Chróinín, Murtagh & Bowles, 2012). Agents working with the Active School Flag body conduct annual workshops in relation to making the school environment more PA friendly and provide online resources. Analysis of data provided by 21 primary schools, who were awarded the Active School Flag, provides support for a whole-of-school approach to PA promotion with evidence of schools prioritising the position of PA more centrally in school life (Ni Chróinín, Murtagh & Bowles, 2012). Whether the benefits of Active School Flag are sustainable in the long-term warrants further investigation.

2.6.4 Project Energize Intervention

Project Energize, a primary school-based PA and healthy eating intervention that is delivered across the Waikato region of New Zealand, also revealed positive intervention effects for a number of markers of health; adiposity, blood pressure (Rush et al. 2012) and CRF (Rush *et al*. The initial evaluation of the project, a longitudinal study, was carried out over a two year period (2004-2006) and involved 62 intervention and 62 control schools. Children (N=1,352) were aged between 5 and 10 years at baseline and 7 and 12 years at follow-up. Results of the study revealed favourable effects for the intervention with slower gains in body fat percentage standard deviation score observed among the 5-7-year old intervention group compared to their counterparts in the control group (0.64 v 0.79, $p<0.05$) (Rush *et al.* 2012). A decrease in systolic blood pressure standard deviation score was also found among the 10-12-year-old intervention group while an increase was observed among the control group(-0.18 vs. 0.05, $p<0.05$) (Rush *et al.* 2012). Furthermore, It was noted that 90% of schools had reported enhanced knowledge of healthy eating and PA at follow-up (Rush *et al*. 2012). A further evaluation of Project Energize involved 7 and 10-year-old children from 193 intervention schools (N=4,804). The study found that the prevalence of overweight and obesity in 2011 between 7 and 10-year-old ‘Energized' children (i.e. those who had received the intervention) was 15 and 31% lower, respectively, than that reported among children who did not receive the Project Energize intervention measured in 2004 (Rush *et al.* 2014). The Energized children also demonstrated higher (approximately 10%) CRF levels (measured as the time taken to complete the 550m run) when compared to children of a similar age from Canterbury New Zealand (Rush *et al.* 2014). Such results further suggest that multi-component school-based interventions are effective for the improvement of primary school children’s health and well-being.

2.6.5 Project Spraoi Intervention

In Ireland, Bolger *et al.* (2017), using the TGMD-2 model found that there were significant, positive intervention effects for locomotor, object-control and total FMS scores ($p<0.01$, large effect sizes). This was a 26-week Project Spraoi, FMS and PA intervention among 6- year old (senior infants and 1st class) and 10-year old (4th and 5th class) children (N=466) from 3 primary schools in Co. Cork, Ireland. The authors concluded that a school-based multi-component FMS and PA-based intervention reduced BMI, improved FMS proficiency and CRF among a cohort of Irish primary school children (Bolger *et al.* 2017). In a separate Project Spraoi study, Murphy *et al*. (2018) explored the effect of a school-based multi-component Project Spraoi intervention on SB and markers of health amongst 6 (5.9 ± 0.6 yrs.) and 10 (9.8 ± 0.5) year old children (N=700) among 11, Co. Cork-based schools. The 6-year-olds for both intervention and control groups were found to decrease overall levels of SB from baseline to follow up. The intervention group showing a mean change of 32.59 ± 0.10 mins/day, p=0.03; while the control group also reduced their SB, it was not found to reach statistical significance. Among 10-year-olds a greater decrease was evident among the intervention group relative to the control group, however, this was not found to reach statistical significance. Furthermore, O'Leary et al. (2018) found positive results for WC (p<0.005), (intervention – control) and heart rate (p=0.003), (intervention – control) among 6 and 10-year-old participants (n=655) following a school-based multicomponent Project Spraoi intervention.

2.7 Process Evaluation

Process Evaluation determines whether programme activities have been implemented as intended and have resulted in certain outputs (Giffin *et al.* 2014). Varying evaluation frameworks have been proposed to help researchers direct the process of evaluation (Ng & De Colombani, 2015) and to assess theoretical contributions. As frameworks allow for broader measures of programme success, they provide the building blocks of the evidence base in health behaviour change that are not limited to randomised trials of efficacy (Glanz & Bishop 2010). There is a consensus on the importance of process evaluation in addition to short and long-term outcomes (Ng & De Colombani, 2015). However, there is little consensus on frameworks for such evaluations (Grant *et al*. 2013). Whilst there is some overlap between process evaluations frameworks seen in the literature (Dane *et al*. 1998; Glasgow *et al.* 1999; Linnan *et al.* 2002; Carrol *et al*. 2007), there are also distinct traits within each framework that distinguish them from one another (Griffin *et al.* 2014).

A brief overview of frameworks used in process evaluation are outlined below.

The WAVES study, conducted by Griffin *et al.* (2014) is a cluster, randomised, controlled trial to evaluate the effectiveness of an obesity prevention intervention programme targeting children aged 6-7 years, delivered by teachers in primary schools across the West Midlands, UK. The intervention promoted activities encouraging physical activity and healthy eating. Dimensions for evaluating the intervention process, included adherence, exposure, quality of delivery, participant responsiveness, context, and programme differentiation. The methods for data collection included interviews with teachers and students, physical activity logbooks and questionnaires. Griffin *et al*. (2014) concludes that this a comprehensive approach to the assessment of the implementation and processes of a complex childhood obesity prevention intervention within a cluster randomised controlled trial. These approaches can be transferred and adapted for use in other/similar complex intervention trials (Griffin *et al*. 2014). However, this framework for process evaluation was refuted by Adab *et al*. (2018), where it was suggested that this data collection process posed several challenges, predominantly when relying on teachers to complete paperwork, which they saw as burdensome on top of their teaching responsibilities.

The RE-AIM framework, first proposed by Glasgow *et al*. (1999), looks to evaluate public health interventions through 5 dimensions, namely reach, effectiveness, adoption, implementation and maintenance (Glasgow, Vogt & Boles 1999). The implementation process is assessed through the reach or percentage of the population receiving the intervention. Outcome evaluation, involves the measurement of the size of the change in a desirable outcome (effectiveness). Adoption is assessed according to the proportion of settings adopting the intervention. Implementation is evaluated by the degree to which the intervention is carried out as planned and the maintenance or sustainability of the intervention (Dunton et al, 2009). The RE-AIM framework has been widely used to assess various health promoting programmes in peer reviewed studies (Ng & De Colombani, 2015). Ng & De Colombani, 2015 conducted a systematic literature review on evaluation frameworks which included school-based PA and nutrition interventions (Dunton *et al*. 2009). This study of Dunton *et al.* (2009) was conducted among 688 students and 16 teachers and measured through classroom observations, teacher and student surveys assessing PA, SB, and dietary intake.

A large scale investigation conducted by a member of the Project Spraoi research team (O'Byrne *et al.* 2017), suggest that the British medical Research Councils (BMRC) guidance for process evaluation (Moore 2015; Craig *et al*. 2008) presents one of the most comprehensive frameworks for process evaluation in the current literature. This framework outlines a systematic approach to designing and implementing a process evaluation of a complex intervention and builds upon two of the key themes for process evaluation outlined in the 2008 British Medical Research Council publication; (i) intervention implementation, and (ii) the impact of contextual factors (Moore *et al.* 2015; Craig *et al*. 2008). In order to enable conclusions about intervention implementation, process evaluation will normally aim to capture the 'dose' or the quantity of the intervention delivered. Furthermore, for school-based, physical activity, health promotion interventions, (Linnan *et al.* 2002) it is suggested that dose is best evaluated through quantifying the total minutes of extra daily PA delivered by implementers via self-report PA logs. Health promotion interventions are effected by the context they are delivered in. Therefore, when evaluating the influence of contextual factors on the delivery of health promotion interventions it is advised that two evaluation dimensions be used, barriers and facilitators (barriers and facilitators are defined in tables 4.6 and 4.7 respectively). Moore *et al*. (2015) identifies close links between the impact of implementation and context, on interventions, as often intervention implementation may need to be tailored in order to suit a new context.

Chapter 3

Methods

3.1 Overview of Project Methodology

The current study is phase 2 of Project Spraoi. Phase 1 of Project Spraoi assessed the efficacy of a health promotion intervention, disseminated by an Energiser assigned to a maximum of two schools. The central tenets of the programme included the promotion of 20 minutes (MVPA) daily, Fundamental Movement Skills (FMS) and the promotion of increased habitual PA and reduced sedentary time. The focus of this research was to build on previous iterations of the project and to assess the effectiveness of the intervention with a larger number of schools, using a step back approach with less direct contact from the Energiser and a more proactive role in the delivery of the project by school staff. Four Cork based primary schools (2 single sex, 2 mixed gender) who had implemented the Project Spraoi intervention during the 2015/2016 academic year with 3 of the schools implementing the intervention in the 2014/2015 academic year were recruited as intervention schools.

Baseline data were collected at the beginning of the academic 2016/2017 school year (3rd – 20th of October) with follow up data collection at the end of the same school year (29th May – 16th June June) in intervention schools. The intervention was delivered to all children in each of the participating schools as part of their daily curriculum between baseline and follow up data collection.

To assess the impact of the intervention results were compared to data from control schools. Repository control school data collected as part of previous iterations of Project Spraoi, collected during 2014 – 2016 was used to compare changes in the intervention schools relative to the control school. The control school had similar characteristics to the intervention schools relating to socioeconomic status (non-DEIS), gender, location. Subjects from the control schools did not participate in the intervention but partook in the same battery of measurements at baseline and follow-up. Repository control data with a total of 306 students from 3 schools was chosen for this research project to maximise the reach of the intervention and to minimise disruption and inconvenience to other schools.

3.2 Participants

Physical fitness, Fundamental Movement Skills (FMS), anthropometric and health markers were collected from a total 282 children across four intervention schools. While the whole school took part in the intervention, data was collected from a cohort of 5-7-year olds (n=145) and a cohort of 9-11-year olds (n=137) from these schools. Data from these children had been collected in previous iterations of the project allowing longitudinal impact across 2 and 3 years to be assessed. The justification of including these age groups was that children in these age ranges are at the advent of important ages for forming and understanding health habits (Rush *et al.* 2013). At commencement of the Project Spraoi programme certain school inclusion criteria was set by Coppinger *et al*. (2016) these include (i) medium sized schools (100 – 300 pupils), (ii) have proximity (20km) to the research institute, (iii) willingness to implement the Project Spraoi intervention and (iv) not currently participating in another health promotion intervention (Coppinger *et al*. 2016).

3.2.1 Ethics

On 2nd October 2013, the Research Ethics Committee at Cork Institute of Technology (CIT) granted ethical approval for Project Spraoi. The primary researcher of this study was subsequently approved for inclusion on the ethics application by the CIT Ethics Committee upon joining the Project Spraoi research team in September 2016. Further to this, the primary researcher and all members of the testing team have undergone training in the Code of Ethics Good Practise for Children's Activities.

Parents and children were provided with consent forms (appendix A) and information sheets (appendix B). Only children who returned these completed consent forms were allowed to participate in the data collection phase of the research. As this project is an extension of the initial Project Spraoi intervention children who had previously consented were provided with a letter (appendix C) outlining the extension of the project in the school and both children and their parents were given the option to opt out if they wished.

3.3 Measurement Procedures

3.3.1 Physical Activity and Sedentary Behaviour

Physical Activity (PA) and Sedentariness was measured using ActiGraph triaxial accelerometers (MTI model 7164, Fort Walton Beach, FL), which Welk *et al.* (2005) found to be a valid measure of PA. The accelerometer sat on the iliac crest of the child's right hip (Coppinger *et al.* 2016). The accelerometers were worn by 5th and 1st class students within 2 of the intervention schools. They were worn by the children for 8 consecutive days, only removed while sleeping, swimming and bathing. Each child took part in a brief workshop conducted by the researcher surrounding the correct use of the accelerometer prior to receiving it and subsequently brought home a parental/child friendly guide to correct use of the device (appendix B). Belton *et al.* (2013) found that if parents receive daily SMS reminders, the children were more likely to wear the accelerometer for that day, as opposed to children of parents who did not receive. Hence, in an attempt to promote adherence, parents who consented, received daily SMS reminders for their children to wear their accelerometers. Wear time validation followed the following protocol.

- The first day of accelerometer data omitted from analysis to allow for subject reactivity (Esliger *et al.* 2005)
- A day was deemed to be valid if there was a minimum of 10 hours recorded wear time (Nyberg *et al.* 2009; Riddoch *et al.* 2004)
- The minimum number of valid days required for inclusion in analysis was 3 week days and 1 weekend day (Rowland *et al*. 2008; Troiano *et al*. 2008)
- Minutes in sedentary, light, moderate, and vigorous PA estimated from the data using 0.5 minutes cut-points derived by Evenson *et al*. (2008) and subsequently validated by Trost *et al*. (2011).

Control data was collected in October 2014, only 48 out of the 306 control subjects met the inclusion criteria for data analysis. Only children who met the wear time criteria of a minimum of 10 hours on three weekdays and one weekend day at both pre- and post-intervention were included in the analysis. A total of 20 children (8 senior infant and 12 4th class students; 41.6% of those who received accelerometers at pre-intervention) provided valid accelerometer data i.e. met the minimum wear time requirements, at both pre- and post-intervention, and were included in the analysis. All accelerometer data provided objective information on the duration of time and intensity spent in active and inactive pursuits. Data was analysed using ActiLife version 6 software.

3.3.2 Anthropometric and Fitness Measurements

Anthropometric data was collected prior to FMS testing by a total of 3 trained evaluators from the Project Spraoi Research Team (staff and postgraduate researchers of Cork Institute of Technology). Prior to this testing, evaluators completed a testing training workshop with a research practitioner who had extensive experience in collecting anthropometric measurements. This testing procedure replicated protocols used by previous researchers in an Irish school context (Bolger *et al.* 2017). Testing of each class group (22 -30 children) took maximum of 1 hour and was carried out in a small vacant classroom in the school environment. Groups of 5 children were allocated to the classroom for testing at any one time.

Anthropometric and cardiorespiratory fitness measurements are outlined in Table 3.1.

Table 3.1: Anthropometric and Fitness Measurements

Measure	No. of Measures	Differences Needed for a Third Measure	Device	Method
Height	2	>0.5cm	Leicester portable height scale.	Measured to the nearest 0.1 cm, without shoes
Body Mass Tanita WB100MZ	2	>0.5kg	Tanita WB100MZ Portable electronic scale	Measured to nearest 0.1kg, with heavy outer clothing removed.
Waist Circumference Non-stretch Seca 200 measuring tape	2	>0.5cm	Non-Stretch seca 200 measuring tape	Measured as the circumference of the abdomen at its narrowest point between the lower costal (10th rib) border and the top of the iliac crest, perpendicular to the long axis of the trunk

3.3.3 Cardiorespiratory Fitness

Recordings of time taken by each participant to complete a 550m run/walk was conducted by the research team as a measure of CRF (Albon *et al.* 2010). A rope measuring a 110 m was placed in a circular pattern on flat grass surface and groups of up to 5 children were asked to run around the perimeter 5 times as fast as they could. Members of the research team recorded running time for a maximum of 3 children per run. Prior to the run, the researcher explained the test to each participant and allowed a one lap warm up run. Recording of the five laps commenced following the warm up. The test ended for each child once the 5 laps were completed, or if a participant stopped running upon feeling he/she could not continue the test. For those who did not complete the test, 'non-completion' was marked beside their name.

3.3.4 Fundamental Movement Skills (FMS)

The assessment of FMS was conducted using the Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000). This FMS assessment is a process-orientated, criterion, norm-referenced and validated tool for use among children aged 3-10 years (Urlich 2000) and is commonly implemented worldwide to evaluate the FMS proficiency of children (Bakhtiar, 2014; Burrows *et al.* 2014; Cliff *et al.* 2009; Hardy *et al*. 2010; Spessto *et al*. 2013). The TGMD-2 consists of 6 locomotor and 6 object-control skill assessments (Urlich 2000). The 6 locomotor skills assessed are run, gallop, slide, leap, hop and horizontal jump (Urlich 2000). The 6 object-control skills are the kick, catch, overhand throw, strike, underhand roll and dribble (Urlich 2000). The TGMD-2 was also used to evaluate the FMS proficiency of participating children in Phase 1 of this research project (Bolger *et al*. 2015). Content validity of the TGMD-2 was established by three expert judges and also quantitatively using Pearson correlation index (Ulrich, 2000). Criterion validity (more specifically criterion-prediction validity) of the TGMD-2 was examined by assessing the FMS of 41 primary school children from Texas using the TGMD-2 and two weeks later using the Basic Motor Generalizations subtest of the Comprehensive Scales of Student Abilities (CSSA) (Hammill & Hresko, 1994). The calculated partial correlations (that controlled for age) between the subsets of the TGMD-2 and the CSSA were 0.63 for the locomotor subsets and 0.41 for the object-control subsets, indicating acceptable criterion validity for the subsets of the TGMD-2. Construct validity of the TGMD-2 was verified by demonstrating that:

(i) FMS proficiency measured according to the TGMD-2 is developmental in nature and is strongly correlated with age (*r* range: 0.69-0.75)

(ii) FMS proficiency assessed using the TGMD-2 can distinguish between children known to have different FMS levels (demonstrated by the difference in FMS levels of typically developing children from three ethnic groups and a sample of children with Down Syndrome)

(iii) the two TGMD-2 subsets measure FMS but in different ways (demonstrated by the moderately sized (r=.41) correlation between locomotor and object-control subset scores of the normative sample)

(iv) the items on the TGMD-2 have acceptable discriminating powers

(v) the TGMD-2 measures overall (or total) FMS proficiency and can also measure locomotor and object-control proficiency (confirmed by explanatory factor analysis)

(vi) the skills included in each respective subset are valid indicators of either locomotor or object-control proficiency (as demonstrated using confirmatory factor analysis) (Ulrich, 2000).

Test-retest reliability was assessed using scores obtained for 75 US children (aged 3-10 year old) with a two week period between the two testing dates. The correlation coefficient reported between these scores were high for the locomotor subset (*r*=.88), object-control subset (*r*=.93) and the gross motor quotient (*r*=.96) (Ulrich, 2000). When 30 randomly selected assessments of FMS from the normative sample were scored by independent evaluators, inter-rater reliability was 0.98 for locomotor subset score, object-control subset score and GMQ (Ulrich, 2000).

<u>FMS Data Collection</u>

FMS testing was conducted at baseline between the 16th and 20th of October 2016 and again at follow up between the 12th and 16th of May 2017 by 9 trained evaluators from the Project Spraoi research team and an external collaborator from UCC, all of whom undertook FMS training prior to testing. Testing of each class took approximately 1 hour and was carried out in a large indoor sports hall. The testing procedure and hall layout took the same protocol from previous researchers in an Irish school-context (Bolger *et al.* 2017; O'Brien *et al*. 2016). The hall was divided into 4 stations that catered for the testing of each of the skills, with the following format:

- Station 1: Run, leap, hop, gallop
- Station 2: Catch, throw, roll.
- Station 3: Kick, strike.
- Station 4: Dribble, jump.

At each station groups of 3-6 children were allocated. When groups were finished at a station they rotated in a clockwise manner simultaneously. A demo of each skill was carried out by an evaluator at each station prior to the first child performing that specific test. Each child performed the skill 3 times, 1 practise and 2 trials. A video camera was used to record each execution of all skills performed. Each child had a personal ID badge on the front of their jumper, this was spoken into the camera by the evaluator prior to execution of each skill. This ensured accuracy when analysing the skills at a later date.

FMS Scoring Protocol

All tested skills were recorded via camera and following testing the videos were uploaded to a laptop for analysis. Each skill has 3 – 5 technical components. If a component was performed correctly a score of 1 would be given. If a component was performed incorrectly, a score of 0 was awarded. Scores were calculated by adding the raw scores of the individual skills. Following this, the Gross Motor Quotient (GMQ) score was calculated and used to categorise the overall FMS performance of each child into 7 different categories ranging from very poor to very superior (Urlich, 2000). Children with a GMQ score below 70 are classified as very poor, those between 70 – 79 are classified as poor, 80 – 89 as below average, 90 – 110 as average, 111 – 120 as above average, 121 – 130 as superior and those above 130 as very superior (Urlich 2000) .

FMS scoring was conducted by two 'FMS evaluators'; this postgraduate researcher and another member of the Project Spraoi Research Team. Prior to the scoring of the pre-intervention data, both FMS scorers completed 2 x 2-hour FMS scoring training sessions with a Research Mentor with over 6 years' experience in FMS assessment and protocol. Inter-rater reliability measures the degree of similarity between the scores of evaluators measured from the same observation and using the same assessment instrument. Higher coefficients indicate higher levels of reliability (Kimberlin & Winterstein, 2008)**.** For 10% of the sample population the primary researcher scored the videos and compared these scores with an expert, based on the guidelines of Thomas *et al.* (2011)**.** There should be a minimum of 85% agreement between the primary researcher and the expert.

$$\frac{\text{agreements}}{\text{agreements + disagreements}} \times 100$$

(Thomas *et al*. 2011)

Intra- and inter-reliability scores for all 12 FMS exceeded the 85% threshold required to demonstrate reliability (Thomas *et al*. 2011).

3.4 Intervention

3.4.1 Needs Analysis

Prior to the implementation of the intervention a needs analysis was conducted among all teachers in the 4 intervention schools (appendix D). Feedback from this, identified perceived barriers and facilitators to the projects implementation. Hence, while there was central tenants (outlined below) to the intervention throughout the 4 schools, the project was tailored for each school in accordance with this feedback to best mitigate any barriers that may be present. Further to this, the energiser conducted a 'school stocktake' with a school leader, which involved a formal meeting around current school policy, and resources in relation to PA and nutritional habits.

3.4.2 Development of the Intervention

Relevant intervention material used in 'Project Energize', New Zealand was made available for use in 'Project Spraoi'. A lecturer within the Department of Sport Leisure and Childhood Studies in CIT, worked on similar project in New Zealand with Project Energize (PENZ) and subsequently set up Project Spraoi in CIT upon arrival. Hence, Project Spraoi is based on the New Zealand health promotion intervention, PENZ. 'Project Energize' in New Zealand found positive prevalence figures for overweight and obesity, physical fitness and nutritional behaviour among New Zealand children following validation and effectiveness of their intervention protocols (Sport Waikato, 2011; Rush *et al.* 2014). Hence, the central tenant of the 'Project Spraoi' programme includes 20 minutes of 'huff and puff'(MVPA) each day, improvement of nutritional habits, FMS, class based activities, promotion of PA and reduced SB.

Prior to the commencement of the first 'Project Spraoi' study, experienced Energisers from 'Project Energize', New Zealand visited Ireland to provide training to the Irish Energisers on the intervention content, structure and philosophy (Coppinger *et al*. 2016). Support from 'Project Energize' for this study remained through email and teleconference.

3.4.3 Intervention Framework

The school-based delivery of Project Spraoi is carried out by trained members of the Project Spraoi research team, known as 'Energisers'. Energisers deliver the project to schools by acting as agents of change in the school settings. Energisers work by supporting school staff members to promote PA and healthy eating among the students.

Due to this projects (phase 2) 'step back' nature, the Energiser/researcher had reduced contact with schools compared to phase 1 of the project in these schools. In phase 1 of the project, the Energiser would have been present in their intervention school 1-2 times per week (figure 1.1). During phase 2 (this project) the Energiser was in each school for one day every two weeks (appendix E) for sample calendar of project structure). During this time, the Energiser would deliver PA sessions with the assistance of the class teacher to each class group throughout the whole school. These PA sessions would be in accordance with a lesson plan (appendix F), which was developed by the Energiser with a specific focus outcome. Such focus outcomes may include one of the 12 Fundamental Movement Skills, aerobic fitness, dance, class room based activities and so. These sessions would include high intensity 'huff and puff' games, and activities (cardiovascular fitness) and sessions which focus on the acquisition of fundamental movement skills. Further to this, PA games and exercise routines were prescribed via 'Outdoor & Indoor Physical Activity Games' booklet (appendix G) designed by Bolger *et al.* (2017).

On the day the Energiser was present within the school, the Energiser would discuss models and plans for targeted physical education classes with each class teacher, and provide specific material in accordance with the teachers needs to offset any barriers to the implementation of the project. Various PA challenges and initiative were implemented throughout the school year, with the aim of maintaining enthusiasm and compliance to the project. A sample of such challenges/initiatives included 'Stride for 5', 'Get up, Get moving challenge', 'Physical activity class of the week', 'Physical activity student of the week' (appendix H). The Energiser also conducted nutrition classes and initiatives to improve dietary intake and knowledge among participating children. During the Energisers 20 minute Project Spraoi time with each class every two weeks, Informal feedback from teachers was ascertained in relation to the implementation of the project. From this, the content of the intervention was constantly evaluated and developed based on reflections and feedback from participating teachers. For example, a number of teachers would have requested a revision for rainy day games. This would have subsequently been developed and prescribed by the primary researcher.

At induction, and then each month, the Energiser undertook combined training with members of the Project Spraoi team (postgraduate supervisors, other academic staff in CIT, external collaborators and postgraduate students), in order to share experience, resources and skills.

All teachers were encouraged to carry out similar sessions on days that the Energiser was not present in the school (appendix F for sample lesson plan) Project Spraoi intervention promotes the accumulation of 20 minutes of PA throughout each school day excluding lunch and break times and PE curriculum times (Coppinger *et al.* 2016). Further to this, each teacher was given an 'FMS Teacher manual' (appendix H) to assist in teaching the FMS skills through physical activities.

As 'Project Spraoi' is designed as a school based intervention, the school was the main setting where the project was delivered, with the community and parents targeted through the school. Initiatives for getting the messages to home included: the 'home play PA challenge', 'FMS homework' with a 'FMS Homework Booklet' (appendix G) and colourful healthy eating fridge magnets.

Collaboration with experts in the fields of coaching, adapted PA, physical education, skill acquisition and FMS in the Department of Sport, Leisure and Childhood Studies at Cork Institute of Technology took place in the development of the intervention. Regular collaboration with experts in the field of FMS from University College Cork, Cork Institute of Technology, and University College Dublin who have delivered effective FMS interventions among children and adolescent populations (Belton *et al*. 2015). Such collaboration was ongoing throughout the FMS intervention design and FMS data analysis. This engagement allowed for the sharing of ideas and experiences and thus helped maximise the quality of the intervention being implemented.

3.5 Process Evaluation

To understand the barriers and facilitators faced by teachers when implementing the programme and the dose (the quanity of the intervention) prescribed by teachers, process evaluation methods were used. The Process evaluation tools by O'Byrne *et al.* (2017) were used to assess the barriers and facilitators and dose (quantity of the programme delivered). Such tools questionnaires (appendix D) which were collected at both pre and post intervention and a classroom PA log sheet (appendix I). The questionnaires identified the barriers and facilitators of the project, while the PA log sheets identified the dose (the quantity of intervention delivered) of the project. A total of 46 teachers were included in this analysis in order to gain a comprehensive, multi-perspective understanding of the Project Spraoi intervention. From this, individual viewpoints and experiences can be verified against others and hence a clear picture of attitudes, behaviours and needs was constructed based on these contributions. The process evaluation methodology was developed for Project Spraoi using BMRC guidance for process evaluation (Moore 2015; Craig *et al*. 2008). The two tools used in this study, were piloted and validated by O'Byrne *et al*. (2017). A summary of the process evaluation key themes, dimensions, data collection tools used, subject size and month of data collection for this research project are outlined in table 3.2.

Table 3.2: Summary of process evaluation conducted

Key Themes	Dimension	Data Collection Tool	Subject size	Month
Context	Barriers and facilitators	Teacher Questionnaire	46	February
Implementation	Dose	Physical activity logbooks	46	September (pre) & May (post)

3.5.1 Physical Activity Logs

Similar to those used by Griffin *et al.* (2014) during the WAVES study, PA logs (appendix I) were designed to collect self-report data on the daily PA dose delivered by class teachers. This data was recorded over a two week period, concurrently (February 6^{th} – February 17^{th}).

The importance of honest reporting was emphasised to teachers regularly throughout the data collection period. The log sheets were developed, reviewed and refined carefully in response to feedback during phase one of Project Spraoi in order to try and make them as simple and concise as possible, whilst still capturing the relevant information sought. Teachers were asked to return their completed log sheet at the end of each week to the researcher. Returned logs were checked for completeness and stored. Teachers who did not return logs were given a verbal reminder by the researcher on the day of collection, followed by a written reminder via email. At no point was the content of the logs used to give feedback to teachers on the quality of intervention delivery (appendix I).

3.5.2 Teacher Questionnaire

At the start of year (September 2016), questionnaires were disseminated to teachers (n=46) to ascertain perceptions of the Project Spraoi intervention to date (Phase 1). Questions sought opinions in relation to barriers and facilitators of the intervention and suggestions for enhancing intervention for the coming year (appendix D).

The end of year (May 2017), questionnaires were disseminated to teachers to ascertain perceptions of this study relative to the project as a whole but specifically with reference to the 'Step-back approach' within the intervention schools. Questions sought opinions about the parts of the intervention with which school staff were most familiar, any changes noted in the school environment including student behaviour and staff morale, noted barriers/facilitators to implementation of the intervention and suggestions for enhancing future implementation of similar interventions (appendix E).

3.6 Data Analysis

All data was analysed using Statistical Package for Social Studies (SPSS) version 22. Children in 1st class and 2nd class were categorised as 5-7-year olds ' while children in 5th class and 6th class were categorised as 9-11-year olds. Analysis was carried out separately for the 5-7 and 9-11-year old groups for all variables. For the evaluation of the intervention, only children who had both pre- and post-intervention data (for each of the measured variables) were included in the analysis. Means, standard deviations and frequencies were used to summarise the data. Data was assessed for normality prior to analysis.

The Kolmogorov-Smirnov test was used to assess normality of data. In this test, a non-significant result (P>0.05) indicates normality (Pallant 2005). Data from histograms were also analysed to assess normality (See appendix N for a sample of the histograms). The shape of the distribution for each group was assessed using a histogram. Normal distribution was classified as a symmetrical bell shaped curve which had the greatest frequency of scores in the middle; with smaller frequency of scores in the extremes (Pallant 2005). When data was identified as normally distributed, a parametric test was used. For categorical variables and those not normally distributed, non-parametric analysis was used. When ambiguity arose in classification of scales as normal or not normal both parametric and non-parametric analyses were run. If no difference was found, results for parametric tests were presented.

Comparison of control and intervention groups at baseline was carried out using independent sample t- test for variables found to be normally distributed and Mann Whitney U tests for those variables found to be not normally distributed. To assess changes over time on continuous variables i.e. change in intervention group from baseline to follow up paired sample t-tests (when data was normally distributed) and Wilcoxon signed rank tests (when data was not normally distributed) were used. Further analysis was conducted using Analysis of covariance (ANCOVA) to detect changes from pre to post-intervention, with adjustment for corresponding baseline values (covariate) and treatment group (intervention v control). Therefore this analysis was used to identify group by time interactions i.e. if the difference between the intervention and control group differed significantly post-intervention while controlling for baseline values. The significance level was set at p<0.05 for all tests. Statistically significant results were supported with the effect size to provide an indication of the relative magnitude between mean values. Therefore, when group*time interaction i.e.

when the difference between the intervention and control groups from pre to post-intervention was significant, partial eta squared values were used to determine the size of the effect (Cohen, 1969) (Table 3.3). Chi squared tests were used to investigate differences in categorical variables (BMI categories) between the intervention and control groups. Cochrane Q tests were used to identify any significant pre to post-intervention differences in these measures among the intervention and control groups.

Table 3.3: Effect size classification (Cohen, 1969)

Effect size classification	**Partial eta squared**
Negligible effect size	<0.0099
Small effect size	$0.0099 <$ partial eta squared < 0.0588
Medium effect size	$0.0588 <$ partial eta squared < 0.1379
Large effect size	≥ 0.1379

Questionnaire data completed by teachers regarding barriers and facilitators to project Spraoi were initially summarised. To assess changes in these perceptions, McNemars test was used to investigate if there were statistically significant difference in barriers and facilitators identified by teachers from the start of this study's intervention to the end of this study's intervention.

Chapter 4:

Results

4.1 Overview of Results

The Results Chapter comprises of the following distinct sections which are presented separately:

II. Baseline analysis of control and intervention groups

III. Evaluation of the efficacy of the intervention (impact evaluation)

- Impact of the intervention on markers of health
- Impact of the intervention on Fundamental Movement Skills

IV. Process evaluation of Project Spraoi step back approach

V. Trends across health measures of Project Spraoi from Year 1 to Year 3.

4.2 Baseline Analysis

A total of 588 children (intervention n=282; control n=306) participated in this research project. Descriptive data relating to the children who participated in the evaluation is presented in Table 4.1.

Table 4.1: Descriptive data relating to the children who participated in the evaluation of the intervention

	5-7-year olds (n=283)			**9-11-year olds (n=305)**		
	Boys (n)	**Girls (n)**	**Age (years) (Mean ± SD)**	**Boys (n)**	**Girls (n)**	**Age (years) (Mean ± SD)**
Intervention (n=282)	72	73	7.20 ± .51	68	69	11.25 ± .54
Control (n=306)	68	70	6.62 ± .54	99	69	10.53 ± .52

Initial analysis was undertaken of measured variables at baseline. The purpose of this analysis was to: (i) assess markers of health and FMS scores of participants at baseline, and (ii) to identify any differences between control and intervention groups. Table 4.2 presents anthropometric data, sedentary and MVPA levels, and FMS scores categorised by age (5-7-year old/ 9-11-year old) and group type (intervention/control).

Among the 5- 7 year old's children in the intervention groups were found to be significantly taller and have a larger body mass. They were also found to be significantly faster in the 550 metre run test and to score better in locomotor skills and total FMS ($p<0.05$). Among 10 year old children those in the intervention group were found to have significantly greater body mass and WC ($p<.05$). No significant difference was found in all other measures between control and intervention.

Table 4.2: Mean scores at baseline observed between intervention and control for both 5-7 and 9-11-year old groups

	5-7-year olds					**9-11-year olds**				
	Control		**Intervention**			**Control**		**Intervention**		
	N	**Mean ± SD**	**N**	**Mean ± SD**	**P-value**	**N**	**Mean ± SD**	**N**	**Mean ± SD**	**p-value**
Markers of Health										
Height (m)	137	1.18 ± .05	140	1.23 ± .06	**.000**	167	1.47 ± .66	128	1.47 ± .066	**.945**
Body mass (kg)	137	23.10 ± 3.3	140	25.76 ± 4.5	**.000**	167	37.48 ± 7.5	128	39.44 ± 7.1	**.013**
BMI (kg/m^2)	137	16.47 ± 1.8	140	16.71± 2.1	**.576**	167	18.36 ± 2.7	128	18.16 ± 2.6	**.577**
Waist circumference (cm)	134	53.38 ± 4.7	142	53.95 ± 3.5	**.121**	165	60.80 ± 7.3	129	61.62 ± 6.2	**.042**
Cardiorespiratory fitness (secs)	110	208.49 ± 22.7	132	194.2 ± 31.8	**.000**	150	164.97 ± 23.5	123	165.98 ± 28.9	**.579**
Sedentary time (mins)	21	488.6 ± 55.6	55	468.38 ± 66.4	**.108**	33	554.22 ± 63.2	44	546.09 ± 87.2	**.537**
MVPA (mins)	21	58.29 ± 19.3	55	65.65 ± 19.8	**.118**	33	59.99 ± 19.1	44	58.38 ± 22.3	**.497**
Fundamental Movement Skills										
Locomotor subset score (range: 0-48)	76	33.91 ± 3.0	71	38.89 ± 6.1	**.000**	85	42.44 ± 3.1	64	42.58 ± 4.09	**.811**
Object-control subset score (range: 0-48)	76	33.74 ± 5.1	70	32.37 ± 6.3	**.170**	85	39.65 ± 3.8	65	39.55 ± 4.2	**.858**
Total FMS score (range: 0-96)	76	67.64 ± 6.5	70	71.00 ± 10.0	**.008**	85	82.08 ± 5.1	64	82.11 ± 6.4	**.534**

4.2.1 BMI Categories at Baseline

BMI results were classified using the International Obesity Task Force (IOTF) method (Cole and Lobstein 2012). Among the 5-7-year old cohort, 21% of children from the intervention group and 17% of children from the control group were overweight/obese pre-intervention (Figure 4.1). Among the senior cohort, 11.6% of the intervention group and 19.8% of the control group were overweight/obese pre-intervention (Figure 4.2).

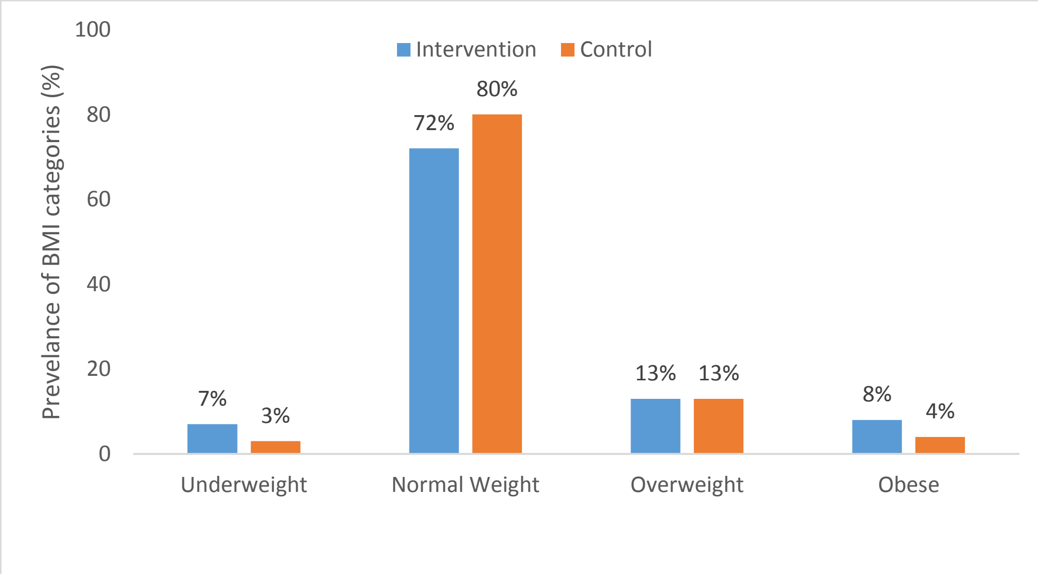

Figure 4.1: BMI Classification for 5-7-year old children at baseline

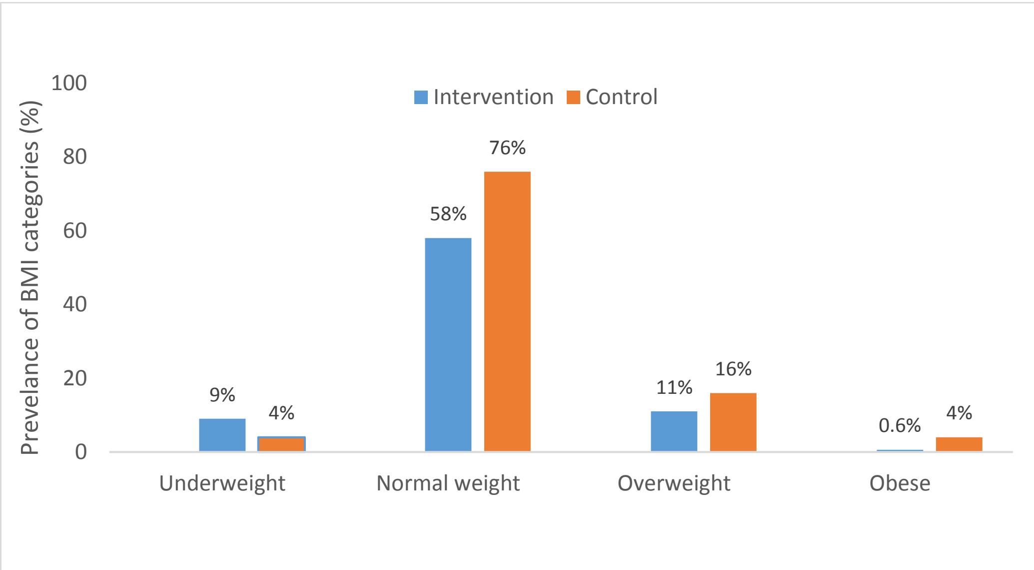

Figure 4.2: BMI classification of 9-11-year old children at baseline

4.3 Impact of the Intervention

Paired samples t-tests/Wilcoxon signed rank tests were used to investigate pre- to post-intervention differences in FMS and markers of health scores for the intervention and control groups. For data that was found to be normally distributed a paired samples t-test investigated differences across time and for data that was not normally distributed a Wlcoxon signed rank test was used to investigate differences across time (Pallant 2005). One way ANCOVA's were conducted to investigate if the pre- to post-intervention change in FMS and markers of health differed significantly between the intervention and control groups. An ANCOVA's was used to investigate the differences in post-intervention scores while controlling for baseline scores (Pallant 2005) Data from these analyses are presented in Tables 4.3 and 4.4.

4.3.1 Impact of the intervention on markers of health – Hypotheses 1

With regard to markers of health the null hypotheses was neither accepted nor rejected, with differing results found.

Children in the intervention and control group in both age categories were found to get significantly taller and heavier from pre to post-intervention ($p<.05$). The ANCOVA results revealed that intervention children in both the 5-7 and 9-11 year groups grew significantly taller ($p<0.01$, large effect sizes) and heavier than their counterparts in the respective control groups ($p<0.01$, large effect sizes).

Among the 5-7-year old group WC was found to increase significantly in the intervention group, while it decreased in the control group. The ANCOVA revealed that after adjusting for baseline scores there was no significant difference between the two groups on post WC scores. For the 550 m runs scores both groups were found to improve significantly from baseline to follow up. The control group were found to have significantly faster times than the intervention group at follow up after adjusting for baseline scores. Children in the control group were also found to increase their MVPA levels from baseline to follow up while no change was found among children in the intervention group.

Among the 9-11-year old cohort, BMI values were found to increase significantly across both groups from baseline to follow up. The magnitude of change was found to be similar across both groups ($p>.05$). Waist circumference values were found not to significantly change in the intervention group, however they were found to increase in the control group. The ANCOVA revealed a statistically significant difference for WC with more favourable results (slower gain in WC) among children in the intervention group. For the 550 m run both groups were found to significantly improve from baseline to follow up ($P<.05$). When the change in both groups were compared no significant difference was found indicating similar changes in both groups. MVPA levels were found to increase in the control group, no change in MVPA was found among the intervention group.

4.3.2 Impact of the intervention on FMS – Hypotheses 2

With regard to FMS the null hypotheses was rejected, as there was a significant positive difference in FMS from baseline to follow up.

For the 5-7-year old cohort, intervention and control group scores for all FMS variables were found to increase from baseline to follow up ($p<0.05$, large effect size). For Object Control and Total FMS variables the increase in the intervention group was found to be significantly greater than the increase in the control group after adjusting for baseline scores ($p<0.05$, large effect size). The locomotor scores were found to increase at a higher rate in the control group relative to the intervention group.

For the 9-11-year old cohort, the difference between the intervention and control group for all FMS variables (locomotor, object-control and total FMS) increased significantly ($p<0.05$, large effect size) from pre- to post-intervention. Control group scores were found to be lower at follow up relative to baseline. A one way ANCOVA found that the intervention group had a more favourable change relative to the control group across all FMS variables ($p<.05$; large effect size).

Table 4.3: Paired samples t-test/Wilcoxon signed rank test and ANCOVA results for the 5-7-year old intervention and control groups

	Intervention				Control				Group* Time	Partial Eta Squared	Effect Size*
	N	Pre	Post	P	N	Pre	Post	P	P		
Markers of Health											
Height (m)	135	1.24 ± 0.06	1.28 ± 0.06	<.001	126	1.20 ± 0.05	1.24 ± 0.06	<.001	<.001	.134	Large
Body mass (kg)	135	25.76 ± 4.5	27.46 ± 4.9	<.001'	126	23.14 ± 3.2	24.77 ± 3.8	<.001'	<.001	.101	Large
BMI (kg/m^2)	135	16.71 ± 2.1	16.69 ± 2.2	.547'	126	16.08 ± 1.3	16.03 ± 1.6	.093'	.082	.012	-
Waist circumference (cm)	135	53.90 ± 3.5	54.03 ± 3.5	.020	124	51.14 ± 3.4	50.79 ± 3.7	.009	.058	.014	Small
550m run time (secs)	118	194.2 ± 31.8	181.66 ± 27.7	<.001'	100	204.43± 25.2	184.38 ± 24.0	<.001'	.741	.001	-
Sedentary time (mins/day)	45	468.38 ± 66.4	469.55 ± 53.7	.791'	13	484.4 ± 64.9	502.61 ± 84.1	.196'	.332	.017	-
MVPA (mins/day)	45	65.65 ± 19.8	69.57 ± 23.0	.132'	13	62.68 ± 31.02	78.39 ± 21.9	.003'	.005	.137	Medium
Fundamental Movement Skills											
Locomotor score (range: 0-48)	61	38.89 ± 6.1	40.00 ± 5.1	.036'	76	33.91 ± 3.0	36.62 ± 3.7	<.001'	<.001	.161	Large
Object-control score (range: 0-48)	60	32.37 ± 6.3	38.38 ± 5.5	<.001'	76	33.74 ± 5.1	31.12 ± 5.1	<.001'	<.001	.085	Large
Total FMS score (range: 0-96)	58	71.00 ± 10.0	78.75 ± 8.7	<.001'	76	67.64 ± 6.5	69.74 ± 6.7	.003'	<.001	.168	Large

'Wilcoxon signed rank test
Group*Time = group by time interaction effect
*Effect size only presented if group*time was significant
BMI = body mass index; **MVPA** = moderate-to-vigorous physical activity

Table 4.4: Paired samples t-test/Wilcoxon signed rank test and ANCOVA results for the 9-11-year old intervention and control groups

	Intervention				**Control**				**Group *Time**	**Partial Eta Squared**	**Effect Size***
	N	**Pre**	**Post**	**P**	**N**	**Pre**	**Post**	**P**	**P**		
Markers of Health											
Height (m)	135	1.46 ± .06	1.50 ± 0.63	<.001	159	1.43 ± .05	1.45 ± 0.6	<.001	<.001	.416	Large
Body mass (kg)	135	38.8 ± 6.9	42.04 ± 7.9	<.001’	159	37.14 ± 7.2	39.56 ± 7.4	<.001’	.005	.029	Medium
BMI (kg/m^2)	135	18.03 ± 2.6	18.48 ± 2.9	<.001’	159	18.24 ± 2.61	18.56 ± 2.5	<.001’	.787	.000	-
Waist circumference (cm)	135	61.35 ± 6.1	61.38 ± 6.7	.616	159	60.61 ± 7.3	62.27 ± 7.3	<.001	<.001	.104	Large
550m run time (secs)	118	163.27 ± 27.9	154.78 ± 21.7	<.001	140	164.35 ± 25.5	155.89 ± 21.7	<.001	.576	.001	-
Sedentary time (mins/day)	45	522.85 ± 66.6	508.29 ± 82.4	.066’	19	550.67 ± 63.3	550.67 ± 63.3	0.28’	.450’	.012	-
MVPA (mins/day)	45	73.36 ± 23.1	83.51 ± 23.3	.567’	19	63.626 ± 14.7	78.46 ± 22.7	.019’	.125’	.048	-
Fundamental Movement Skills											
Locomotor score (range: 0-48)	61	42.49 ± 4.1	43.69 ± 2.8	.030’	84	42.45 ± 3.1	41.32 ± 2.9	<.001’	<.001	.161	Large
Object-control score (range: 0-48)	60	39.55 ± 4.2	41.40 ± 6.5	.009’	85	39.64 ± 3.8	38.38 ± 3.4	<.001’	<.001	.085	Medium
Total FMS score (range: 0-96)	58	82.11 ± 6.4	85.05 ± 7.6	.009’	84	82.04 ± 5.1	79.73 ± 4.7	<.001’	<.001	.168	Large

‘Wilcoxon signed rank test
Group*Time = group by time interaction effect
*Effect size only presented if group*time was significant
BMI = body mass index; **MVPA** = moderate-to-vigorous physical activity

4.3.3 Intervention Effect on BMI Category

The prevalence overweight and obesity from pre-intervention to post-intervention among 5-7 and 9-11-year old children in the intervention and control groups are presented in Table 4.5. A chi-square test for independence found that there was no significant difference in the proportion of children in the 5-7-year old intervention group that were 'overweight/obese' when compared to the 5-7-year old control group at pre- or post-intervention ($p>0.05$). Similar results were found among the 9-11-year old group. Among both cohorts, there was no significant pre-post-intervention difference (Cochrane Q test) in the prevalence of 'overweight/obese' children among the intervention or control groups ($p>0.05$).

Table 4.5: The proportion of 'overweight/obese' children in the intervention and control groups pre- and post-intervention

	Intervention				Control				Difference between intervention and control groups	
	N	**Pre**	**Post**	***p***	**N**	**Pre**	**Post**	***p***	**Pre**	**Post**
5-7-year old children										
Overweight/obese	140	21%	21%	.180	126	18%	14%	.480	0.601	0.226
9-11-year old children										
Overweight/obese	125	16%	17%	.317	159	21%	19%	1.00	0.431	.575

4.4 Process Evaluation – Hypotheses 3

With regard to process evaluation the null hypotheses was rejected as there was an increase in the delivery of physical activity sessions among participating teachers and there was a positive change in barriers/ facilitators from baseline to follow-up.

A questionnaire was completed by teachers at baseline and follow up which examined their perceptions of the Project Spraoi intervention. Further to this, a daily PA log was completed over two consecutive weeks (February 6th – February 17th) to highlight the dose of PE and PA delivered by the class teacher.

4.4.1 Questionnaire Analysis

Findings from this questionnaire are presented in the following section. Table 4.6 presents barriers identified by teachers at pre and post intervention. Teachers were asked to choose from a list of potential barriers that they felt impacted on the implementation of the Project Spraoi programme. Table 4.7 presents facilitators identified by the teachers at pre and post intervention. Teachers were asked to choose from a list of facilitators that may further promote the programme in their school.

McNemar's test was used to investigate changes in perceived barriers and facilitators from pre to post intervention (Table 4.6 and Table 4.7). The figures presented represent the percentage of teachers who agreed that the variable in question was either a barrier or a facilitator to PA in the school environment.

In relation to barriers to PA, there was no significant differences found between perceived barriers at pre and post intervention. Primary barriers identified by the class teachers were time constraints due to a crowded curriculum (noted by 96% teachers at pre and, 86% at post), and poor school facilities (noted by 19% teachers at pre and noted, 37% teacher at post).

Facilitators/positive aspects that were found to be significantly different from pre to post intervention were benefits incurred by whole school PA challenges throughout the school year (noted by 26% teachers at pre and noted by 89% teachers at post). The increase in teachers confidence to take PA sessions from pre to post (noted by 13% at pre and noted by 69% at post) and perception of benefits associated with cross curricular games to promote PA (noted by 33% at pre and 74% at post).

Table 4.6: Barriers to the implementation of physical activity pre- and post-intervention

	N	Pre	Post	P
Is time constraints a barrier to physical activity?	46	96%	87%	.157
Is curriculum constraints a barrier to physical activity?	46	54%	72%	.059
Is class behaviour a barrier to physical activity?	46	13%	6%	.317
Is lack of teaching resources a barrier to physical activity?	46	11%	15%	.480
Is school facilities/equipment a barrier to physical activity?	46	19%	37%	.059

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

Table 4.7: Facilitators to the implementation of physical activity pre- and post-intervention

	N	Pre	Post	P
Does classroom physical activity games further facilitate physical activity?	46	52%	59%	.513
Do cross curricular games further facilitate physical activity?	46	33%	74%	.004
Does the presence of an Energiser facilitate physical activity?	46	69%	73%	.617
Does physical activity challenges in school facilitate more physical activity?	46	26%	89%	.000*
Do the school facilities/Equipment facilitate physical activity?	46	37%	35%	.808
Do multiple physical activity break facilitate physical activity?	46	43%	54%	.336
Does your confidence to lead physical activity further facilitate physical activity?	46	13%	69%	.000*

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

4.4.2 Physical Activity Logbook Analysis

Teachers from the intervention group (n=96) were asked about the children's level of engagement in PA and PE throughout the course of the intervention. 36 (34% of the total) teachers returned data. This data was documented using a PA logbook by each teacher which was completed daily over a two week (February 6th – February 17th) period. Findings from this are presented in Table 4.8 and 4.9.

For analysis purposes, this data was broken into total PA (exclusive of PE) per week and per day, total PE (exclusive of PA) per week and per day and total activity (inclusive of both PA and PE) per week and per day.

Descriptive analysis, from week 1 of the PA logs found that PA (excluding PE) weekly time was 73.3 ± 22.7 minutes, with an average of 14.66 ± 4.54 minutes spent at PA per day. In relation to PE curriculum time, classes engaged in 44.4 ± 21.3 mins per week, which was conducted on one designated day of the week (see table 4.8)

Table 4.8: Intervention group physical activity logbook mean per day and per week (week 1, February, 2017)

	N	Minutes per day (Mean ± SD)	Minutes per week (Mean ± SD)
Total physical activity (excluding PE)	36	14.66 ± 4.54	73.3 ± 22.7
		Minutes per week (Mean ± SD)	
Total PE (excluding physical activity)	36	44.4 ± 21.3	

Similar results were found from week 2 of the PA logs. Through PA alone, classes accumulated 60.3 ± 16.4 minutes per week, with an average of 12.74 ± 3.28 minutes per day accumulated. In relation to PE, classes engaged in 40.8 ± 13.3 mins/week.

Table 4.9: intervention group physical activity logbook results (week 2, February, 2017)

	N	Minutes per day (Mean ± SD)	Minutes per week (Mean ± SD)
Total physical activity (excluding PE)	36	12.74 ± 3.28	63.7 ± 16.4
		Minutes per week (Mean ± SD)	
Total PE (excluding physical activity)	36	40.8 ± 13.3	

4.5 Trends across Time

An in-depth analysis of longitudinal trends from baseline to phase 2 of Project Spraoi is beyond the scope of this research. However, as the 'step-back approach' of this study, is a follow on from baseline and phase 1 findings, this section provides a brief overview of the impact of Project Spraoi on the markers of health and FMS proficiency on Irish children across a 3 year period. Data presented includes baseline and Phase 1 data which precedes this study and is the work of previous Energisers (Merrotsy 2018; Bolger 2018; Bolger 2018; Murphy 2017). Variables presented in this analysis are 550m run (CRF), BMI (kg/m2), WC (cm), MVPA (mins/day), and total FMS proficiency for both age cohorts. Due to the fact that the current study used repository control data only intervention data is presented in this analysis (as 3 time points for control data was not collected). Mean scores from previous work is included in conjunction with mean scores from this work to provide these trend data.

With regard to the change over time (i.e. baseline to phase 2 post intervention data collection), both 5 -7 year olds and 9 -11 year olds highlighted increases in relation to MVPA (mins/day) (Figure 4.9 & 4.10), and total FMS proficiency (figure 4.11 & 4.12) among 5-7 and 9 -11 year old groups. Further to this, a positive decrease was found for the 550m run (minutes) (Figure 4.3 & 4.4). Both BMI (figure 4.5 & 4.6) and WC (Figure 4.7 & 4.8) were found to have increased among both cohorts.

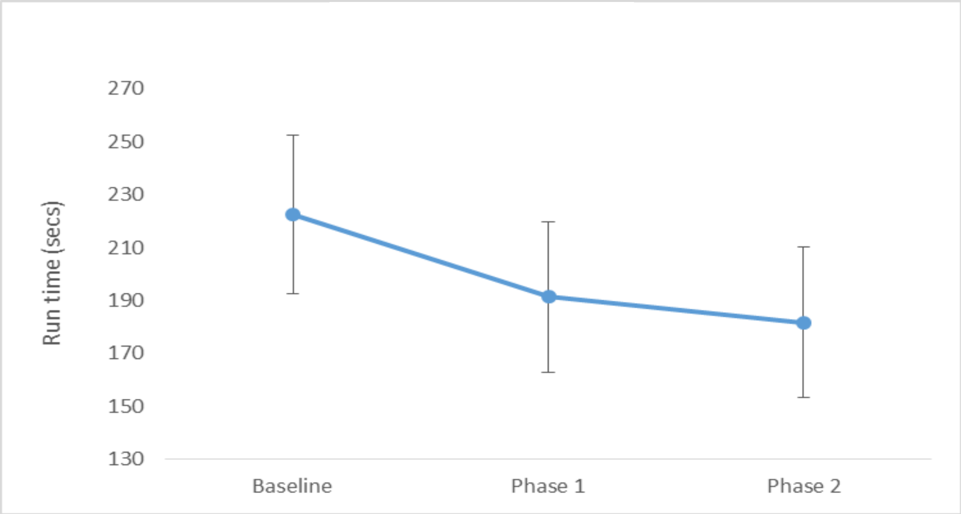

Figure 4.3: 550m run from baseline to phase 2 (5-7 year old group)

Figure 4.3 highlights 550m run scores for the 5-7 year old group. These scores were 222.4 ± 29.9 secs at baseline, 191.4 ± 28.5 secs at end of phase 1. At the end of phase 2 these scores decreased to 181.6 ± 29.9 secs. This declining trend (41 secs faster) to complete the 550m run suggests that CRF increased over time.

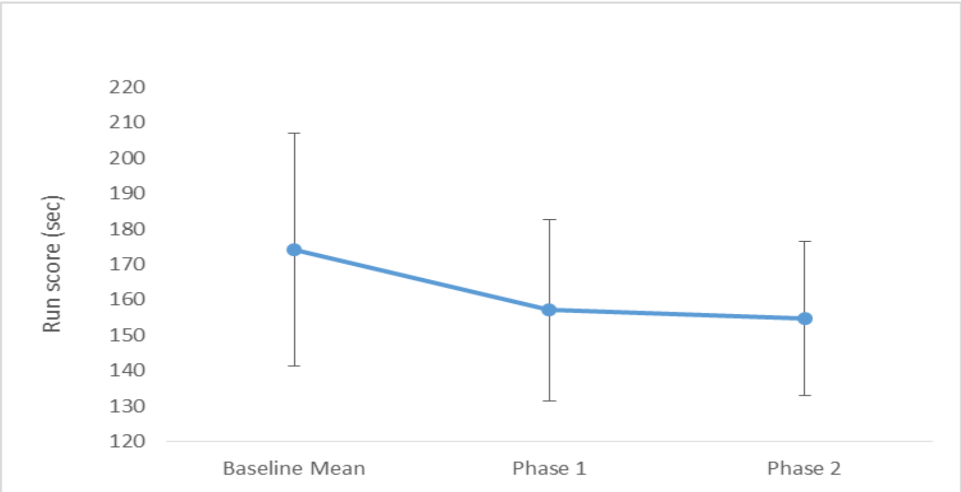

Figure 4.4: 550m run time from baseline to phase 2 (9-11 year old group)

Figure 4.4 highlights 550m run scores for the 9-11 year old group. These scores were 174.2 ± 32.9 secs at baseline, 157.1 ± 25.5 secs at phase 1. At the end of phase 2 these scores decreased to 154.7 ± 21.7 secs. This declining trend (20 secs faster) over time to complete the 550m run suggests that CRF increased over time.

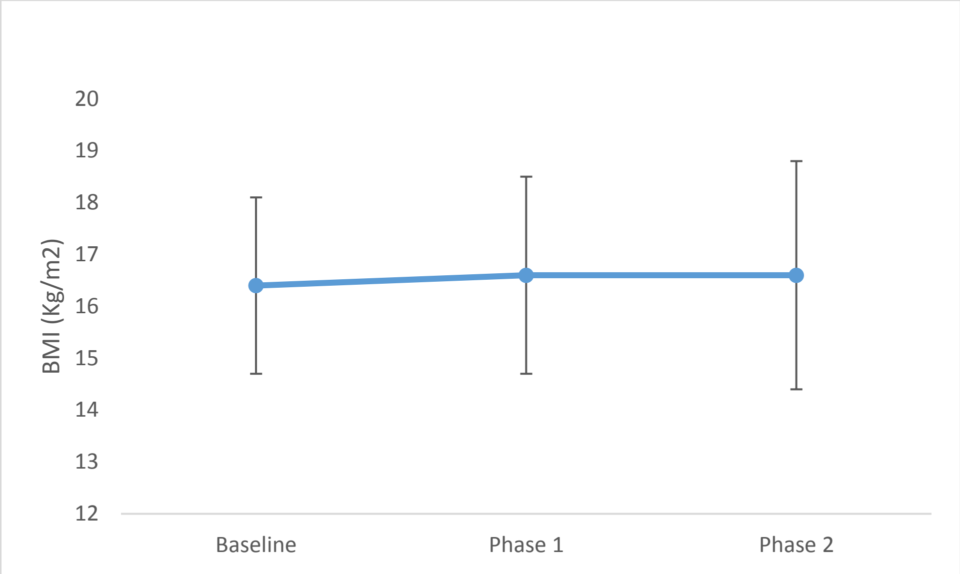

Figure 4.5: BMI from baseline to phase 2 (5-7 year old group)

Figure 4.5 highlights BMI scores for the 5-7 year old group. These scores were 16.4 ± 1.7 at baseline, 16.6 ± 1.9 at the end of phase 1 and 16.6 ± 2.2 at the end of phase 2. This trend suggests that there was minimal increase in BMI from baseline to phase 1, but then a plateau occurred from phase 1 to phase 2.

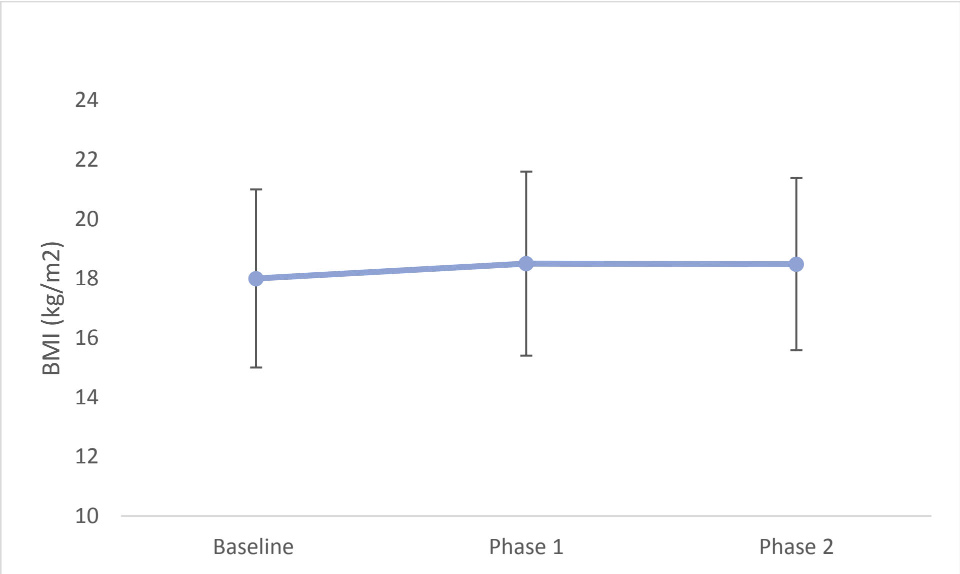

Figure 4.6: BMI from baseline to phase 2 (9-11 year old group)

Figure 4.6 highlights BMI scores for the 9-11 year old group. These scores were 18.4 ± 3.0 at baseline, 18.6 ± 3.1 at the end of phase 1 and 18.6 ± 2.9 at the end of phase 2. This trend suggests that there was a slight increase in BMI from baseline to phase 2.

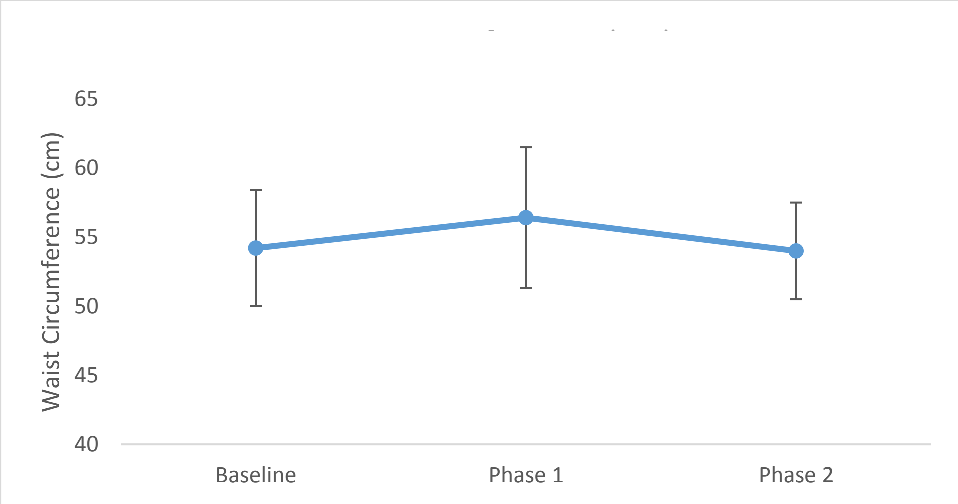

Figure 4.7: WC scores from baseline to phase 2 (5-7 year old group)

Figure 4.7 highlights WC scores for the 5-7 year old group. These scores were 54.2 ± 4.2 cm at baseline and increased to 56.6 (± 5.1) at the end of phase 1. At the end of phase 2, these scores decreased to 54.0 ± 3.5. This trend suggests that while there was an increase in WC (2.4 cm) from baseline to the end of phase 1, WC returned to baseline levels at the end of phase 2 (2.6 cm decrease).

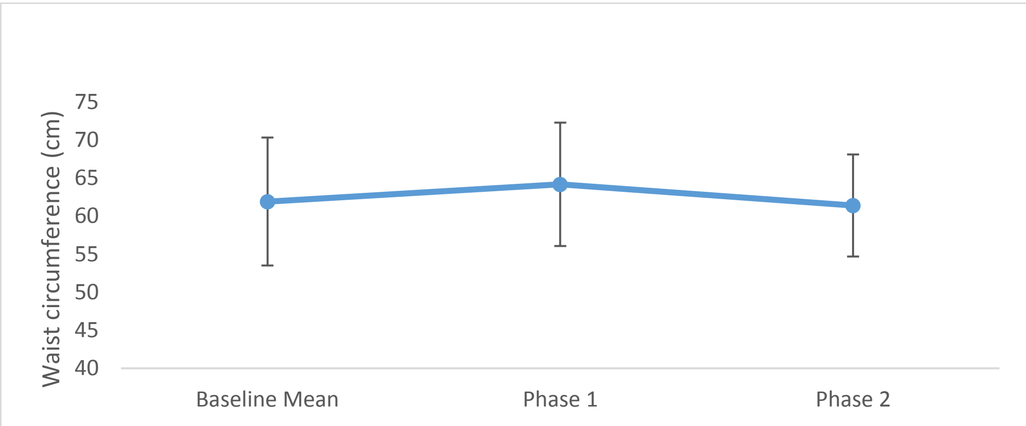

Figure 4.8: Waist circumference from baseline to phase 2 (9-11 year old group)

Figure 4.8 displays WC score for the 9-11 year old group. At baseline, mean WC scores was 61.9 ± 8.4. These scores increased to 64.2 ± 8.1 at the end at phase 1, but decreased to 61.4 ± 6.7 at the end of phase 2. This trend suggests that while there was an increase in WC from baseline to phase 1 (2.3 cm increase), by the end of phase 2 WC had returned to a level similar to baseline (2.8 cm decrease from the end of phase 1).

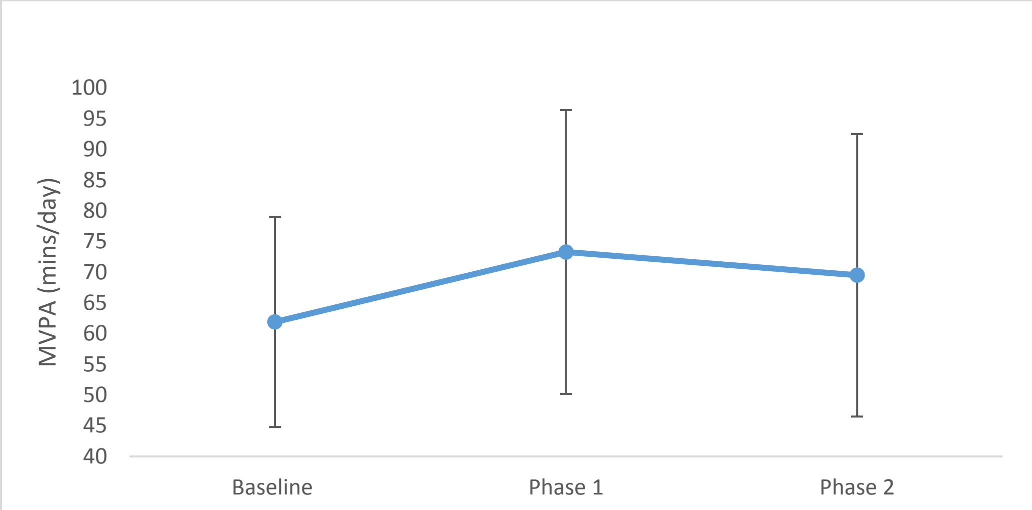

Figure 4.9: MVPA from baseline to phase 2 (5-7 year old group)

Figure 4.9 displays MVPA scores for the 5-7 year old group. The MVPA score at baseline was 61.9 ± 17 mins/day which had increased to 73.3 ± 23.1 mins/day at the end of phase 1. At the end of phase 2, these scores decreased to 69.5 ± 23.3 mins/day. The increase in MVPA/day (11 mins) from baseline to phase 1 suggests that PA levels increased. However, the decrease in MVPA/day (4 mins) from phase 1 to phase 2 suggests that these PA levels dropped slightly but still remained higher than baseline levels.

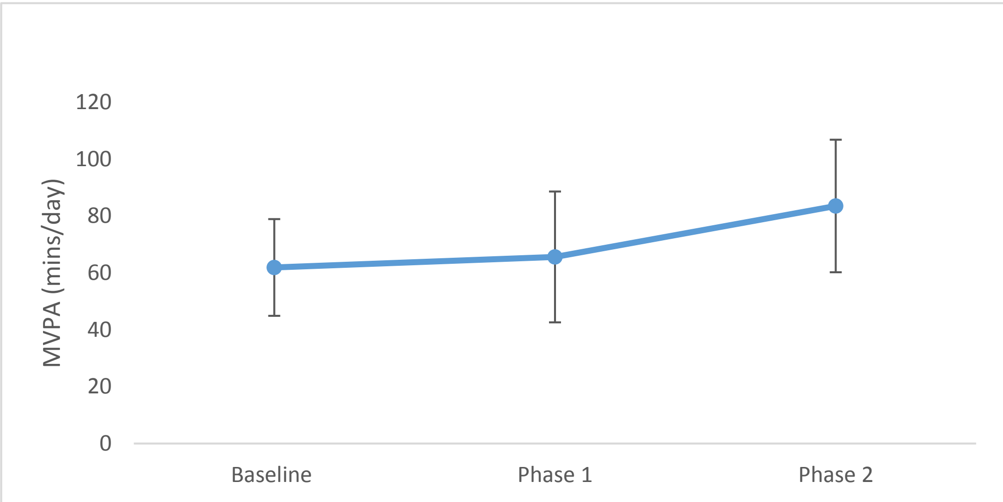

Figure 4.10: MVPA from baseline to phase 2 (9-11 year old group)

Figure 4.10 displays the MVPA scores for the 9-11 year old group. These scores were 61.9 ± 17 mins/day at baseline and increased to 65.6. ± 23 mins/day at the end of phase 1. These scores increased further to 83.5 ± 23.3 mins/day at the end of phase 2. This inclining trend (22 additional minutes of MVPA) over time suggests that PA levels increased over time.

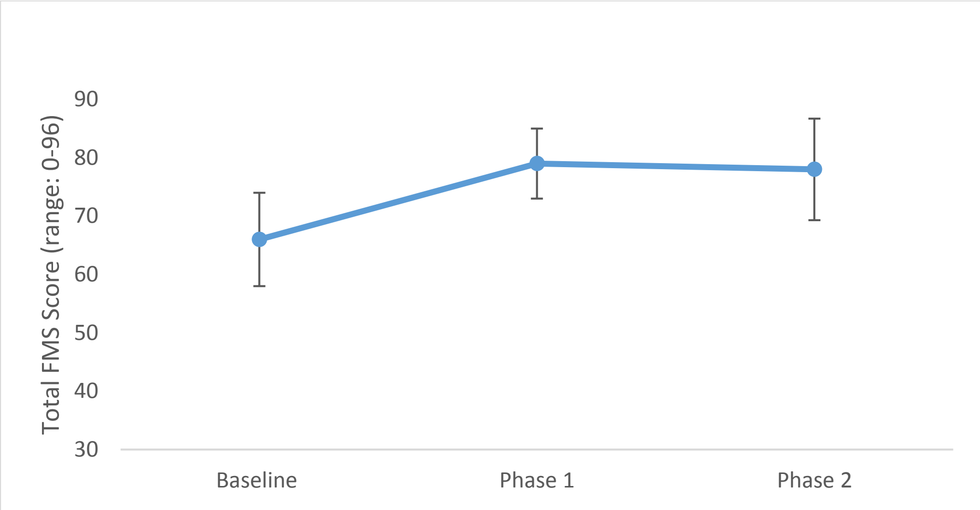

Figure 4.11: Total FMS proficiency from baseline to phase 2 (5-7 year old group

Figure 4.11 presents the total FMS proficiency score of the 5-7 year old group. These scores were 67 ± 8 at baseline and increased to 79 ± 6 at the end of phase 1. At the end of phase 2, total FMS score was 78 ± 8.7, similar to that achieved at the end of phase. The increase (of 12) from baseline to the end of phase 1 suggests FMS proficiency increased across this time, while the proficiency levels were maintained from phase 1 to phase 2.

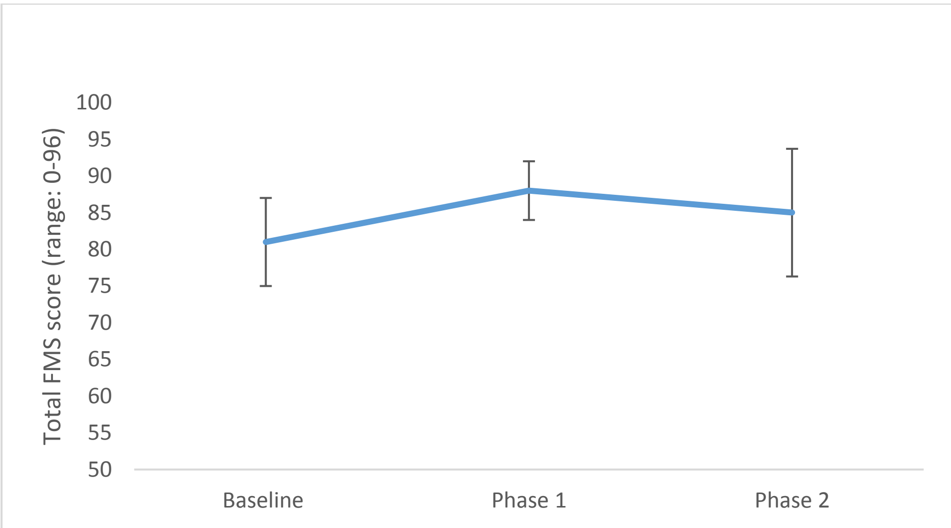

Figure 4.12: Total FMS proficiency score from baseline to phase 2 (9-11 year old)

Figure 4.12 displays the total FMS proficiency score for the 9-11 year old group. Total FMS scores were 82 ± 8 at baseline and increased to 88 ± 4 at the end of phase 1. At the end of phase 2, this score decreased to 85 ± 8.7. This trend suggests that while FMS proficiency increased (by a score 6) from baseline to phase 1, it decreased (by a score of 3) from phase 1 to 2. However, total FMS score at the end of phase 2 remained higher than that at baseline.

Chapter 5:

Discussion

5.1 Overview of Discussion

This study is the first of its kind to evaluate a school-based health promotion intervention using a step back approach aimed at increasing PA levels, enhancing FMS proficiency, and reducing the prevalence of overweight / obesity amongst Irish children. While only 5-7 year old children and 9-11 year old children had measurements recorded, the intervention was a whole school initiative. Therefore, the intervention reached 1375 children and 62 school staff from 4 primary schools in Cork, Ireland. While the intervention was delivered to 1375 children a total of 588 children were a part of the evaluation (with 2 additional schools being control schools).

This chapter discusses the following elements: (i) findings relating to baseline analysis, (ii) impact of the intervention on health markers, (iii) impact of the intervention on FMS proficiency, (iv) process evaluation and (v) Project Spraoi trends to date. Key findings relating to each section are presented and discussed relative to previous literature in the field. Where possible, practical implications and policy recommendations are provided based on the findings of this research.

5.2 Baseline Analysis

A total of 588 children (intervention n=282; control n=306) participated in this research project. At baseline, both the 5-7 and 9-11 year old children in the intervention groups were found to be significantly taller, have a larger body mass and greater WC than their control counterparts. A possible explanation for this may be that the mean age for the intervention group was 7.20 ± .51 and the mean age for the control group was 6.62 ± .54. Similarly among the 9-11 year old cohort, the mean age for the intervention group was 11.25 ± .54, while the control groups mean age was 10.53 ± .52. Stratton *et al.* (2007) outline that increases in height and mass occur with age and so the greater age of the intervention group may explain the larger values for these variables reported among the intervention group compared to the control.

Approximately 1 in 5 participants were either overweight or obese, with 21% of the 5-7 year old group and 18% of the 9-11 year old group in the overweight or obese category. Such findings are in agreement with previous representative samples of Irish primary school children (Heinen *et al.* 2014; O'Leary *et al*. 2018) and shows Irish children to have among the highest rates of overweight and obesity in Europe (Ahrens *et al*. 2014). Across the European Union (EU) countries it is estimated that 23% of boys and 21% of girls are overweight or obese with Ireland ranked in the top 50% with more than 20% of Irish children overweight or obese (Organisation for Economic Co-Operation and Development and European Union, 2016).

Among the 5-7 year old group, children in the intervention group were found to be significantly faster in the 550 metre run test and to score better in locomotor skills and total FMS ($p<0.05$) than their counterparts in the control group. As the intervention was conducted in the intervention schools in the previous two years, this may have resulted in improved cardiovascular fitness and FMS levels among intervention children. Interestingly, these differences between control and intervention children at baseline were not reported among the 9-11 year old children. A potential explanation for this discrepancy maybe that younger children have rapid increases in both FMS proficiency and CRF than their older counterparts. Lubans *et al*. (2010), reported that children under the age of 8 see rapid improvements in overall FMS and CRF compared to an older group, which in this study were 12 year olds. The author further states, that this may be due to the fact that the younger group had a low FMS and CRF training exposure at the start of the intervention and hence were more likely to see spikes in improvement early on relative to their older counterparts who had 2 years more exposure to FMS and CRF (Lubans *et al*. 2010).

5.3 Impact of the Intervention

5.3.1 Impact of the intervention on markers of health – Hypotheses 1

With regard to markers of health the null hypotheses was neither accepted nor rejected. Perhaps hypothesising on 'markers of health' was overly ambitious, due to the complexity of childhood obesity and its multifaceted nature (Wang et al. 2015)
Among both age cohorts, height and mass showed significant differences with the intervention group getting taller and heavier relative to the control groups ($p<.001$). A possible explanation for this may be due to the fact that there was a longer period between pre and post testing among the intervention group. For example, anthropometric measures for the intervention group were collected between the 19th and 25th of September, pre intervention and between the 29th May and 16th June, post intervention. The control groups data was collected between the 9th and 15th of November, pre intervention and between the 16th and 23rd of May, post intervention. This time lapse (approximately 4 months) was due to timetable constraints and has been identified as a limitation of the current study and may explain the discrepancy between groups.

Interestingly, for the 9-11 year old group, WC did not increase significantly from baseline to follow up for the intervention group ($p>.05$) but did increase for the control group ($p<.05$). Hence, despite the increase in height found among the intervention group the same increase was not found for WC, highlighting that individuals got taller but their girth size remained the same, suggesting an overall positive improvement in waist to height ratio among 9-11 intervention children. Such findings support that of Brambilla *et al*. (2013) where they found weight to height ratio improved following a primary school intervention programme that focused on enhancing PA levels. Brambilla *et al*. (2013) further state that WC to height ratio, is a better predictor of adiposity than BMI among children as results are highly reproducible given the ease at which the bony landmarks required for measurement can be located.

Such findings from this study are in support of findings from a systematic review by Tompsett *et al*. (2017) who reported that it is not conclusive that health promotion interventions impact positively on BMI status among primary school children. Furthermore, in the review, Tompsett *et al*. (2017) found that only four of nine (44%) interventions that were evaluated in terms of BMI revealed significant positive effects. It has been suggested that longer interventions are more effective for the alteration of BMI than shorter interventions (Back Giuliano Ide *et al*. 2005; Dobbins *et al*l. 2009; Kavey *et al*. 2006; Williams *et al*. 2002). Further to this, other factors may influence BMI such as nutrition and home health related behaviours (Lai *et al*. 2014). While the focus of this study was on the school environment greater efforts may be needed to target these elements of children's lives.

In relation to CRF among 5-7 year olds, both control and intervention groups improved significantly. The control group were found to have a greater improvement compared to the intervention group, whereby the control group improved by 20 seconds and the intervention group improved by 13 seconds. However, when looking at the findings in more depth, the intervention groups test completion time (181 seconds) was still 3 seconds faster that the control group (184 seconds) at follow-up. Furthermore, as discussed in the previous section, the intervention group had faster times at baseline (194 seconds', intervention v 204 seconds', control) possibly due to the previous year's delivery of Project Spraoi positively impacting on CRF levels. As a result it may be that the control group had more scope for improvement relative to the intervention group and hence improved significantly more than the intervention group. Among the 9-11 year old group, both the intervention and control group improved significantly, however there was no significant difference between the two groups.

Another potential reason for the control group making significant improvements may be due to the fact that these schools contained vast PA facilities (a large grass field, an astro-turf pitch, a large yard, a large indoor sports hall and a small sports hall) and equipment when compared to 2 of the intervention schools who had limited space and shared a sports hall. The findings from this study provides support that the Project Spraoi intervention shows continuous improvement across 3 years in relation to the enhancement of CRF (Fig 4.5 & Fig 4.6). Furthermore, as the 'huff and puff' sessions were targeting the improvement of CRF, it would seem that the intervention was effective in doing this. The current study indicates that CRF could be a useful marker of health among school-aged children. This is similar to previous Irish and European research (Hussey *et al.* 2007; Ruiz *et al*. 2006). Furthermore, as evidence from a systematic review has found that low CRF is associated with obesity, high BP and metabolic syndrome (Janssen & Leblanc, 2010) in youth, the promotion of regular high intensity activity is recommended. Cardiorespiratory fitness was estimated based on time taken to complete a 550-m run, which is considered a straight forward measure (Rush *et al*. 2016). Therefore there is merit in considering the use of this test nationally on a biannual basis as a means of informing teachers, parents and health professionals of levels and trends among children.

Findings relating to accelerometer use need to be interpreted with caution due to the small sample size included in the control group (n=13 for 5-7 year old group and n=19 for 9-11 year old group). Repository control group data limited the amount of individuals meeting the required criteria. Hence, a single recorded score that is an outlier to the mean score may result in findings being somewhat skewed. For example, at baseline, 2 children from the 5-7 year old group with the highest recording from the control group recorded a score of 93 ± 1.2 minutes/day with the next highest score being 81 minutes/day. At post intervention, the mean highest score from the top 3 children, MVPA was 85 ± 3.2 minutes/day and the next highest score recorded was 77 minutes/day. Similarly, among the 9-11 year old group, at baseline, 3 children recorded 118 ± 2.5 minutes/day with the next recorded score being 101 minutes/day and at follow-up the mean of the 3 highest scoring children was 112 ± 6.0 minutes/day with the next recorded score being 85 minutes/day. Findings from this study suggest that among the 5-7 year old group there was a large increase in the control group which may be partly explained by small sample size and 1 – 2 children inflating the results. For the 9-11 year old group, while both intervention and control groups improved significantly there was no significant difference noted between both groups. Findings from the current research indicate a positive intervention effect with an increase in 5 minutes per day among the younger cohort and 10 minutes per day among the older cohort. Ordinarily these findings would be viewed as being extremely positive. In the current research these findings may be masked a little due to the high MVPA scores among the control group at follow up. To make more definitive conclusions relating to MVPA larger sample sizes are recommended, in particular for the control groups.

Relative to SB, the younger (5-7 year old) group were found to partake in less PA time relative to their older (9-11 year old) counterparts for both control and intervention groups at baseline and follow up. In relation to the 5-7 year old group, mean daily sedentary time was constant among intervention children while it was found to increase by 18 minutes per day among control children. In relation to the 9-11 year old group, a decrease in SB was found from baseline to follow up (14 minutes per day) among intervention children with the control group reporting similar levels of SB. Such findings, would indicate positive findings for intervention children, however, due to the small sample size of the control group and accelerometer data being collected at different stages of the year, findings must be interpreted with caution. Future research should utilise a larger sample size and disseminate accelerometers at similar time points, for clear comparisons to be made. Nonetheless, findings from this study are in support of Salmon *et al.* (2010) who found a positive association with a health promotion intervention and SB.

5.3.2 Intervention Effect on FMS Proficiency – Hypotheses 2

With regard to FMS the null hypotheses was rejected, as there was a significant positive difference in FMS from baseline to follow up.

In relation to total FMS proficiency, significant improvements in favour of the intervention group relative to the control group were found among both age cohorts ($p<0.05$). Findings from the current study support those of Mitchell *et al*. (2013) who found significant increases in the proportion of children who demonstrated mastery (i.e. could correctly perform all components of the skills) in all 12 skills assessed following a 6 week Project Energize intervention (that involved the support and mentorship of classroom teachers for the delivery of FMS based teaching during their PE and fitness classes) ($p<0.01$). Cohen *et al*. (2015), conducted an evaluation of a 12 month FMS intervention study, testing at pre intervention, mid-intervention (6 months) and post intervention. No significant difference was found from pre- to mid-intervention for locomotor, object-control proficiency or total FMS among Australian primary school children (N=460, mean age: 8.5 ± 0.6 years) ($p>0.05$). However, they did find that the intervention group improved significantly more than the control group from pre- to post-intervention for total FMS score (as well as PA and CRF) at the end of the intervention i.e. at 12 months ($p<0.05$). These findings suggest that longer interventions may produce greater improvements in FMS (and markers of health). The current intervention which was carried out over 1 school year (September – May) involved approximately 100 minutes of instruction time from the teacher and the Energiser for each FMS. The Department of Education, Victoria, Australia (1996) recommend 240-600 minutes of instruction for the mastery of each FMS and so an intervention of longer duration may have an even greater effect on children's FMS proficiency than the current intervention.

Furthermore, it has been suggested that intervention duration is positively associated with sustained PA impacts (Lai *et al* 2014).

Overall, the findings of the current study are similar to those reported by Jarani *et al*. (2016) and Bolger *et al*. (2018) who following a 5-6 month, FMS based intervention reported significant improvements among the intervention groups in FMS proficiency. The novelty of this study is that it was conducted via a step back approach giving more autonomy to school staff in the implementation of the project. Previous findings suggest developing FMS has the potential to promote physically active lifestyles in childhood, adolescence and adulthood (Breuer & Wicker, 2009). Stodden et al.'s (2008) conceptual model suggested that the development of FMS is a key factor in their proposed 'spiral of engagement' (along with higher perceived competence, higher PA levels and greater fitness levels) that will promote a healthy weight. Systematic reviews have reported positive associations between FMS and physical activity, fitness (Cattuzzo *et al*. 2016; Lubans, *et al*. 2010) and healthy weight status (Lubans *et al*. 2010). Although significant improvements in PA did not result from the current intervention, studies have reported a positive relationship between childhood FMS levels and adolescent PA (Barnett *et al*. 2009; Jaakkola *et al*. 2015), and adult PA (Lloyd *et al*. 2014). Furthermore, findings suggest that improvements in FMS may positively affect markers of health later in life (through continued or improved engagement in PA (Barnett *et al.* 2009; Jaakkola *et al.* 2015)). These suggestions provide support for the implementation of FMS interventions as opposed to general PA interventions, as the development of FMS may lead to long-term PA and health. Moreover, findings from this study suggest that an exercise specialist, such as the Energiser in this study, working with school staff to increase their competence and confidence in taking FMS lessons, is effective in improving FMS proficiency of children.

Findings from Project Spraoi to date (inclusive of this study) would suggest consistent improvements in FMS proficiency from baseline to stage 2 for the 5-7 year old group (Fig 4.11), while the 9-11 year old group, from baseline to stage 2 see a spike in proficiency from baseline to stage 1 and plateau from stage 1 to stage 2 (Fig 4.12).This finding is in support of Logan *et al*. (2017), who suggest that FMS interventions highlight greater improvements in FMS proficiency from 4-6 years of age as opposed to older >6 year old cohorts. To ensure that children develop a high level of FMS during their primary school years, FMS levels should be assessed at the end of each year. If trainee teachers were to undertake a module dedicated to FMS as part of their college degree and/or if a modified (i.e. more basic) version of the TGMD-2 was developed, it would be envisaged that teachers would be able to assess the FMS level of children in real time. The results of such assessments and feedback should then be passed onto parents/guardians in a similar way to the academic results (during parent-teacher meetings, report cards and so on). This may encourage teachers to place more of an emphasis on the quality of their teaching of FMS and PE, and encourage parents to encourage children to practice FMS and engage in PA at home. The FMS intervention conducted as part of this research found that when such an emphasis is placed on FMS, significant improvements in skill proficiency can be attained.

5.4 Process Evaluation – Hypotheses 3

With regard to process evaluation the null hypotheses was rejected as there was an increase in the delivery of physical activity sessions among participating teachers and there was positive change in barriers/ facilitators from baseline to follow-up.

Elements of process evaluation for this study included teacher questionnaires and class PA logbooks. Teacher questionnaires were completed at pre (n=46) and post (n=46) intervention. Class (n=36) PA logbooks were completed over two consecutive weeks (February 6^{th} – February 19^{th}). The questionnaires identified the barriers and facilitators of the project, while the PA log sheets identified the dose (the quantity of intervention delivered) of the project.

In relation to findings from teacher questionnaires at pre intervention, 96% of teachers noted that time constraints were the biggest barrier they faced in implementing physical activity throughout the school day, while only 13% of teachers stated that they had confidence to lead PA classes effectively. This pre intervention finding, is in agreement with Morgan *et al.* (2008) findings, where respondents (n=365) held only a 'moderate' level of confidence to lead PE teaching classes in a primary school setting in Australia.

The central tenet of this study was to create greater school autonomy in the implementation of the Project Spraoi programme via a step-back approach. This was done to further analyse the effectiveness of the programme with less direct Energiser contact. A positive finding from this study was that at post intervention, 69% of teachers reported confidence to lead PA classes, while this shows there is still improvement possible in this space, it was a vast improvement to baseline (13%). Morgan *et al*(2008), further state that to increase teacher's confidence to lead PE classes they need a wider variety of PE resources that suit all student capabilities and this should be further complemented with relevant and purposeful professional development for all classroom teachers. Morgan *et al*. (2008) recommendations support the step-back approach mechanisms used in this study to increase teacher confidence to lead PA classes. Such mechanisms included experts (Energisers) delivering PA sessions with the assistance of the class teacher, that was lesson plan focused. The teacher would then be advised to conduct that lesson plan throughout the school week. Further to this, PA games and exercise routines were prescribed via an 'Outdoor & Indoor Physical Activity Games' booklet (see appendix G). The Energiser also provided professional development workshops and resources for teachers in relation to FMS and PA development throughout the school year to promote confidence and competence in teachers in order to increase habitual PA for the class.

Further findings from the teacher questionnaires found that whole school PA challenges facilitated greater levels of PA. Interestingly at pre intervention only 26% of teachers noted this as a facilitator, at post intervention this percentage increased to 89% ($P<.001$). This provides support for the role of the Energiser as a facilitator and manager of the programme as opposed to the more 'hands on' approach of the Energiser in previous iterations of Project Spraoi. Such a finding is in agreement with the work from Project Energize (Rush *et al*. 2016).

Project Spraoi aims to promote 20 minutes huff and puff throughout each school day excluding lunch and break times and PE curriculum times (Coppinger *et al.* 2016). Findings from the PA logbook revealed that children in Project Spraoi schools accumulated 14.66 ± 4.54 minutes per day of PA on average over the first week and for the second week there was a slight decrease with 12.74 ± 3.28 minutes in PA pursuits. Findings from this study show that schools did not reach the desired 20 minutes of PA per day. However, these findings are still very positive relative to Project Spraoi findings when the programme was first initiated in schools, where it was found by Delaney *et al.* (2015) that classes spend 6.2 ± 3.3 minutes at PA pursuits on a daily basis. In a more recent iteration of Project Spraoi, Murphy *et al*(2018), found that classes partook in 11 ± 2.2 minutes of daily PA.

Further to this, and given that children spend more than one third (5 hours 40 minutes) (Irish National Teacher's Organisation, 2017), of their waking day (13-15 hours) (Hirshkowitz *et al*. 2015) in school, such classroom activity levels found in this study enabled children to accumulate a significant portion of the recommended levels of PA while in school. Notably, it was not required that this 20 minutes be accumulated in the one session; smaller more frequent activity breaks were also encouraged (e.g. 4 x 5 minute activity breaks throughout the school day), to overcome curriculum constraints barriers. The method of breaking activity up into short bouts throughout the day is based on Project Energize, who seen positive results in markers of health and FMS (Rush *et al.* 2016).

Findings from this study may also suggest that the aim of 20 minutes physical activity each day is overly ambitious due to time constraints, which was reported in the teacher questionnaires, with 72% of teachers agreeing that curriculum constraints was a barrier to increased PA being conducted throughout the school day.

Findings from this study suggest, despite an overcrowded curriculum, Project Spraoi was able to work with teachers in a flexible manner to increase PA so that children accumulated extra exercise per day in addition to PE. Strategies such as cross curricular games, PA activity challenges, lesson plan prescription, PA game booklets and an FMS teaching manual were developed to assist teachers in the implementation of the Project. This provides further support that the Project Spraoi intervention using a step back approach is effective in increasing children's PA levels throughout the school day.

5.5 Project Spraoi Trends to Date

Findings from this study (phase 2), add to the findings of previous iterations of the Project Spraoi programme from baseline to phase 1. Thus, a clear picture of trends has emerged. Findings from baseline to phase 1 all highlight positive outcomes in relation to CRF, MVPA and total FMS proficiency. Similar positive outcomes have been found with Project Energize in relation to the same variables (Rush *et al.* 2016). However, it must be noted that the studies are not directly comparable due to the study of Rush *et al*. (2016) assessing trends over a 10 year period which included a much larger sample size (n=1348). Additionally, findings from baseline to stage 1 show natural increases for WC and BMI. Such trends found in this study are similar to those found by Turnbull *et al*. (2004) with consistent increases in body mass found overtime. However, Stratton *et al.* (2007) stresses caution when interpreting measures relating to children's adiposity overtime. They suggest that such findings may be a consequence of physical maturation (Stratton *et al*. 2007).

Further in-depth analysis of longitudinal trends from baseline, to phase 2 of Project Spraoi is beyond the scope of this research. However, trends to date highlighted in this study, show distinct improvements in the participating children's markers of health and FMS proficiency. Further to this, at a recent Project Spraoi forum in September 2018, school staff from participating schools highlighted how the Project Spraoi programme greatly enhanced the health promotion culture within the school:

"*The children loved it and all the school staff bought into it. We have kept it going in the school since the energisers have left. Each class aims to accumulate 20 minutes of physical activity every day"*

"We have a new found labour of love for physical activity since Project Spraoi"

"It was amazing to see the children's health, physical fitness and nutritional knowledge increase since Project Spraoi started in our school. A fantastic project"

(Project Spraoi forum 2018)

5.6 Limitations

The limitations of the current research are outlined below.

- In relation to measuring MVPA, there was relatively smaller control group numbers for both 5-7 year old groups (n=13) and 9-11 year old groups (n=19) in comparison to the intervention groups (n=45 for 5-7 year old group and n=45 for the 9-11 year old group). Hence a single recorded score that is an outlier to the mean score may alter the total mean findings. Such an occurrence did occur with one child in the 5-7 year old group accumulating 128 minutes of MVPA and one child in the 9-11 year old group accumulating a total of 128mins of MVPA.
- Due to limited resources, the evaluation of the interventions involved only children from a limited number of class groups. Future research should evaluate the intervention among a sample of children from every class group (i.e. junior infants to 6^{th} class).

- Due to the large sample size and the limited availability of the Project Spraoi research team members and accelerometers, testing of the intervention and control groups were not conducted at the same time. For example, PA data were collected at pre-FMS intervention from the intervention groups, during three different weeks (the weeks beginning 19th September and the 26th September) while physical activity data were collected from the control group, during the week beginning 19th November. This meant that PA data was collected from children in the intervention and control schools in different weather conditions, different day lengths, and so on. This difference in testing periods may have resulted in lower pre-intervention levels of PA among the control group (compared to what may have been recorded if PA data were collected at the same time period as the intervention groups) due to poor weather conditions and given that many sports clubs often cease club activities and training during the winter months. These potentially lower pre-intervention values may have subsequently resulted in a 'false' or misleading change in PA across time among the control group when calculated using post-intervention data.
- Accelerometer data was not collected in the same year. Repository accelerometer control data was used among the same age cohort for this study to maximise the reach of the intervention and to minimise disruption and inconvenience to other schools.
- FMS testing was carried out with class groups of children (approximately 28-30) in a large hall at the same time. While the class group was subdivided into smaller groups (4-7 per group) and these smaller groups allocated to their own testing station, children's attention to the silent demonstration provided and their on-task behaviour may have been affected by the large amount of activity going on either in their own group while they were waiting to perform their test trials or at the other testing stations around them. FMS testing of two children at a time in the hall may assist in gaining a more accurate measure of FMS proficiency and is something future research should consider.
- FMS proficiency was measured using the TGMD-2, a tool designed and developed in the United States. The skill components required to demonstrate mastery of the skills are based largely upon the technique that can be later applied to American sports (e.g. baseball). Although the technique/components of 11 out of the 12 skills can be applied across cultures (i.e. to both Irish and American sports), correct performance of the fundamental 'baseball' strike (as outlined in the TGMD-2) differs

from that of the fundamental ‘hurling’ strike (used in hurling and camogie which are among the most popular sports played by Irish children). The correct hand position for baseball requires that the dominant hand grips the bat above the non-dominant hand. However, the opposite holds for hurling/camogie (i.e. the non-dominant hand should grip the hurl above the dominant hand). As a result, children who demonstrated a correct hurling grip in their performance of the strike were awarded a zero for the strike component that required the ’the dominant hand grips bat above the non-dominant hand‘. An adapted version of the TGMD-2 may be more appropriate for use in an Irish context. Gaelic games (Gaelic football and hurling) are among most popular sports played by Irish children (and also adolescents and adults) (Fahey, Delaney and Gannon, 2005; Sport Ireland, 2016; Woods *et al*. 2010). However, the TGMD-2 lacks a number of fundamental skills (e.g. the Gaelic football kick from the hand, hurling ground strike, hurling ground block) that apply to a these sports due to its American origin and so culturally relevant FMS assessment tool should be designed.

Chapter 6:

Conclusion

6.1 Conclusion

This study adopted a step back approach with less direct contact from the Energiser and a more proactive role in the delivery of the project by school staff. This study concludes that the Project Spraoi intervention adopting a step back approach can be effective in improving FMS proficiency, increasing teacher's level of confidence to lead PA sessions, and positively contributing to school based PA. Longer intervention and follow – up may be necessary to evaluate the efficacy of the intervention in controlling the prevalence of overweight / obesity and to determine the sustainability of behavioural change. Given the current obesity epidemic and declining PA levels of youth, the inclusion of interventions in primary schools should be considered with the support of a paediatric exercise specialist (e.g. Energiser). With the estimated annual direct healthcare costs of childhood overweight and obesity (e.g. in-patient, prescription, GP visit costs) in the Republic of Ireland amounting to €1.7 million each year (Perry *et al.* 2017) and findings that highlight the tracking of overweight and obesity from childhood to later life (Evensen *et al*. 2016; Herman *et al*. 2009; Serdula *et al.* 1993; Simmonds *et al*. 2016), interventions such as this could have substantial health and economic benefits on both an individual and national level.

6.2 Practical implications and Recommendations

Firstly, the author recommends that weekly PE time for Irish primary school children should be increased. Currently, schools are 'recommended' to deliver 1 hour of PE per week (Department of Education and Science, 1999). However, a study among Irish primary schools (N=53) revealed that not all schools are timetabled for, or receive this (Woods *et al*. 2010). In fact, only 35% of Irish primary schools were timetabled for the recommended one hour of PE per week (Woods *et al*. 2010). While the current research encouraged teachers to allow children to engage in at least 20 minutes MVPA every day, process evaluation results (section 4.4) found that 'time constraints' due to a crowded curriculum was identified as the primary barrier to achieving this. This study, however found that classes accumulated approximately 15 minutes PA per day, which was largely conducted through short 5 minute breaks. This would suggest that more emphasis should be placed on shorter consistent bouts of exercise throughout each school day, in addition to a 1 hour session of PE per week. A central component of this intervention was cross-curricular PA lessons and with 74% of teachers post-intervention stating this was a facilitator in promoting PA for their class, this would further suggest that physical activity may also be incorporated into academic lessons in a cross curricular context. A study by Martin and Murtagh (2015) concurs with this, where they found that the integration of physical activity into the teaching of academic lessons was effective in increasing mean MVPA minutes per day.

While these would be significant adaptations to the current primary school structure, it is likely that the economic benefits that result would exceed the costs incurred as recent figures highlight that total lifetime costs attributable to childhood overweight/obesity in Ireland amount to over €4 billion (€16,036 per person) (Perry *et al*. 2017).

The quality of PE lessons delivered by classroom teachers has previously been highlighted as an area of concern (Morgan & Hansen, 2008) and at baseline the current study supported this with only 13% of teacher reporting confidence to lead PA session (section 4.4). It has been reported that primary school PE classes often involves large-sided games resulting in a very limited focus given to the development of movement skills, the provision of appropriate feedback and the promotion of PA (Morgan & Hansen, 2008). Inadequate time spent on PE in teacher training colleges has been identified as a barrier to the teaching of quality PE (Morgan & Hansen, 2008; Sofo & Asola, 2016). Efforts should be made to increase the quality of PE provision. Such provisions, may include the adoption of intervention protocols similar to this study where an exercise specialist is assigned among a number of schools to act as an agent of health promotion enhancement. Similar methods, which produced favourable health enhancing results have been used with Project Energize in New Zealand (Rush *et al.* 2016). In this study they had 1 energiser (exercise specialist) to 6-10 schools overseeing and assisting in the Implementation of health promotion strategies (Rush *et al.* 2016)

In Ireland, pre-service teachers are required to complete just two PE-based modules (Dublin City University, 2018; Mary Immaculate College, 2018). Furthermore, these modules are shared with other subjects, for example 'Drama and Physical Education' (Dublin City University, 2018) and 'Social, Personal, Health and Physical Education' (Mary Immaculate College, 2018). A greater amount of time should be devoted to PE in teacher training colleges so that teacher confidence and competence in the delivery of PE lessons can be developed.

Teacher specialisation (when teachers who specialise or are very competent in one subject, such as PE, swap classes with another teacher who specialises in a different subject such as music), should also be encouraged more at a local and national level as this would potentially increase the quality of PE provision.

To ensure that children develop a high level of FMS during their primary school years, FMS levels at the end of each half year should be assessed. If trainee teachers were to undertake a module dedicated to FMS as part of their college degree and/or if a modified (i.e. more basic) version of the TGMD-2 was developed, it could be envisaged that teachers would be able to assess the FMS level of children in real time. The results of such assessments and feedback should then be passed onto parents/guardians in a similar way to the academic results (during parent-teacher meetings, report cards and so on). This may encourage teachers to place more of an emphasis on the quality of their teaching of FMS and PE, and encourage parents to encourage children to practice FMS and engage in PA at home. The FMS intervention conducted as part of this research found that when such an emphasis is placed on FMS, significant improvements in skill proficiency can be attained.

Teachers should also be encouraged to allow children to take short activity breaks throughout the school day. Alternatively incorporating curriculum-focused PA breaks (i.e. PA breaks with some curriculum content included) (Mahar *et al*. 2006) throughout the day and/or integrating PA into their academic lessons (Martin & Murtagh, 2015; Riley, Lubans, Holmes, & Morgan, 2014; Riliey, Lubans, Holmes, & Morgan, 2016) could be incorporated into the school day. In this way, teachers can provide opportunities for children to engage in PA as well as enhance their learning. Studies that have investigated the effect of such activity during the school day have reported better attention (Palmer, Miller, & Robinson, 2013), better on-task behaviour (Goh *et al.* 2016; Mahar, 2011) ,enhanced enjoyment (Vazou & Smiley-Oyen, 2014), better cognitive function (Hill *et al.* 2010), better concentration levels (Tsai, Boonpleng, McElmurry, Park, & McCreary, 2009) and higher academic scores among children (Caterino & Polak, 1999; Hillman & Pontifex 2009; Watson *et al*. 2017) in addition to positively impacting PA levels (Martin & Murtagh, 2015; Murtagh *et al*. 2013). It has also been found that less disciplinary intervention is required among children who engage in such activity breaks during the school day (Barry *et al*. 2003).

Given the effectiveness of this intervention, it is recommended that policy makers adapt or introduce new policies that would result in mandatory daily PA sessions. Such sessions would be FMS-based and also include activities that would facilitate children's engagement in MVPA. Health-promoting countries such as Denmark and Finland have used this strategy (adapting/introducing new school-based PA policies) in an attempt to increase PA levels and/or reduce overweight/obesity. For example, in Denmark since 2014 primary schools are now required to deliver 45 minutes of mandatory PA every day (European Commission & WHO, n.d.). In Finland, reformed national policies that require schools to provide compulsory health education and PE to children are among those believed to have contributed to the country's stabilising overweight/obesity levels (WHO, 2015). Ireland should implement policy changes at the primary school level as such changes have the potential to enhance the health of children and future generations of adolescents and adults.

6.3 Recommendations for Future Research

- Further research should adopt a greater step back approach, whereby the Energiser provides only a consultancy and support role school staff in the implementation of the Project Spraoi intervention. Potentially, this type of approach could include a wider range of schools who have previously implemented the Project Spraoi intervention. Such a study would further evaluate the reach, fidelity and sustainability of the programme going forward.
- Future avenues for research should include a more in-depth investigation of the impact of the intervention on teachers. Lack of time was identified as the primary barrier to implementation of 20 minutes daily MVPA, which has also been reported elsewhere (Usher & Anderton, 2014; Amini *et al.* 2015). In order to overcome time related barriers it has been suggested that principals allocate adequate time to PA within the weekly timetable to ensure compliance (Usher & Anderton, 2014). Whether this is feasible in Irish primary school settings should be explored.
- A nationwide evaluation of Irish pre-school children's FMS proficiency should be conducted. This would add to the body of research among Irish primary school children highlighted by Bolger *et al*. (2017) and Farmer *et al*. (2017) and among post-primary school children (O'Brien *et al*. 2016).

- Given that children have the potential to master FMS by the age of 6 years and that the early childhood years have been identified as a critical period for FMS development (Gallahue & Ozmun, 2006), it is essential that this development process begins during the pre-school years so that children's FMS proficiency levels are in line with the recommended levels for their age as they progress through pre-school and transition to primary school. Therefore there is merit in the delivery of Project Spraoi in a preschool setting.

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Appendices

Appendix A: Information Sheet for Parents/Guardians

Consent Form for Parents/Guardians and Children

Study title: Project Spraoi

Name of Researcher: Conor Hammersley

If you agree, please tick the box:

I agree to allow my child to take part in the physical measurement, fitness testing & questionnaire ☐

I agree to allow my child to be videoed in the fundamental movement skills testing ☐

Print Name of Child: ______________________________

I agree to take part in the above study

Child Signature: ______________________________

Or

Colour the box YES NO

Parent/Guardian Signature:

Sign: ______________________________ Date: ________________

Parent/Guardian - If you would like to receive texts to remind your child to wear their activity monitor please provide a text number here: ________________________________

If you require further information please contact:

Conor Hammersley

MSc Researcher,

Dept of Sport, Leisure & Childhood Studies,

Cork Institute of Technology.

T: 087 2355119

E: conor.hammersley@mycit.ie

Dr. Con Burns, Ms Jean O'Shea

MSc Supervisors,

Dept of Sport, Leisure & Childhood Studie

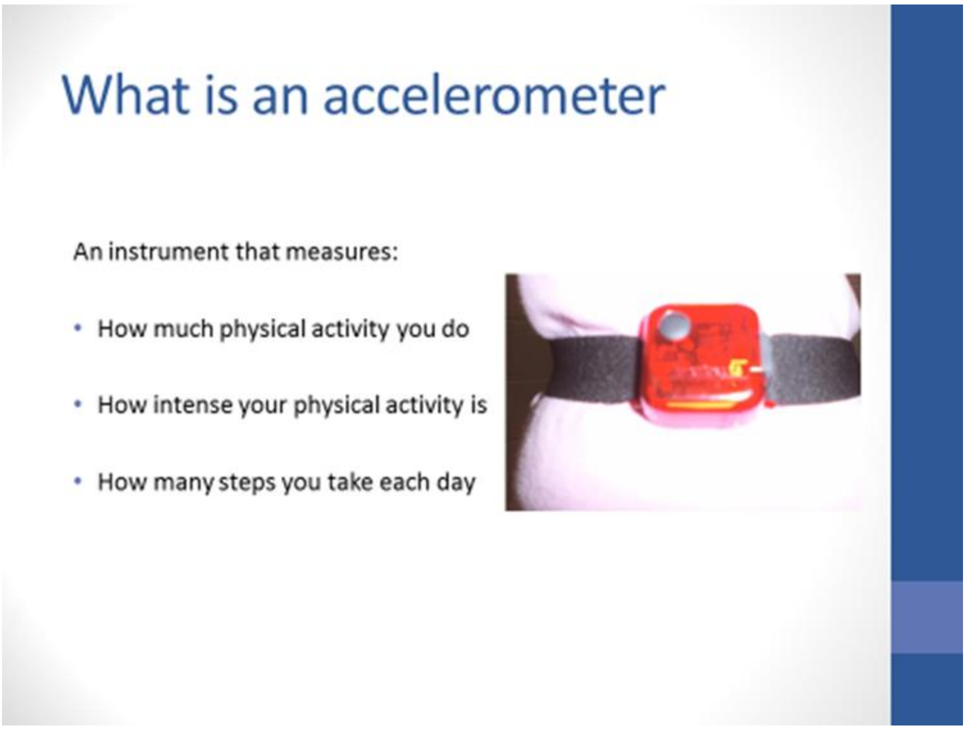
Cork Institute of Technology.

T: 021 4335321

E:con.burns@cit.ie,jean.oshea@cit.ie

Appendix B: Information Sheet for Children and Parents

Information sheet for parents:



Where to place accelerometer?

- Put belt on around waist
- Make sure the belt is comfortable – loosen or tighten to make sure it is comfortable
- Turn the belt so the accelerometer is over the right hip
- You can wear the accelerometer over or under clothing.

When do I wear the accelerometer?

The accelerometer **must not be worn** while:

- Swimming
- Taking a bath
- Having a shower
- In bed

The accelerometer **must be worn** at all other times including

- ✓ While playing sports
- ✓ During school

How long do I wear the accelerometer for?

- You will wear the accelerometer for 1 week
- After 1 week the researcher will collect the accelerometer from you

What happens if I lose the accelerometer?

- If you lose the accelerometer you must contact me as soon as possible
- Contact details: **Conor Hammersley 087-2355119**
- It is very important that you mind the accelerometer and take good care of it

Appendix C: Letter to Parents Regarding Accelerometry

Dear Parents/Guardians,

As you know, during the 2016/117 school year, Cork Institute of Technology, in conjunction with Scoil an Spioraid Naoimh Girls National School, worked together on a research project called 'Project Spraoi'. Your child played a vital role in this project which is investigating if a school-based health promotion intervention can improve healthy lifestyle habits in children.

As of tomorrow afternoon, your child will be given an accelerometer (information in relation to the accelerometer is on the attached sheet). This is part of our physical activity study that we are conducting. If for whatever reason you would not like your child to partake in this study, please to do not hesitate to contact me and we will not assign an accelerometer to your child.

Thanking you in advance,

Conor Hammersley

Dept. of Sport, Leisure & Childhood Studies,
Cork Institute of Technology,
Bishopstown,
Cork.
Email: conor.hammersley@mycit.ie / **Tel:** 087-2355119

Appendix D: Baseline Questionnaire

Teacher Name ____________________ **Classs**____________________

Project Spraoi – Needs Analysis

Please state what components of the Project Spraoi intervention you think **worked well** for you/your class/school last year?

____

____

____

____

____

____

____

____

____

____

____

Please state any **improvements, additional help or activities** you would like to see implemented in the Project Spraoi intervention in your class/school this year?

____

____

____

____

____

____

____

____

Project Spraoi in your school

Since the beginning of the 2016/17 school term……

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

No. sessions: ________Average time / session: _________ *mins* Total time: ____ *mins*

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

No. sessions: ________Average time / session: _________ *mins* Total time: ____ *mins*

3. What written/electronic resources do you use to plan for PE or PA? (tick the box)

P.E. curriculum ☐ Project Spraoi gam☐ Irish Heart ☐
Foundation

Bizzy Breaks ☐ Go Noodle ☐ Get Ireland ☐
Active

Other (please specify below) ☐

____
____

Please note the barriers you face when implementing Project Spraoi? * (tick the box of any relevant barriers to you and your class)

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

Time constraints ☐ Curriculum constrai☐s Lack of ☐ confidence to lead PA

Class management ☐ Lack of teaching re☐urces School ☐ facilities/equipment

Other (please specify below)☐

____

____

Please note the facilitators you face when implementing Project Spraoi? ** (tick the box of any relevant facilitators to you and your class)

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

Teaching resources ☐ Classroom PA ideas ☐ Cross ☐ curricular games

Energiser ☐ PA challenges (e.g. Stride☐r 5) School ☐ facilities/equipment

Multiple PA breaks (e.g. 4 x 5mi☐ Confidence to lead PA ☐ Other ☐ (please specify below)

Appendix E: Follow-Up Questionnaire

Project Spraoi in your school

Please state what components of the Project Spraoi intervention you think **worked well** for you/your class/school during the 2016/2017?

Please state any **improvements, additional help or activities** you would like to see implemented in the Project Spraoi programme?

Please state how you felt the step back approach of Project Spraoi worked in your school for the 2016/2017 academic year?

Project Spraoi in your school

Since the beginning of the 2016/17 school term……

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

No. sessions: ________Average time / session: _________ *mins* Total time: ____ *mins*

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

No. sessions: ________Average time / session: _________ *mins* Total time: ____ *mins*

3. In your opinion, what is the current status of Project Spraoi in your school? (please rate on a scale of 1 – 6)

Please note the barriers you face when implementing Project Spraoi? * (tick the box of any relevant barriers to you and your class)

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

Time constraints ☐ Curriculum constraints ☐ Lack of confidence to lead PA ☐

Class management ☐ Lack of teaching resources ☐ School ☐ facilities/equipment

Other ☐ (please specify below)

____

Please note the facilitators you face when implementing Project Spraoi? ** (tick the box of any relevant facilitators to you and your class)

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

Teaching resources ☐ Classroom PA ideas ☐ Cross ☐ curricular games

Energiser ☐ PA challenges (e.g. Stride for 5) ☐ School ☐ facilities/equipment

Multiple PA breaks (e.g. 4 x 5min) ☐ Confidence to lead PA ☐ Other ☐ (please specify below)

____

Please state any additional comments?

____

____

____

____

Appendix F: Sample Format of the Step Back Approach

Block 1 (Week 1 –week 4)					
Date	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Mon 9th Jan – Fri 13th Jan	Whitechurch	Btown Boys	Btown Girls	Upper Glanmire	
Mon 16th Jan – Fri 20th Jan	Whitechurch	Btown Boys	Btown Girls	Upper Glanmire	
Mon 23rd Jan – Fri 27thth Nov	Whitechurch			Upper Glanmire	
Mon 30th Jan – Fri 3rd Feb		Btown Boys	Btown Girls		
Mon 21st Nov – Fri 25th Nov	Whitechurch			Upper Glanmire	
Mon 6th Feb – Fri 10th Feb		Btown Boys	Btown Girls		
Mon 13th Feb – Fri 17th Feb	Whitechurch			Upper Glanmire	
Mon 20th Feb – Fri 24th Feb		Btown Boys	Btown Girls		
Mon 27th Feb – Fri 3rd March	Whitechurch			Upper Glanmire	

Appendix G: Sample Lesson Plan

Lesson plan: Athletics (Jump)

Strand: Athletics

Topic: Horizontal/Broad Jump

Objectives:

Learn components of the jump:

- ARMS STRAIGHT ABOVE HEAD – elbows fully extended

Learn 2 footed (broad) jump

20 mins of high intensity activity

Introduction (1 minute):

Review previous lesson – ask for key points of skill practiced, demonstration (by teacher or one or two children)

Explain lesson focus

Warm-up game (8mins):

Stride for 5 – 1min

Will do first thing every PE day – when EVERYONE can go for this time without walking or stopping, add on 1 min and continue until 5mins

Crocodile Crocodile – Similar to Bulldog:

- Children on the line shout 'Crocodile Crocodile may we cross the water, to see your ugly daughter just like you'
- Crocodile says: Only if you are wearing the colour….(pick a colour)
- If they are wearing that colour they can gallop across to the other side without being caught. On the whistle, the remaining children must run without getting caught by the crocodile.

Development (10mins):

- On the line, demonstrate the correct arm movement for jumping – bend knees, arms behind you, bring arms straight over your head and back down. On 'Ready', children bend knees with arms behind body. On 'Go', children bring arms straight up and down. Practice 10 times on your count. Pick someone out that is doing it correctly to demonstrate to class and practice 10 more times on your count.
- On 'Ready', they get ready and on the whistle, they jump. Practice several times.
- Scatter cones around the hall. Children run around the hall. When they come to a cone, they stop and jump with 2 feet together with arms straight over head during flight.

Jump the River:

Make 2 rivers with rope or cones or bibs. Let children practice in lines of 6 first. After a few attempts, they must go in single file. They have 3 lives. They lose a life if they do not keep their arms straight while jumping. When they have no lives left, 2 correct jumps gains a life for them.

Fun Game (9mins):

Cats and Rats:

Children line up side by side with a partner

O	P1 P2	O
O	P1 P2	O

All player 1's are the cats and player 2s are the rats. When teacher shouts rats, rats must get to the line closest to them before the cats catch them and vica versa if cats are called. if you don't catch your partner, you must do 3 broad or vertical jumps on teachers call.

Conclusion (2mins):

What was the skill today?

What games use the jump?

What 3 key points did we learn today?

- ❖ Keep arms straight over head
- ❖ Bend knees
- ❖ Land on two feet

Three people to demonstrate the roll and class feedback

Resources:

Cones

Bibs/cones/ropes for jump the river

Assessment:

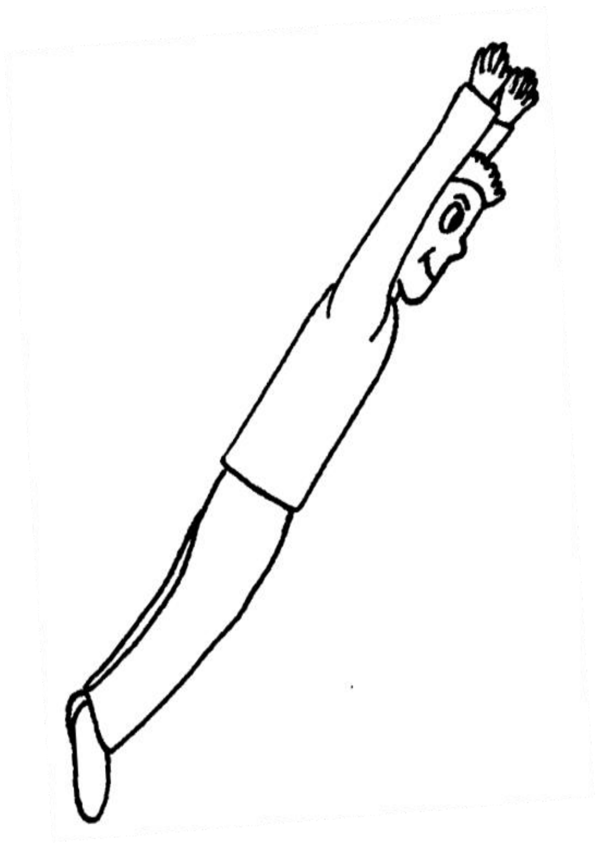
Observation

Lose a life when arms bend for jump during 'Jump the River'

Questions at end of lesson and review of next lesson

Differentiation:

Adjust the size of the river



Appendix H: Indoor and Outdoor Physical Activity Game Booklet for Teachers

Outdoor and Indoor

Physical Activity Games

Appendix I: Physical Activity Initiatives in School

Stride for 5

STRIDE FOR 5

5 MINUTES

4 MINUTES

3 MINUTES

2 MINUTES

1 MINUTE

Get up, Get Moving Challenge: Sample chart for junior classes

	MONDAY 10 jumping jacks 10 rolls • "Stand, step & roll" • Hand down and back as you step • Keep chest facing forward	TUESDAY 10 bunny jumps 10 rolls • "Stand, step & roll" • Hand down and back as you step • Keep chest facing forward	WEDNESDAY 10 secs high knees 10 rolls • "Stand, step & roll" • Hand down and back as you step • Keep chest facing forward	THURSDAY 10 secs sprinting 10 rolls • "Stand, step & roll" • Hand down and back as you step • Keep chest facing forward	FRIDAY 10 secs running arms 10 rolls • "Stand, step & roll" • Hand down and back as you step • Keep chest facing forward
START OF DAY					
BEFORE BREAK					
AFTER BREAK					
BEFORE LUNCH					
AFTER LUNCH					
END OF DAY					
EXTRA SPRAOI TIME					

Date: **15th April** **Class:**

Spraoi Homework (Mon-Thurs):

- Read page 10
- Any exercise on page 11.

Get up, Get Moving Challenge: Sample chart for senior classes

	MONDAY 10 jumping jacks 10 rolls • "Stand, step & roll" • Hand down and back as you step • Keep chest facing forward	TUESDAY 10 bunny jumps 10 rolls • "Stand, step & roll" • Hand down and back as you step • Keep chest facing forward	WEDNESDAY 10 secs high knees 10 rolls • "Stand, step & roll" • Hand down and back as you step • Keep chest facing forward	THURSDAY 10 secs sprinting 10 rolls • "Stand, step & roll" • Hand down and back as you step • Keep chest facing forward	FRIDAY 10 secs running arms 10 rolls • "Stand, step & roll" • Hand down and back as you step • Keep chest facing forward
START OF DAY					
BEFORE BREAK					
AFTER BREAK					
BEFORE LUNCH					
AFTER LUNCH					
END OF DAY					
EXTRA SPRAOI TIME					

Date: **15th April** **Class:**

Spraoi Homework (Mon-Thurs):

- Read page 10
- 1 exercise **AND** 1 challenge from page 11 (Whatever ones you want.)

Active Class Award

COMHGHAIRDEACHAS

This is to certify that

____

(Teacher Name)

and

____

(Class)

finished in

____

(Place)

in the Physical Activity Chart Competition which ended at Easter 2016

SUPER

Physical activity student of the week:


THIS WEEK'S PE STUDENT OF THE WEEK

GREAT JOB!

This is to certify that

____

(Name)

is the PE Student of the week from

____

(Class)

for the week ending

____

(Date)

Signed __________ Date __________

Well done!

CONGRATS!

Appendix J: Fundamental Movement Skill Homework Manuals

Homework Manual: Senior Infant and 1st Class Homework Manual

Fundamental Movement Skills

Home Challenge/Parent Manual

Name: ___________________________

Class: ____________________________

School: ____________________________

What are fundamental movement skills?

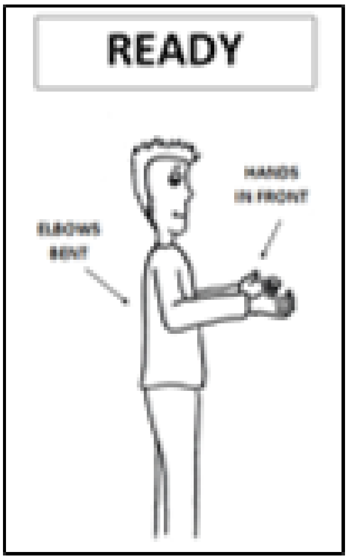
- Fundamental movement skills (i.e. the skills in this manual) are the basic movements needed for a physically active lifestyle.
- Children who can perform these skills correctly are **FITTER, HEALTHIER** and are **LESS LIKELY TO BE OBESE**. This is very important in today's world with Ireland predicted to be the fattest nation by 2030.
- Children who can perform these skills properly are **MORE ACTIVE, PERFORM BETTER ACADEMICALLY** and also demonstrate **BETTER BEHAVIOUR**.

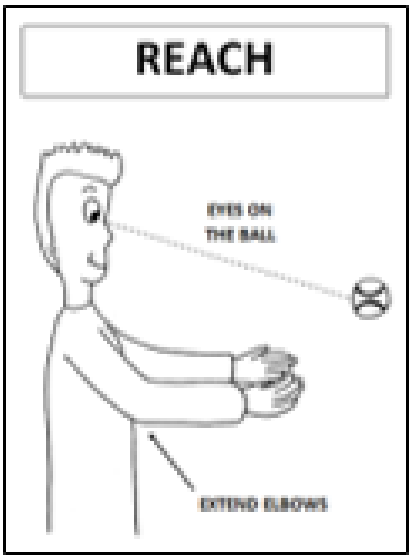
Children should engage in at least 60 minutes of moderate to vigorous physically active EVERY day. Use this manual to learn and practice the correct way to perform these fundamental movement skills and have lots of fun being active! ☺

How do I use this manual?

- Each evening, do as many of the fun activities as you can. Remember to record which activities/exercises you practiced at home each evening. You can do this on the pages at the back of this manual.
- Each night, you will be given one exercise for homework. When you complete this exercise while performing the skill correctly, write it in the record sheet at the back. Every Friday, Linda/Lisa will collect your manual and allocate you with points for your exercises. If you have completed the homework exercise, performing the skill correctly, you will get 10 points. For every extra exercise you complete, you will be awarded 5 points.
- The student in the class with the most points and the class with the most points will get a prize each term.

THE CATCH





WHEN CATCHING, INSTRUCT YOUR CHILD TO:

- Have your hands ready with your elbows bent and your hands in front of your body.
- Watch the ball at all times.
- Move your hands toward ball when catching.
- Cup your hands slightly so that all you have to do when the ball arrives is close your fingers on it.

You will need:

- A small ball (e.g. tennis ball/sliotar)
  OR A pair of socks **OR** Any item that is not breakable

EXERCISE 1: THROW THE BALL UP INTO THE AIR AND CATCH IT 20 TIMES.

EXERCISE 2: THROW THE BALL TO A PARTNER

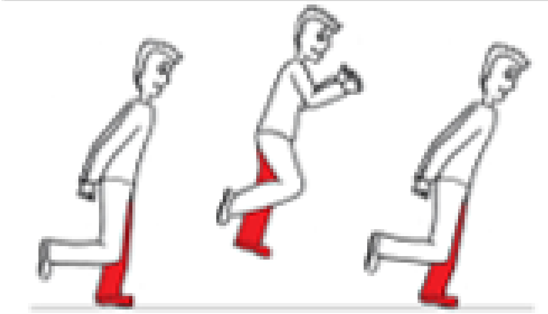
Can you get 20 catches in a row??

EXERCISE 3: WALL CATCHES

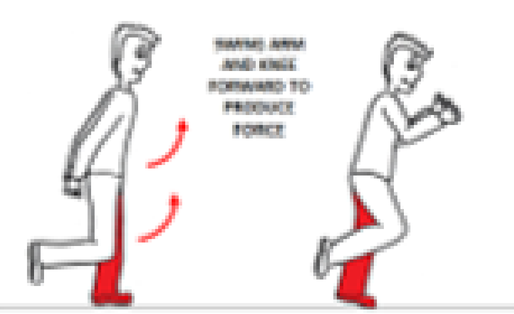
Can you throw the ball off the wall and catch it as it comes back? How many can you get?

THE HOP

TAKE OFF AND LAND ON SAME FOOT



KNEE AND ARM BOP



KEEP BACK FOOT BEHIND HOPPING LEG

WHEN TEACHING YOUR CHILD TO HOP, ENCOURAGE YOUR CHILD TO:

- Bend your leg to push off.
- Swing your arms forward to help you move.
- Bring your knee forward to help you move (but make sure your foot stays behind your hopping leg!!).
- Keep your swinging foot behind your hopping leg.

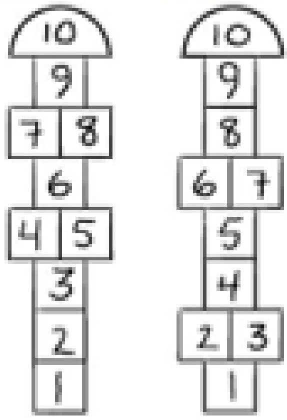
Warm Up:

- Balance on your right leg for 1 minute.
- Balance on your left leg for 1 minute.
- Hop 5 times on your right leg (Remember to keep your left foot behind your right leg! ☺)
- Hop 5 times on your left leg (Remember to keep your right foot behind your left leg! ☺)

4

EXERCISE 1: HOW FAR CAN YOU HOP?

Pick a starting point. Hop 5 times on your right foot and see how far away from the starting point you can get. Mark where you land after your 5th hop. Try to beat this mark at your next attempt. Measure the distance that you hopped. You can do this using a measuring tape, a ruler or simply using your feet. Repeat this by hopping on your left foot.



Can you hop further with one foot? Does one foot feel more comfortable to hop on? (Hint: Remember your "knee and arm bop" to help you hop further with each hop).

EXERCISE 2: PLAY HOPSCOTCH

Draw or mark out a series of boxes/shapes on the ground as in the picture. You can use chalk to draw on the ground, or use lollipop sticks to mark out the boxes. Standing just before the number 1 box, throw a small stone/eraser onto the drawing. Hop from number to number in order to reach the thrown object and hop back to the start.

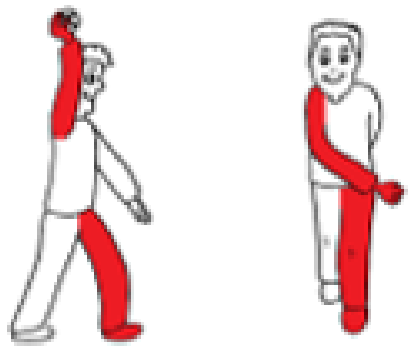
HOP

THE THROW

STAND

STEP and TWIST

FOLLOW THROUGH TO OPPOSITE HIP



WHEN TEACHING YOUR CHILD TO THROW, INSTRUCT THEM TO:

- Look at your target.
- Step and twist so that you are standing side on to your target.
- Bring your arm up and then down and back as you twist.
- Follow through, down and across your body with your throwing arm.
- Throw as hard as you can.

You will need: A ball **OR** a pair of socks

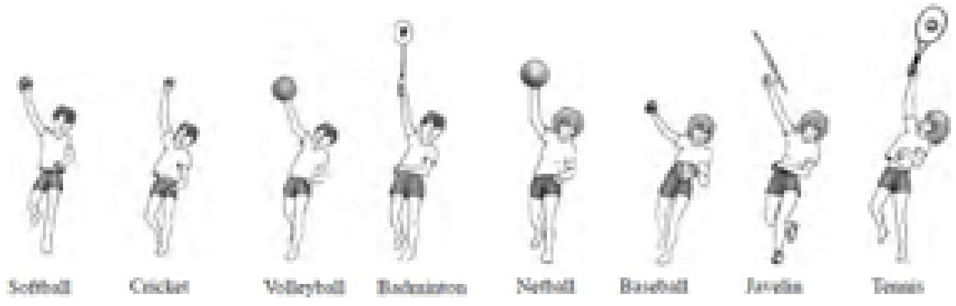
EXERCISE 1: THROW THE BALL AS HARD AS YOU CAN

Stand approximately 5-7 steps away from a wall. Throw the ball of the wall as hard as you can. (Remember to stand, step and throw for every throw). Throw the ball 20 times.

EXERCISE 2: HOW FAR CAN YOU THROW THE BALL?

Mark a line on the ground/grass. Stand about 1 metre back from this line. Stand, step and throw the ball as far as you can into open space. Mark where the ball finishes. Try to beat this mark on your next go.

THROW



THE LEAP

JUMP OFF ONE FOOT AND LAND ON THE OTHER

REACH

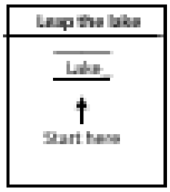
WHEN TEACHING YOUR CHILD TO LEAP, INSTRUCT THEM TO:

- Jump off one foot and land on the other.
- Reach forward and try to touch your opposite foot.
- Stay in the air as long as you can.
- Leap as far as you can.
- Straighten your leg during the flight.

EXERCISE 1: LEAP THE LINE 20 TIMES

Find a line marked on the ground/place a small object/ pick a mark on the ground. Take approximately 5 steps back from the mark you have picked. Run and leap over the mark. (Hint: Try and stay in the air as long as you can.)

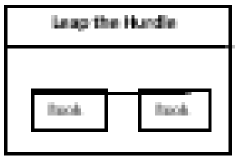
EXERCISE 2: LEAP THE LAKE



Mark two lines as shown. You can use ropes, cones, pieces of paper, socks, chalk etc. to mark the lines. The area inside the two markers is the lake. Start a distance back from the lake (this can be any distance you want e.g. 5m). Run up and leap over the lake without touching the banks of the lake (which are the two marked lines). (Hint: Remember to jump off one foot and land on the other foot.) Every time you successfully leap over the lake, make the lake wider.

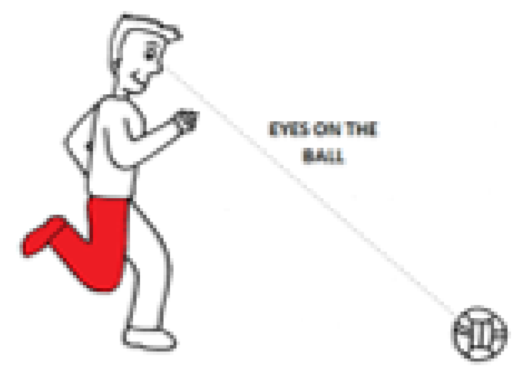
EXERCISE 3: LEAP THE HURDLE 20 TIMES

Place 2 books on the ground approximately 20cm apart. Place a plastic ruler across the gap between the two books, with the ends of the ruler resting on the books. Start a distance back from the hurdle (any distance you like).
Leap over the hurdle.

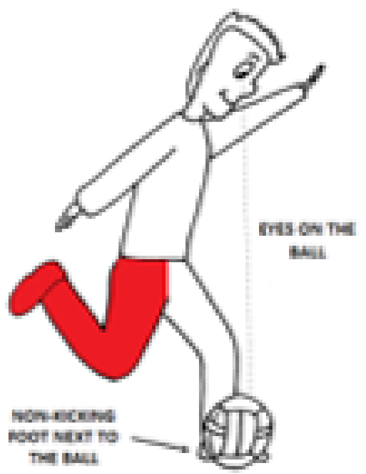


THE KICK

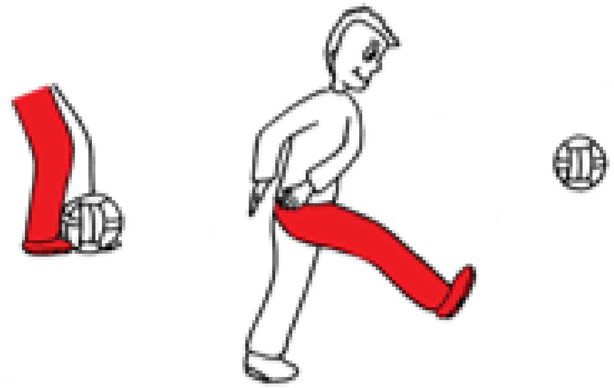
RUN TO THE BALL



PLANT FOOT



KICK AND FOLLOW THROUGH



WHEN TEACHING YOUR CHILD TO KICK, INSTRUCT THEM TO:

- Watch the ball at all times.
- Plant your non-kicking foot beside the ball.
- Make your last step towards the ball a long step.
- Try to kick the ball with the top of your foot (i.e. the shoelaces).
- Follow through after the kick.

You will need: a ball/a balloon

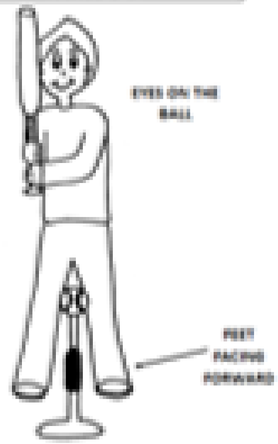
EXERCISE 1: KICK THE BALL 20 TIMES TO A PARTNER OR OFF A WALL

EXERCISE 2: HOW FAR CAN YOU KICK IT?

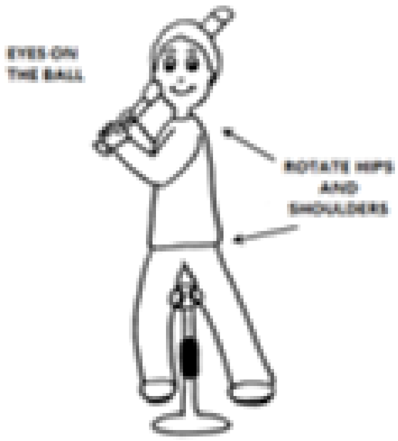
Mark the point from which you are going to kick. Run and kick the ball from your starting point. Mark the point where the ball lands. Can you kick it further the next time?

THE STRIKE

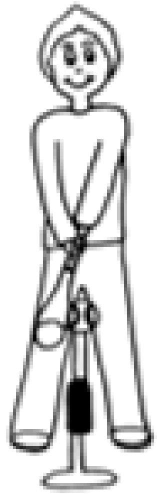
POINT SHOULDER TO TARGET



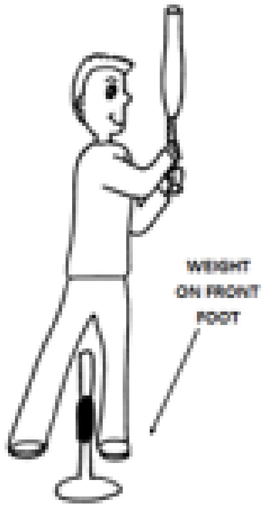
SWING BACK



EYES ON THE BALL



FOLLOW THROUGH



You will need: string/wool, blue-tack, a newspaper bat (a newspaper, elastic bands/sellotape)/hurl/tennis racket/bat, ball

How to make a bat from newspaper:
Hold the newspaper as if you are reading the front page. Roll the paper from left to right into a cylinder. Put sellotape/wrap 3 elastic bands around the cylinder (one at the top, one in the middle and one at the bottom). This is your bat. If the bat is too thick to grip, take some of the pages out of the newspaper and repeat the process.
How to make a ball from newspaper:
Scrunch 2-3 pages of the newspaper up in a ball. Wrap sellotape around the ball to keep it in a ball shape.

WHEN TEACHING YOUR CHILD TO STRIKE A BALL, INSTRUCT THEM TO:

- Stand side-on to your target i.e. point your shoulder to the target.
- Keep your feet in line with your shoulders.
- Keep your two hands together on the bat.
- Watch the ball until the ball has left the striking tee.
- Rotate your hips away from the target before your strike.
- Rotate your hips as you strike.
- Follow through, finishing the swing with the bat at your ear.

EXERCISE 1: STRIKE THE BALL 20 TIMES

Place your newspaper ball on an object approximately the height of your waist (e.g. a stool/a wall/a table/a high pile of books etc). Strike the ball using the newspaper bat

OR

Using a hurl and ball, strike the ball along the ground as far as you can.

EXERCISE 2: KEEPY-UPPIES

Using a hurl, a tennis racket or your newspaper bat, see how many times you can bounce the ball of the hurl/racket/bat without it dropping to the floor.

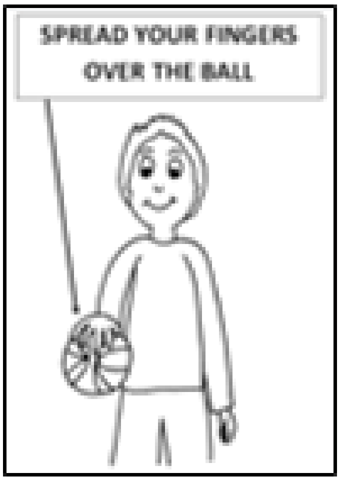
EXERCISE 3: SHOOT FOR GOAL

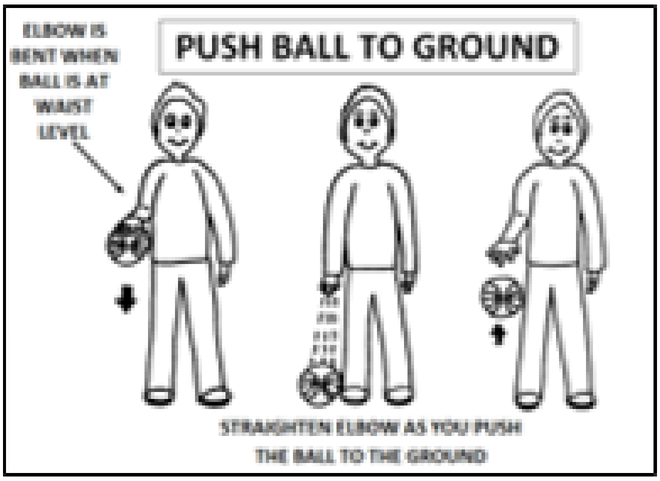
Make a goal using two markers (these can be cones, bottles, jumper etc.). Place the ball on the ground approximately 10m from the goal. Using a hurl and ball, try to strike the ball through the goal.

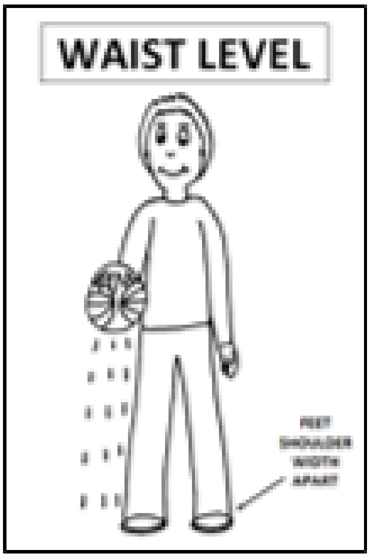
If you don't have a bat and ball play some HANDBALL

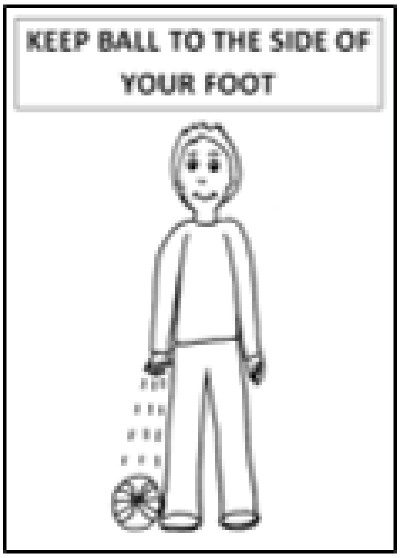
Bounce a tennis ball on the ground and with your hand, strike the ball off the wall.

THE DRIBBLE









WHEN TEACHING YOUR CHILD TO DRIBBLE, INSTRUCT THEM TO:

- Watch the ball throughout the dribble
- Spread your fingers over the top of the ball.
- Begin with your elbow bent. Extend your arm while PUSHING the ball to the ground.
- Bounce the ball at the side of your foot.

You will need: a ball

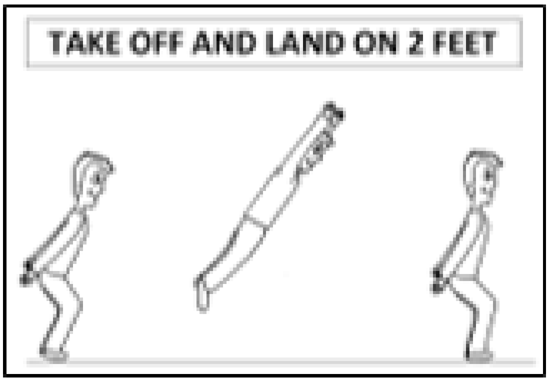
EXERCISE 1: BOUNCE AND CATCH

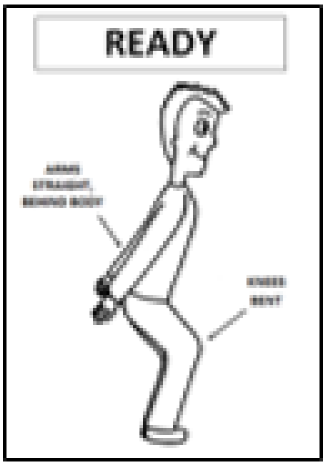
- Bounce the ball once and catch it. Do this 20 times.
- Bounce the ball twice in a row and catch it. Do this 10 times.
- Bounce the ball three times in a row and catch it. Do this 5 times.
- Bounce the ball four times in a row and catch it. Do this 5 times.

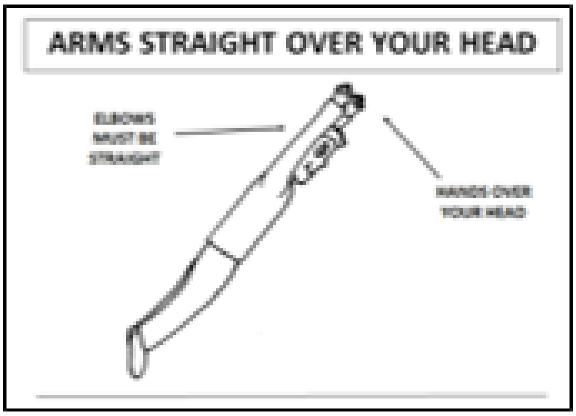
EXERCISE 2: HOW MANY BOUNCES IN A ROW?

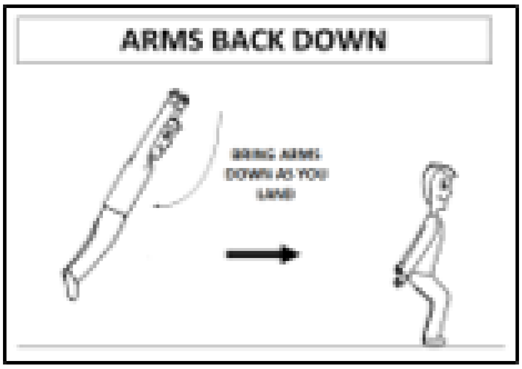
Count how many bounces in a row you can do. Have 5 goes. Try to beat your best score every time.

THE JUMP









WHEN TEACHING YOUR CHILD TO JUMP, INSTRUCT THEM TO:

- Have your knees bent, hands back before you jump
- Have your arms straight over your head/elbows straight while you are in the air.
- Bring your arms back down as you land.

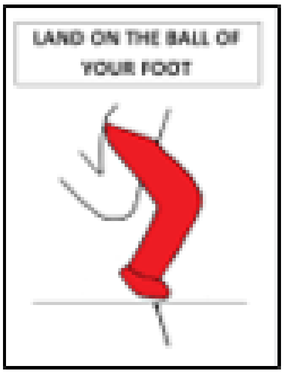
EXERCISE 1: JUMP THE RIVER

Using two ropes/cones/leaves/pieces of paper, mark out two lines, approximately 15cm apart. These are your riverbanks. Stand at the edge of one bank and try to jump to the other side without landing in the river. If you successfully jump across the river, make the river wider. This may seem easy but can you jump keeping your arms straight over your head while you are in the air?

EXERCISE 2: HIGH JUMPS

Jump as high as you can 20 times. Stand with your two feet shoulder width apart. Bend your knees and bring your hands back. Jump up, bringing your hands straight up over your head so that your elbows are straight. Bring your hands back down as you land.

THE RUN



WHEN TEACHING YOUR CHILD TO RUN, INSTRUCT THEM TO:

- Land on the balls of your feet.
- Toes up.
- Hip to lip.
- Elbows at 90 degrees.
- Lift your knees.

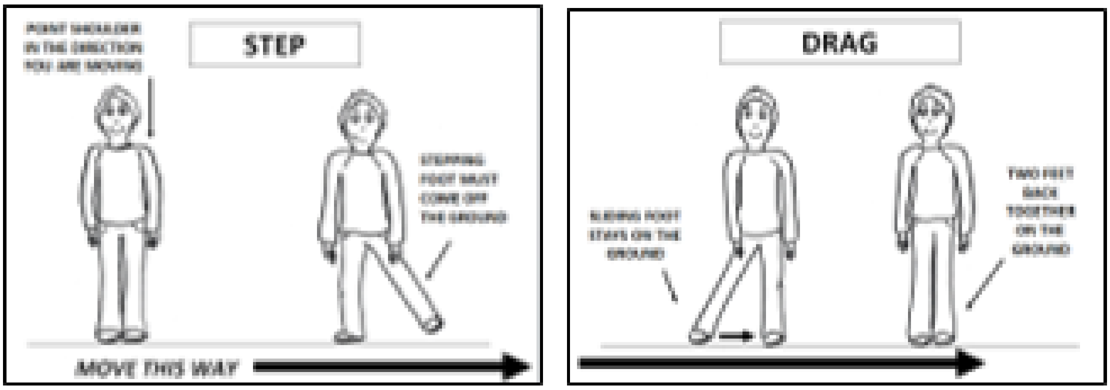
EXERCISE 1: PLAY TAG

Ask a friend or someone at home to play tag with you. Take it turns to be the chaser. When you are the chaser, you must run after your partner and touch them to catch them. When you catch them, they become the chaser and you must avoid your partner for as long as you can.

EXERCISE 2: STRIDE FOR 5

Get someone to time you and see can you run without stopping for 30 seconds (half a minute. *(If you don't have a watch or if there is no one at home to time you, count to 30 in your head.)* If you can do this, tomorrow try to run for 1 minute. Keep adding on 30 seconds (i.e. half a minute) every time you succeed and see can you build it up so that you can run without stopping for 5 minutes. (Don't worry if you can't keep running. If you feel you have to stop, try to walk. You will feel better and get your breath back faster if you walk. And don't worry you can always try again tomorrow to reach your goal.)

THE SLIDE



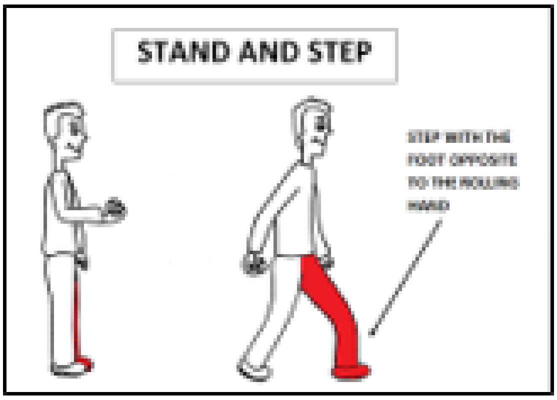
WHEN TEACING YOUR CHILID TO SLIDE, EMEMBER TO:

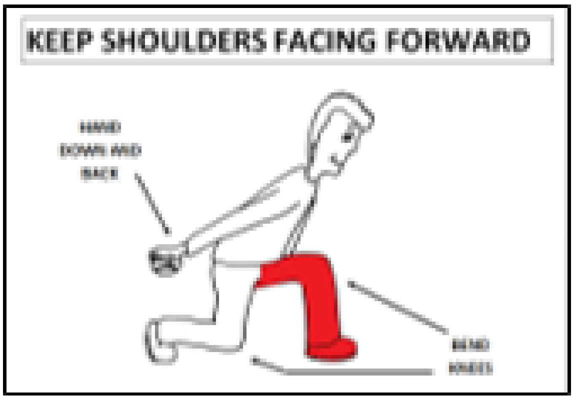
- "Step, drag, step, drag"
- Align your body so that your shoulder points in the direction you are moving.
- Lift your lead foot and step to the side.
- Keep your trail foot on the ground as you slide it to a position next to the other foot.

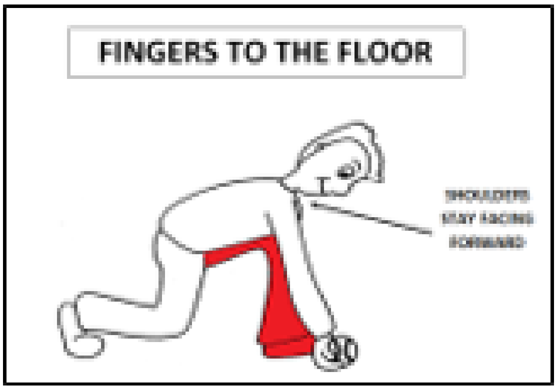
EXERCISE 1: SLIDE UP AND BACK

Pick two points. These will be called point A and point B. Stand at point A with your right shoulder pointing to point B. Slide from point A to point B. Remain facing the same way. Now point your left shoulder is pointing towards point A. Slide from point B back to point A. Do this 5 times. How many slides did it take?

THE ROLL







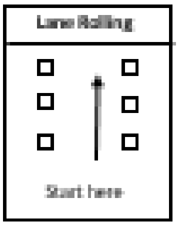
WHEN TEACHING YOUR CHILD TO ROLL, INSTRUCT THEM TO:

- Keep your shoulders facing forward.
- Step forward with the foot opposite to the rolling hand.
- Bring your hand down and back.
- Bend your knees to get low to the ground.
- "Fingers to the floor" when releasing the ball.
- "Step and roll"

EXERCISE 1: ROLL TO A PARTNER OR A WALL 20 TIMES

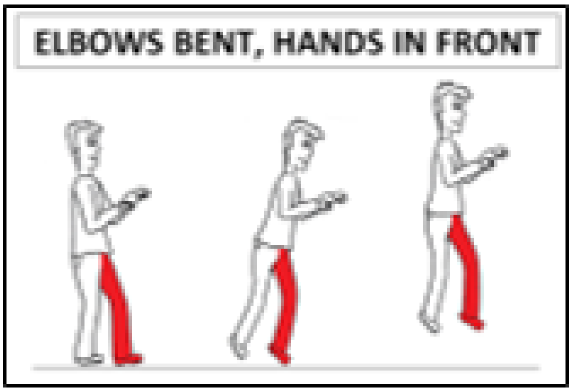
Stand 10 giant steps away from your partner. Stand with your two feet together, with the ball in your hand facing your partner. "Step and roll" the ball to your partner.

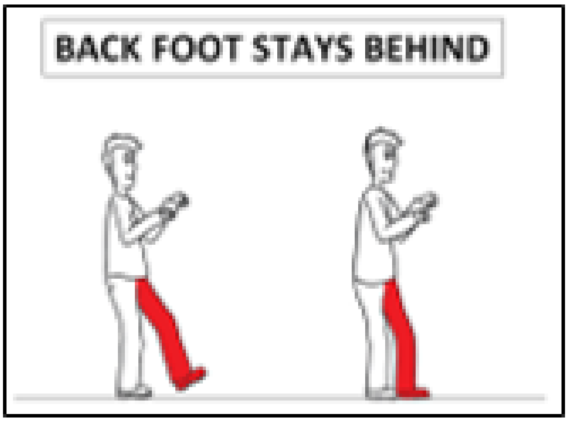
EXERCISE 2: LANE ROLLING



Mark out a lane with objects (e.g. bottles, pencils, books etc.). The lane should be two giant steps wide and 10 giant steps long. Start at one end of the land and roll the ball through the lane. Try to roll the ball so that it stays within the lane and rolls through the end of the lane. If the ball stay in the lane, make the land narrower or/and longer.

THE GALLOP





WHEN TEACHING YOUR CHILD TO GALLOP, INSTRUCT THEM TO:

- Keep your trail/back foot behind the front foot.
- Bend your elbows, hands out in front.
- Keep facing forward.

EXERCISE 1: GALLOP UP AND DOWN

Mark out two points approximately 10 giant steps apart. Call one point A and the other point B. Gallop from A to B. Gallop back to A. Do this 10 times.

GALLOP

Remember to record your activity.

Day	Date	Skill	Exercise	How did you find it? Easy? OK? Hard?	Spraoi Points
Monday	*5th Sept*	*Catch*	*1, 2, 3*	*Hard*	
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Monday	*5th Sept*	*Catch*	*1, 2, 3*	*Hard*	
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4th and 5th Class homework Manual

Fundamental Movement Skills

Home Challenge Manual

Name: ________________________

Class: ________________________

School: ________________________

What are fundamental movement skills?

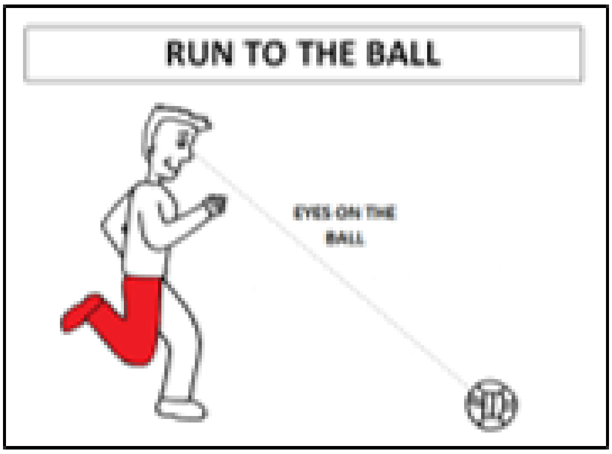
- Fundamental movement skills (i.e. the skills in this manual) are the basic movements needed for a physically active lifestyle.
- Children who can perform these skills correctly are **FITTER, HEALTHIER** and are **LESS LIKELY TO BE OBESE**. This is very important in today's world with Ireland predicted to be the fattest nation by 2030.
- Children who can perform these skills properly are **MORE ACTIVE, PERFORM BETTER ACADEMICALLY** and also demonstrate **BETTER BEHAVIOUR**.

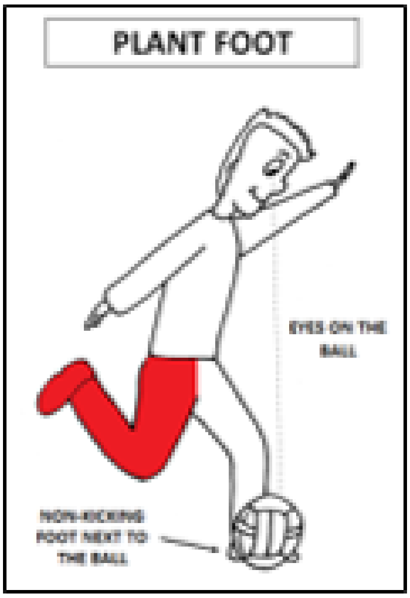
Children should engage in at least 60 minutes of moderate to vigorous physically active EVERY day. Use this manual to learn and practice the correct way to perform these fundamental movement skills and have lots of fun being active! ☺

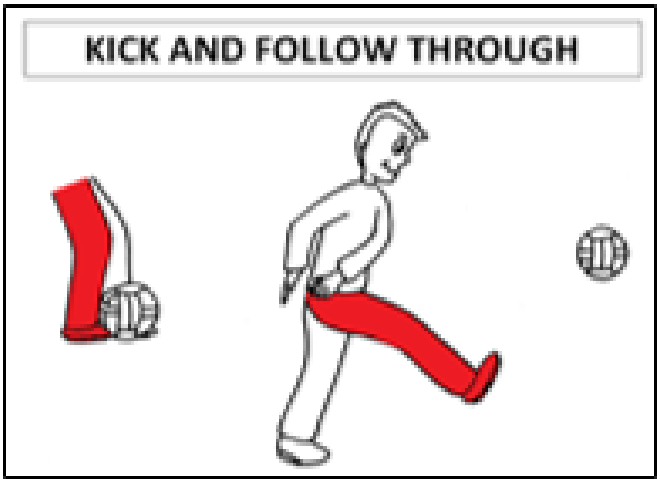
How do I use this manual?

- Each evening, do as many of the fun activities as you can. Remember to record which activities/exercises you practiced at home each evening. You can do this on the pages at the back of this manual.
- Each night, you will be given one exercise for homework. When you complete this exercise while performing the skill correctly, write it in the record sheet at the back. Every Friday, Linda/Lisa will collect your manual and allocate you with points for your exercises. If you have completed the homework exercise while performing the skill correctly, you will get 10 points. For every extra exercise or challenge you complete while performing the skill correctly, you will be awarded 5 points.
- The student in the class with the most points and the class with the most points will get a prize each term.

THE KICK





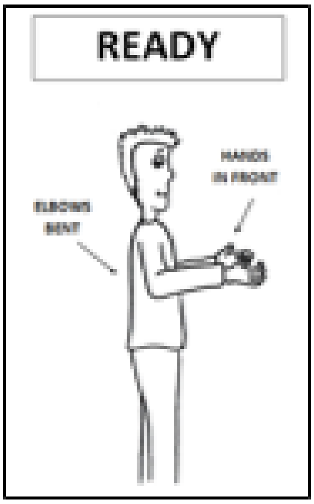


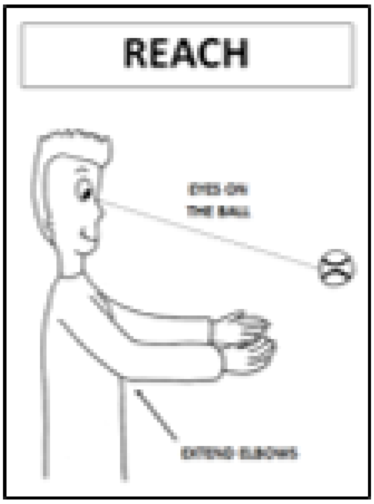
You will need: a ball/a balloon

WHEN KICKING, REMEMBER TO:

- Watch the ball at all times.
- Plant your non-kicking foot beside the ball.
- Make your last step towards the ball a long step.
- Try to kick the ball with the top of your foot (i.e. the shoelaces).
- Follow through after the kick.

THE CATCH





You will need:

- A small ball (e.g. tennis ball/sliotar) **OR** A pair of socks **OR** Any item that is not breakable

WHEN CATCHING, REMBEMBER TO:

- Have your hands ready with your elbows bent and your hands in front of your body.
- Watch the ball at all times.
- Move your hands toward ball when catching.
- Move your feet so that your body is in line with the incoming ball.
- Cup your hands slightly so that all you have to do when the ball arrives is close your fingers on it.

EXERCISE 1: THROW THE BALL UP INTO THE AIR AND CATCH IT 20 TIMES.

Challenge A: Throw the ball into the air and count how many times you can clap your hands before catching it.
Challenge B: See how high you can throw the ball and catch it.
Challenge C: Throw the ball in the air and spin around and catch it.

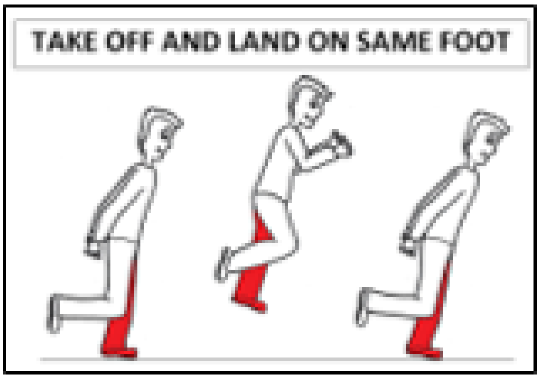
EXERCISE 2: THROW THE BALL OFF A WALL AND CATCH IT WHEN IT COMES BACK TO YOU. GET 20 SUCCESSFUL CATCHES.

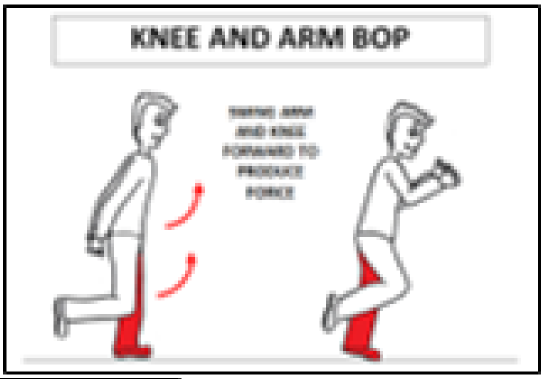
Challenge D: Take 2-3 big steps from the wall. Get a friend/family member to time you for 1 minute. See how many catches you can get in 1 minute. Let your friend/family member to have a go. See who gets the most.
Challenge E: Stand 2 steps away from the wall. See can you get 20 successful catches in a row. If you can, move out so that you are 3 steps away from the wall. See how far from the wall you can go before you can no longer get 20 catches in a row.

EXERCISE 3: WITH A PARTNER THROWING YOU THE BALL, GET 20 SUCCESSFUL CATCHES

Challenge F: With your partner, try to get 20 successful catches in a row. If you drop the ball, go back to zero and start again. When you get 20 catches in a row, take one step further apart. See how far you and your partner can move away and get 20 catches in a row.

THE HOP





WHEN HOPPING, REMEMBER TO:

- Bend your leg to push off.
- Swing your arms forward to help you move.
- Bring your knee forward to help you move (but make sure your foot stays behind your hopping leg!!).
- Keep your swinging foot behind your hopping leg.

Warm Up:

- Balance on your right leg for 1 minute. ((If you don't have someone to time you, count to 60 slowly in your head.)
- Balance on your left leg for 1 minute.
- Hop 5 times on your right leg (Remember to keep your left foot behind your right leg!)
- Hop 5 times on your left leg (Remember to keep your right foot behind your left leg!)

Challenge A: Balance on your right leg with your eyes closed for 30 seconds. Balance on your left leg with your eyes closed for 30 seconds.

EXERCISE 1: HOW FAR CAN YOU HOP?

Pick a starting point. Hop 5 times on your right foot and see how far away from the starting point you can get. Mark where you land after your 5^{th} hop. Try to beat this mark at your next attempt. Measure the distance that you hopped. You can do this using a measuring tape, a ruler or simply using your feet. Repeat this by hopping on your left foot. Can you hop further with one foot? Does one foot feel more comfortable to hop on? (Hint: Remember your "knee and arm bop" to help you hop further with each hop).

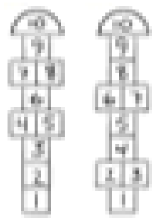
Challenge B: Play "How far can you hop?" (Exercise 1 above) with a partner. If you do not hop correctly, your attempt does not count.

EXERCISE 2: THE FEWEST HOPS

Pick a starting point. Pick an end point. Count how many hops it takes to get to the end point by hopping on your right leg. (Remember that you must do continuous hops). Have as many attempts as you like to try to get as few hops as possible. Repeat on your left leg.

EXERCISE 3: HOPSCOTCH

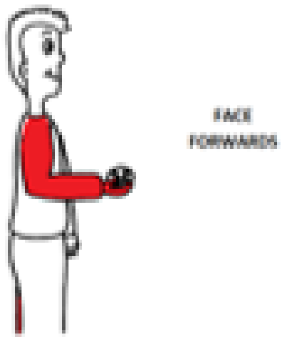
Draw or mark out a series of boxes/shapes on the ground as in the picture. You can use chalk to draw on the ground, or use lollipop sticks to mark out the boxes. Standing just before the number 1 box, throw a small stone/eraser onto the drawing. Hop from number to number in order to reach the thrown object and hop back to the start.



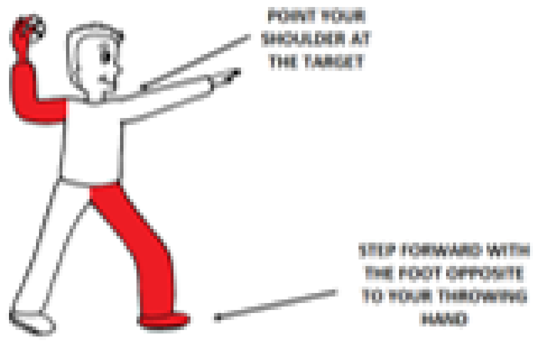
Challenge C: Draw your own shape on the ground with as many numbers as you like and play hopscotch.
Challenge D: Hopscotch-first to 50. Throw the object. Whatever number the object lands on, you score that many points when you retrieve the object. Continue to do this, adding your score from each turn together until you reach 50 points. (If the object lands outside the hopscotch grid, you score 0 points but still get to hop to collect the object.) How many turns did it take you to reach 50?
Challenge E: Hopscotch-first to 50 with a partner. Challenge a partner to a game and see who makes it to 50 points first.

THE THROW

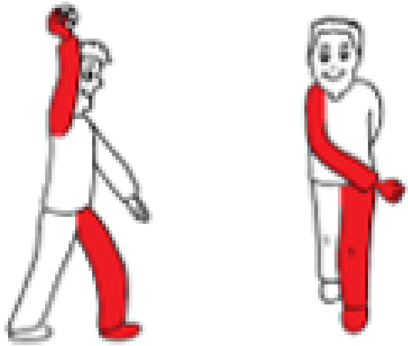
STAND



STEP and TWIST



FOLLOW THROUGH TO OPPOSITE HIP



You will need: A ball **OR** a pair of socks

WHEN THROWING, REMEMBER TO:

- Look at your target.
- Step and twist so that you are standing side on to your target.
- Bring your arm up and then down and back as you twist.
- Follow through, down and across your body with your throwing arm.
- Throw as hard as you can.

EXERCISE 1: 20 WALL THROWS

Stand approximately 5-7 steps away from a wall. Throw the ball of the wall as hard as you can. (Remember to stand, step and throw for every throw). Throw the ball 20 times.

Challenge A: Mark a line/spot approx. 5m away from the wall. This is your starting line. Throw the ball as hard as you can and mark the spot where it hits the ground on its way back out from the wall. Try to beat this mark with your next throw.

EXERCISE 2: HOW FAR CAN YOU THROW?

Mark a line on the ground/grass. Stand about 1 metre back from this line. Stand, step and throw the ball as far as you can into open space. Mark where the ball finishes. Try to beat this mark on your next go.

Challenge B: With a partner, play "how far can you throw?" Instead of marking where the ball lands, get your partner to mark where the ball bounces. The throw does not count if you cross the starting line as you throw or if you throw incorrectly. (Your partner judges this and must tell you what you did wrong if you did not throw correctly.)

EXERCISE 3: HIT THE TARGET

Hang a small piece of paper on the wall. Stand approximately 10m away from the target. Using a ball or a pair of socks, throw and try to hit the target. If you hit the target, move back further or make the target smaller. (Hint: Remember to throw as hard as you can.)

Challenge C: "Points throwing"- Hang 1 large, 1 medium and 1 small piece of paper firmly on a wall. Write 1 point on the large piece of paper, 2 on the medium sized piece and 5 on the small piece. Stand approximately 10m from the target. Stand, step and throw. If you hit a target, you score that amount of points on that target. How many throws does it take to get 100 points? (Hint: the follow through across your body to the opposite hip is very important for accuracy.)

Challenge D: Challenge a partner (a friend/a family member) to a game of "points throwing" and see who can be the first player to 100 points.

Challenge E: "Points throwing"- Instead of first to 100 points, take 10 throws each. Whoever has the highest number of points after the 10 throws is the winner.

THE LEAP

JUMP OFF ONE FOOT AND LAND ON THE OTHER

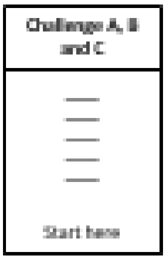
REACH

WHEN LEAPING, REMEMBER TO:

- Jump off one foot and land on the other.
- Reach forward and try to touch your opposite foot.
- Stay in the air as long as you can.
- Leap as far as you can.
- Straighten your leg during the flight.

EXERCISE 1: LEAP THE LINE 20 TIMES

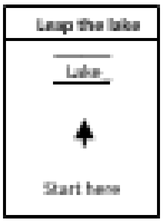
Find a line marked on the ground/place a small object/ pick a mark on the ground. Take approximately 5 steps back from the mark you have picked. Run and leap over the mark. (Hint: Try and stay in the air as long as you can.)



Challenge A: Draw 5 lines in a row approximately 5m apart using chalk or place 5 small objects in a row. Start approximately 5m before your first marker. Run and leap over the 5 objects in a row. (Hint: remember to reach your arm forward as you leap.)
Challenge B: Try to do challenge A by leaping using the opposite foot that you used in challenge A (so if you used your right leg to leap over the objects in challenge A, now use you left leg to leap).
Challenge C: Now do challenge A but this time leap over the first object with your right leg, the second object with your left leg, the third with your right leg and so on, alternating legs for each leap.

EXERCISE 2: LEAP THE LAKE

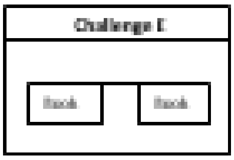
Mark two lines as shown. You can use ropes, cones, pieces of paper, socks, chalk etc. to mark the lines. The area inside the two markers is the lake. Start a distance back from the lake (this can be any distance you want e.g. 5m). Run up and leap over the lake without touching the banks of the lake (which are the two marked lines). (Hint: Remember to jump off one foot and land on the other foot.)



Challenge D: Leap the lake challenge. Set up the lake as before. The aim of the game is to run and leap over the lake marked without touching the banks of the lake. Start with a small lake. Every time you successfully leap over the lake, make the lake wider.

EXERCISE 3: LEAP THE HURDLE 20 TIMES

Place 2 books on the ground approximately 20cm apart. Place a plastic ruler across the gap between the two books with the ends of the ruler resting on the books. Start a distance back from the hurdle (any distance you like). Leap over the hurdle.



Challenge E: Raise the height of the hurdles every time you successfully leap the hurdle without knocking the ruler off.

9

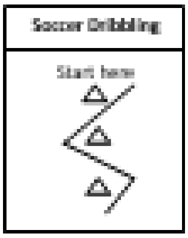
EXERCISE 1: KICK THE BALL 20 TIMES TO A PARTNER OR OFF A WALL

EXERCISE 2: CAN YOU KICK 20?

Mark the point from which you are going to kick. Mark a point 20 metres away from this (approximately 20 large steps). Run and kick the ball from your starting point. Can you kick it as far as the mark you have placed 20 metres away?

Challenge A: How far can you kick? Mark the point from which you are going to kick. Kick the ball as far as you can into open space. Mark the point where the ball lands. Try to kick the ball further than this mark the next time. Challenge a friend/family member to play this.

EXERCISE 3: SOCCER DRIBBLING

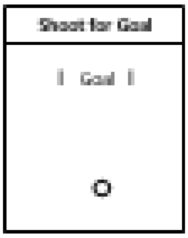


Place 3 objects on the ground (These can be cones, bottles, books etc.). Using your feet to move the ball, dribble in and out of the cones as shown.

Challenge B: The football solo-The football solo is like kicking the ball to yourself. Hold the ball in your hands, drop it to your foot and kick it back up to catch it in your hands.

Challenge C: Keepy-uppies-How many times can you kick the ball in a row without catching it or letting it hit the ground?

EXERCISE 4: SHOOT FOR GOAL



Make a goal using two markers (these can be cones, bottles, jumper etc.). Place the ball approximately 10m from the goal. Run up to and kick and try to kick the ball through the goal.

Challenge D: PENALTIES-With a partner, mark out two goals approximately 10m apart. Each partner stands in a goal each. Kick the ball and try to score a goal on your partner who is standing in the opposite goal.

Challenge E: Hit the target. Place an object (this can be a ball/a bottle/a bag etc.). Place the object approx. 10m away. Kick the ball and try to hit the target.

THE STRIKE

You will need: string/wool, blue-tack, a newspaper bat (a newspaper, elastic bands/sellotape)/hurl/tennis racket/bat, ball

How to make a bat from newspaper:
Hold the newspaper as if you are reading the front page. Roll the paper from left to right into a cylinder. Put sellotape/wrap 3 elastic bands around the cylinder (one at the top, one in the middle and one at the bottom). This is your bat. If the bat is too thick to grip, take some of the pages out of the newspaper and repeat the process.

How to make a ball from newspaper:
Scrunch 2-3 pages of the newspaper up in a ball. Wrap sellotape around the ball to keep it in a ball shape.

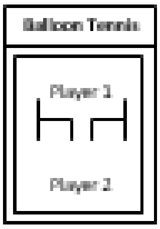
WHEN STRIKING A STATIONARY BALL FROM A TEE, REMEMBER TO:

- Stand side-on to your target i.e. point your shoulder to the target.
- Keep your feet in line with your shoulders.
- Keep your two hands together on the bat.
- Watch the ball until the ball has left the striking tee.
- Rotate your hips away from the target before your strike.
- Rotate your hips as you strike.
- Follow through, finishing the swing with the bat at your ear.

EXERCISE 1: HANDBALL

Bounce a tennis ball on the ground and with your hand, strike the ball off the wall.

Challenge A: How many times can you strike the ball off the wall in a row (You may only let the ball bounce once after it hits the wall before you have to strike it.)
Challenge B: Balloon tennis-Make a net using two chairs. Mark out an area of court on both sides of the chairs. With your hand, you must strike the balloon to the other player's side of the court over the chair. The balloon must not hit the ground. If the balloon hits the ground on your side of the court, your opponent is awarded the point. Also, if the balloon does not o over the net or lands outside the marked court area, your opponent scores a point.



EXERCISE 2: STRIKE A STATIONARY BALL 20 TIMES.

Place your ball on an object approximately the height of your waist (e.g. a stool/a wall/a table/a high pile of books etc). Strike the ball using the newspaper bat.

Challenge C: Strike the ball in the opposite direction (i.e. if you were striking the ball swinging from right to left, now strike swinging from left to right.)
Challenge D: Hang your ball from the ceiling. Tie a piece of string around your newspaper ball and tie a knot on top. Tie another piece of string around your ball and tie a knot on it. (The 2 pieces of string should make an X on the newspaper ball. Place a third piece of string under the two pieces of string already on the ball. The two ends of this piece of string will be attached to the roof with blue tack so that the ball will hang down at belt level. Strike this hanging ball 20 times. Make sure the ball is stationary before striking it.

EXERCISE 3: HOW FAR CAN YOU STRIKE?

Place the ball on an object approximately the height of your waist. Strike the ball as far as you can. Mark the point at which the ball lands. Try to strike it further than this the next time.

Challenge E: Play "how far can you strike?" with a friend or a family member. See who can strike the ball the furthest.

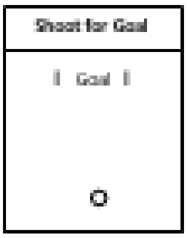
EXERCISE 4: KEEPY-UPPIES

Using a hurl, a tennis racket or your newspaper bat, see how many times you can bounce the ball of the hurl/racket/bat without it dropping to the floor.

Challenge F: Keepy-uppies with a twist- How many bounces can you get, twisting to the opposite side of the hurl/racket/bat for every bounce?
Challenge G: Keepy-uppies with a partner-using a hurl/racket/bat, count how many bounces you can get as a team, swapping from person to person for each bounce.

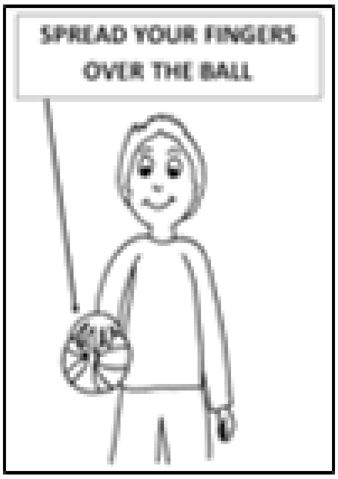
EXERCISE 5: SHOOT FOR GOAL

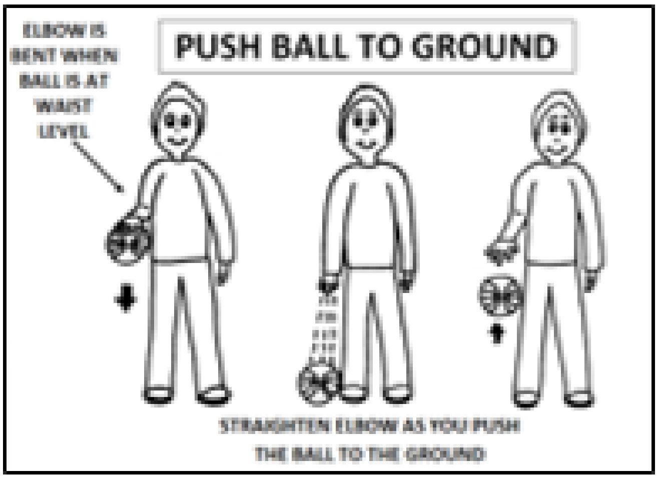
Make a goal using two markers (these can be cones, bottles, jumper etc.). Place the ball on the ground approximately 10m from the goal. Using a hurl and ball, try to strike the ball through the goal.

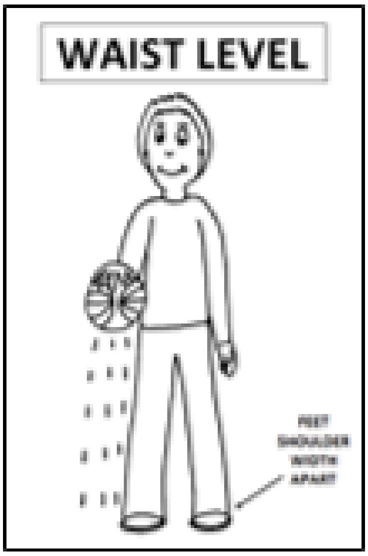


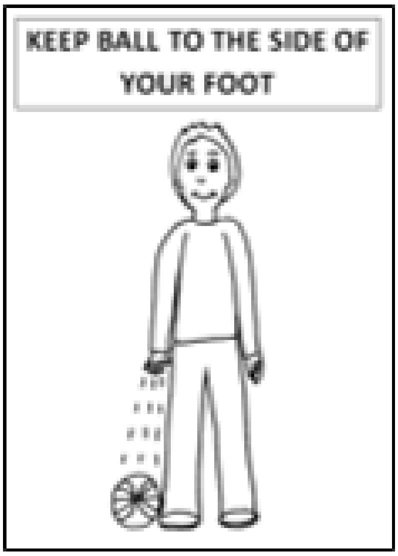
Challenge H: HURLING PENALTIES-With a partner, mark out two goals approximately 10m apart. Each partner stands in a goal each. Strike the ball and try to score a goal on your partner who is standing in the opposite goal.
Challenge I: Hit the target. Place an object (this can be a ball/a bottle/a bag etc.). Place the object approx. 10m away. Kick the ball and try to hit the target.

THE DRIBBLE









You will need: a ball

WHEN DRIBBLING, REMEMBER TO:

- Watch the ball throughout the dribble
- Spread your fingers over the top of the ball.
- Begin with your elbow bent. Extend your arm while PUSHING the ball to the ground.
- Bounce the ball at the side of your foot.

EXERCISE 1: BOUNCE AND CATCH

Bounce the ball once and catch it. Do this 20 times.
Bounce the ball twice in a row and catch it. Do this 10 times.
Bounce the ball three times in a row and catch it. Do this 5 times.
Bounce the ball four times in a row and catch it. Do this 5 times.

Challenge A: Repeat the bounce and catch with the opposite hand.
Challenge B: Tape 10-Place a piece of tape on the ground to the side of your foot. Stand in the same spot while dribbling, not moving your feet. See can you bounce the ball on the tape 10 times in a row without moving your feet.

EXERCISE 2: HOW MANY BOUNCES IN A ROW?

Count how many bounces in a row you can do. Have 5 goes. Try to beat your best score every time.

Challenge C: Count how many bounces you can get in a row without having to move your feet to reach the ball.

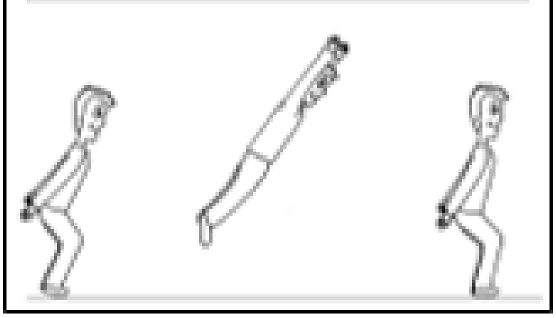
EXERCISE 3: 5 RIGHT, 5 LEFT

Bounce the ball 5 times in a row with your right hand. ON the sixth bounce, bounce it across in front of your body to your left hand and do 5 bounces with your left hand.

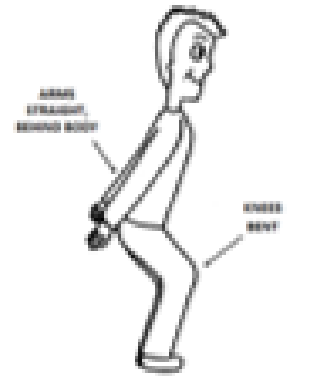
Challenge D: Can you bounce it under your leg-Bounce the ball 5 times with your right hand. On the sixth bounce, lift your left leg and bounce it under your leg to your left hand. Bounce the ball 5 times using your left hand. On the sixth bounce, lift your right leg and bounce it back across to your right hand.
Challenge E: Dribble on the run-Run approximately 10m, bouncing the ball as you run. Start off slow at the start and speed up as you get better. Try to get at least 5 bounces in as you run the 10 metres.
Challenge F: Dribble up and back-Place two markers on the ground. These should be approximately 10m apart. Start at the first marker and dribble up to the second one using your right hand. Dribble back to the start using your left hand.

THE JUMP

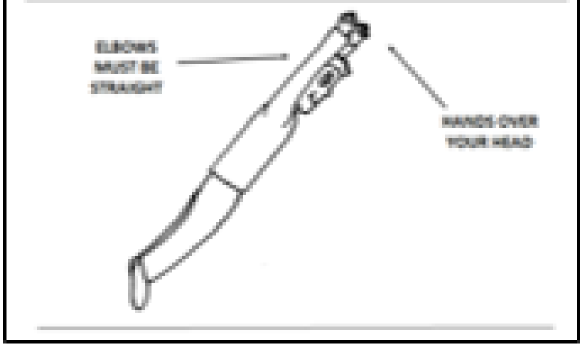
TAKE OFF AND LAND ON 2 FEET



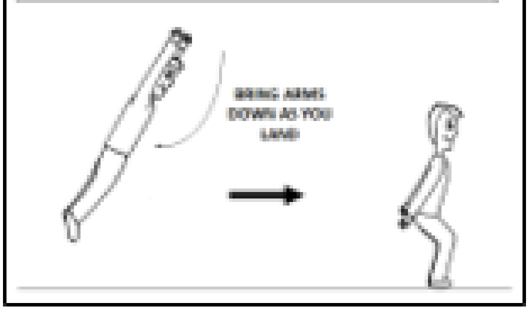
READY



ARMS STRAIGHT OVER YOUR HEAD



ARMS BACK DOWN



WHEN JUMPING, REMEMBER TO:

- Have your knees bent, hands back before you jump
- Have your arms straight over your head/elbows straight while you are in the air.
- Bring your arms back down as you land.

EXERCISE 1: JUMP THE LINE.

Find a line/mark on the ground. This can be a line that you have drawn with chalk or simply a leaf or a ruler. Start on one side of the line and jump over it. This may seem easy but can you jump keeping your arms straight over your head while you are in the air?

Challenge A: Jump the river-Using two ropes/cones/leaves/pieces of paper, mark out two lines, approximately 15cm apart. These are your riverbanks. Stand at the edge of one bank and try to jump to the other side without landing in the river. If you successfully jump across the river, make the river wider.

EXERCISE 2: HIGH JUMPS

Jump as high as you can 20 times. Stand with your two feet shoulder width apart. Bend your knees and bring your hands back. Jump up, bringing your hands straight up over your head so that your elbows are straight. Bring your hands back down as you land.

Challenge B: Wall jumps. Stand next to a wall, with your shoulder pointing towards the wall. See how high up the wall you can reach. Make sure to straighten both of your arms over your head. Find a mark on the wall (e.g. a line, top of the door, light switch etc.) See can you do a wall jump and reach this mark.

Challenge C: Can you touch the ceiling? Jump as high as you can and see can you touch the ceiling with your two hands.

EXERCISE 3: SKIPPING

Try skipping with your two feet together.

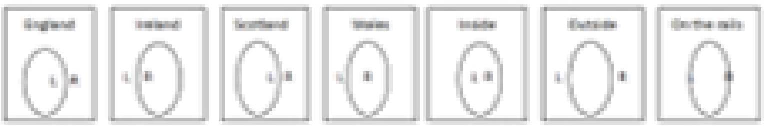
Challenge D: How many skips (with your two feet together can you do in a row?

Challenge E: Double skips-Can you jump and bring the rope under your feet twice before you land.

Challenge F: Cross skipping-Do 1 normal skip and for your second skip, cross your hands in front making an X with the rope, and jump through the rope. Can you do the following in a row: normal skip, cross skip, normal skip, cross skip.

EXERCISE 4: ELASTICS

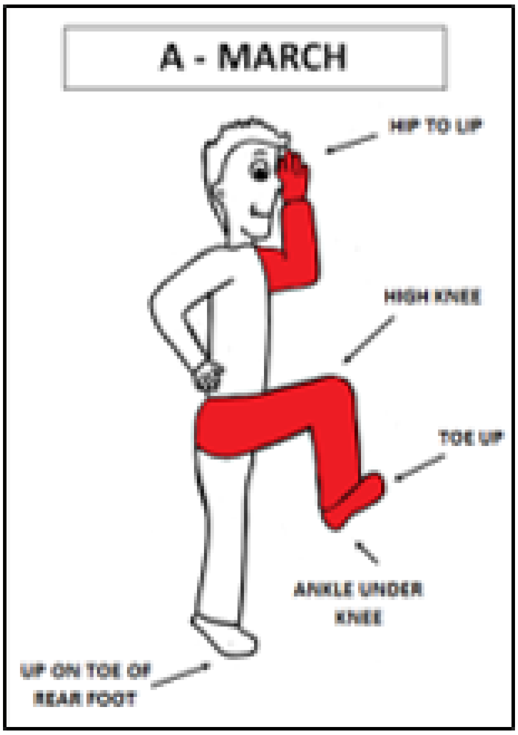
You will need a big elastic band (You can make one by tie lots of elastic band together.) You can do this with two partners or two chairs. Tie the elastic around the chairs/partners legs at a very low height. Start in the middle and jump to the right so that the elastic is between your two feet, with your right foot outside the elastic and the left inside. Do a jump on the spot. (Say "England" with these two jumps). Jump to the left so that the other side of the elastic is between your feet, this time with your left foot outside and your



right foot inside. Do a jump on the spot. (Say "Ireland" with these jumps). Repeat this and say "Scotland, Wales" as you go. Next jump so that your two feet are inside the elastic. Do a jump on the spot (Say "inside" with these two jumps). Jump and bring your feet outside the elastics (one each side). Do a jump on the spot (Say "Outside" as you do these two). Next try to jump so that you feet land on the elastics, one foot on each side of the elastic (Say "On the rails" as you do this.) If you manage to step on the two rails, move the elastics higher for the next go. So the rhyme is "ENGLAND, IRELAND, SCOTLAND, WALES, INSIDE, OUTSIDE, ON THE RAILS"

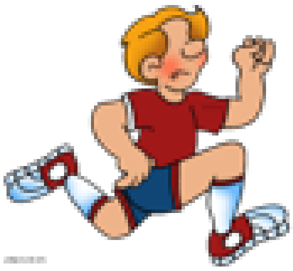
Challenge G: Come up with your own rhyme to go with the game elastics.

THE RUN



WHEN RUNNING REMEMBER TO:

- Land on the balls of your feet.
- Toes up.
- Hip to lip.
- Elbows at 90 degrees.
- Head up, looking forward.
- Lift your knees.

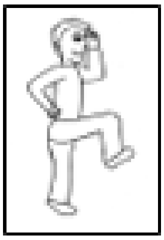


EXERCISE 1: HIP TO LIP

Move your arms as if you are running. (Remember to keep your elbows bent. Your hands should go from "hip to lip".) Do this for the count of 20.

EXERCISE 2: A-MARCH

Pick two points. This can be any two points you like (e.g. your front door to your front gate, one side of your bedroom to the other, two markers in the grass etc.). "A-march" from one point to the other. (The A-march is a type of exaggerated walk that will help you run better. Take a step with your left foot and push up onto the ball/toe of your left foot. Bring your right knee up to the same height of your hip. Keep your ankle directly under your knee and point your toe up. At the same time bring your left hand up to your lip and your right hand should be almost touching your right hip. Now repeat by taking a step with your right foot. Continue to do this until you reach your second marker- Try A-marching around your room/the kitchen.



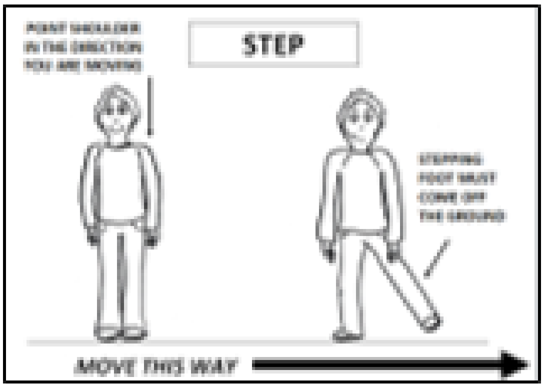
Challenge A: TAG-Ask a friend or someone at home to play tag with you. Take it turns to be the chaser. When you are the chaser, you must run after your partner and touch them to catch them. When you catch them, they become the chaser and you must avoid your partner for as long as you can.

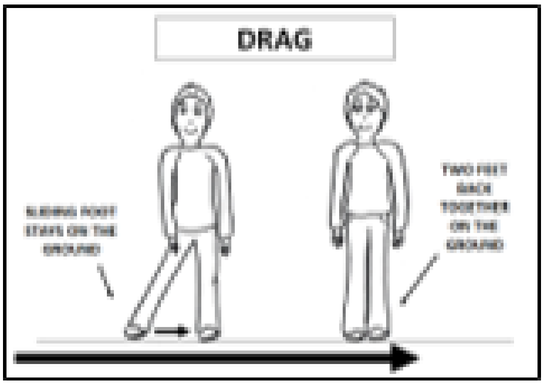
EXERCISE 3: STRIDE FOR 5

Get someone to time you and see can you run without stopping for 30 seconds (half a minute. *(If you don't have a watch or if there is no one at home to time you, count to 30 in your head.)* If you can do this, tomorrow try to run for 1 minute. Keep adding on 30 seconds (i.e. half a minute) every time you succeed and see can you build it up so that you can run without stopping for 5 minutes. (Don't worry if you can't keep running. If you feel you have to stop, try to walk. You will feel better and get your breath back faster if you walk. And don't worry you can always try again tomorrow to reach your goal.)

Challenge B: Ask someone at home (your brother, sister, parent, guardian etc.) to "stride for 5" with you. It is great fun to run with a partner.
Challenge C: Ask a friend (This can be someone in your class if you like or a neighbour) to "stride for 5" with you.

THE SLIDE





WHEN SLIDING, REMEMBER TO:

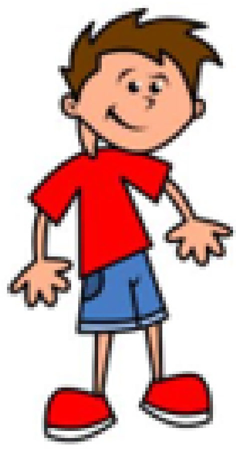
- "Step, drag, step, drag"
- Align your body so that your shoulder points in the direction you are moving.
- Lift your lead foot and step to the side.
- Keep your trail foot on the ground as you slide it to a position next to the other foot.

EXERCISE 1: SLIDE UP AND BACK

Pick two points. These will be called point A and point B. Stand at point A with your right shoulder pointing to point B. Slide from point A to point B. Remain facing the same way. Now your left shoulder is pointing towards point A. Slide from point B back to point A. Do this 5 times. How many slides?

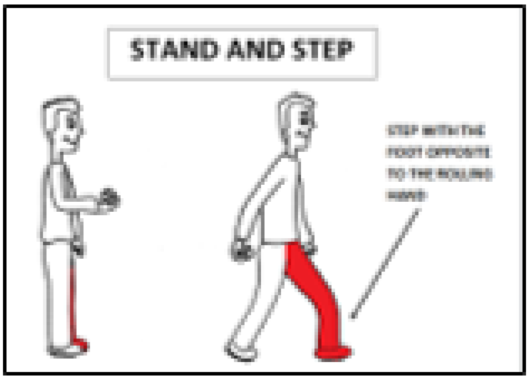
EXERCISE 2: HOW MANY SLIDES?

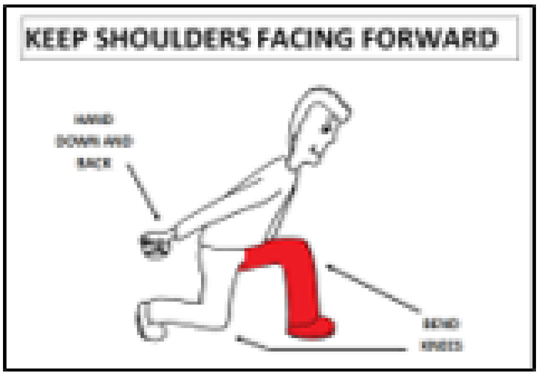
Place two markers 10m apart. Slide from one marker to the other. See how many slides it takes you to reach the second marker. Does it take you more, less or the same number of slides on the way back? Move the markers to different places. Count how many slide it takes between these two points.

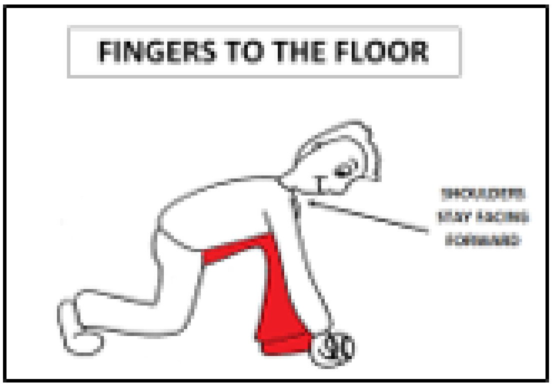


Challenge A: At lunchtime in school, slide from one side of the yard to the other.
Challenge B: Sliding mirrors. Face a friend/family member. Slide in whatever direction you want to. Your partner (the mirror) must match/mirror your movement. You can also make faces and perform arm actions that the mirror must copy. Swap roles after a few minutes.

THE ROLL







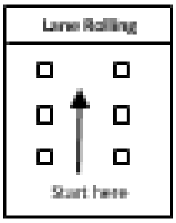
WHEN ROLLING, REMEMBER TO:

- Keep your shoulders facing forwards.
- Step forward with the foot opposite to the rolling hand.
- Bring your hand down and back.
- Bend your knees to get low to the ground.
- "Fingers to the floor" when releasing the ball.
- "Step and roll"

EXERCISE 1: ROLL TO THE WALL 20 TIMES

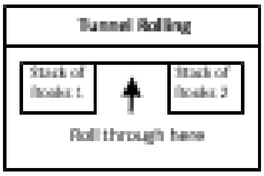
Take 5 giant steps away from a wall. Stand with your two feet together, with the ball in your hand facing the wall. "Step and roll" the ball to the wall so that it comes back out towards you after it hits the wall.

Challenge A: Teach a friend/family member how to roll the ball correctly. Stand approximately 10 giant steps away from your partner and roll the ball to each other 20 times. Tell your partner whether or not they rolled correctly. Tell them how to improve if they did not roll correctly.



EXERCISE 2: LANE ROLLING

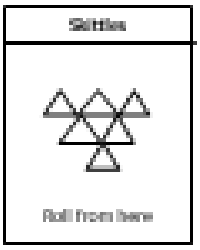
Mark out a lane with objects (e.g. bottles, pencils, books etc.). The lane should be two giant steps wide and 10 giant steps long. Start at one end of the land and roll the ball through the lane. Try to roll the ball so that it stays within the lane and rolls through the end of the lane. If the ball stay in the lane, make the land narrower or/and longer.



EXERCISE 3: TUNNEL ROLLING

Make two stacks of 5 books. Place a ruler across the two stacks to make a tunnel as shown. Take 5 giant steps back from the tunnel. This is your starting point. Step and roll and try to roll the ball through the tunnel. If the ball goes through the tunnel, move your starting point back further from the tunnel.

Challenge B: Hit the target-Place a piece of paper at the bottom of a wall. Take 5 giant steps back from the wall. This is your starting point. Roll the ball towards the wall and try to hit the piece of paper. If you hit the piece of paper, move your starting point further away from the wall or make your target smaller.

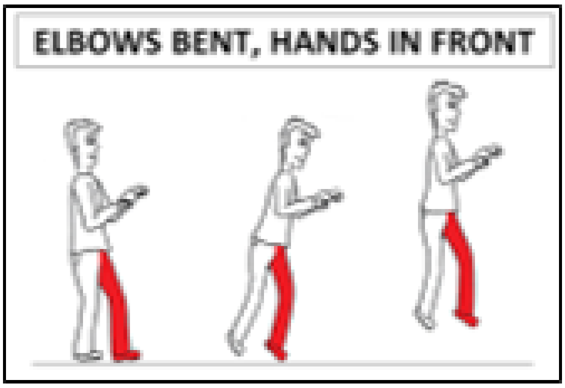


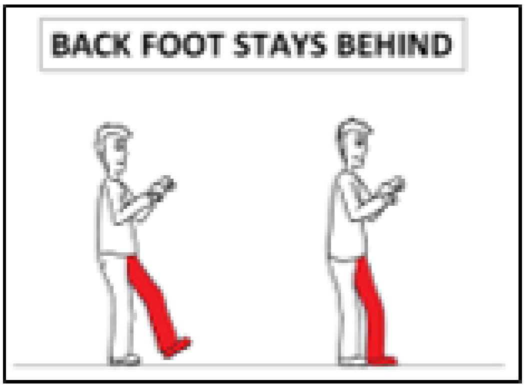
Challenge C: Skittles-Stand 6 bottles up. Take 5 giant steps back from the skittles. This is your starting point. Roll the ball and try to knock down the skittles. You have 3 attempts to knock all the bottles down. You score 10 points for every skittle you knock down. If you knock all the bottles down, move your starting point further away from the skittles.

Challenge D: Single skittle knockdown-Stand 1 bottle on the ground. Take 5 giant steps back from the skittles. This is your starting point. Roll the ball and try to knock the skittle down. You have 3 attempts to knock the bottle down. If you knock the bottle down, move your starting point further away from the skittles.

Challenge E: Challenge a friend/family member to a game of skittles. See who can be the first to 100 points.

THE GALLOP





WHEN GALLOPING, REMEMBER TO:

- Keep your trail/back foot behind the front foot.
- Bend your elbows, hands out in front.
- Keep facing forward.

EXERCISE 1: GALLOP UP AND DOWN

Mark out two points approximately 10 giant steps apart. Call one point A and the other point B. Gallop from A to B. Gallop back to A. Do this 10 times.

Challenge A: Teach a friend/family member how to gallop.

EXERCISE 2: RIGHT AND LEFT

Do 6 gallops with your right foot in front. Do 6 gallops with your left foot in front. Do this 5 times. Does it feel more comfortable galloping with your right or your left leg in front? Did you remember to have your elbows bent and your hands out in front?

Challenge B: Can you do 10 correct gallops in a row. Remember to keep your rear foot behind your leading leg and your elbows bent and hand up in front. (If your rear foot lands in front of your leading foot, you must go back and start at 0 again.)

GALLOP

Remember to record your activity.

Day	Date	Skill	Exercise	Challenge	How did you find it? Very easy? Easy? OK? Difficult? Very difficult?	Spraoi Points
Monday	*5th Sept*	*Catch*	*1, 2, 3*	*A, B*	*Very difficult*	
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Appendix K: Fundamental Movement Skill Teacher Manual

FMS Teacher Manual

FUNDAMENTAL MOVEMENT SKILLS MANUAL

Fundamental Movement Skills

Teacher Manual

1

Table of Contents

The Catch

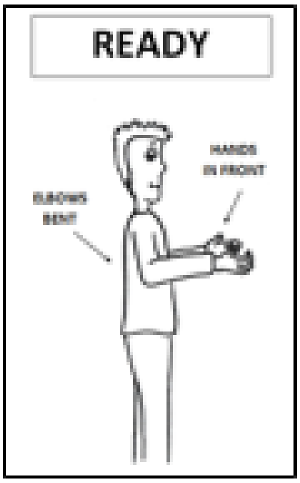
THE SKILL

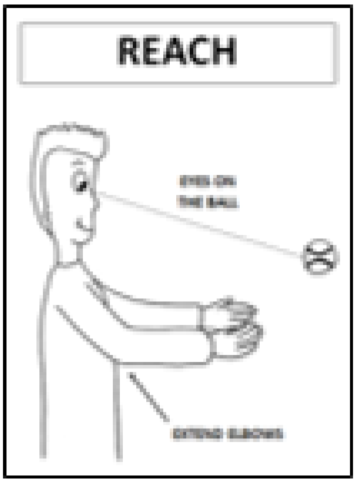
The catch is an object-control skill that involves taking a moving object from the air and holding it in the hands. There are many different types of catch, such as the two handed catch, one-handed catch, overhead catch etc.

The catch is a very common activity and is used in recreational games and activities such as *donkey, quinee-eye-aye, no man's land* etc. and in many sports such as *Gaelic football, hurling, basketball, rounders, rugby* etc.

SKILL COMPONENTS

- Before the ball is thrown, prepare your hands with your elbows bents and your hands in front of your body.
- Extend your arms while reaching for the ball as it arrives.
- Catch the ball in your <u>two hands only.</u>





USEFUL TIPS AND TEACHING CUES FOR CATCHING

- Watch the ball at all times.
- Move hands toward ball when catching.
- Move your feet so that your body is in line with the incoming ball.
- Cup your hands slightly so that all you have to do when the ball arrives is close your fingers on it

COMMON ERRORS

- Turning the head away, closing eyes or leaning backwards away from the object
- Not moving feet towards the object
- Not reaching hands out towards the object
- Having stiff and extended arms when catching
- Having wrists or heels of hands hinged together to catch (crocodile jaws technique)
- Using other parts of the body, such as the chest or upper body to catch
- Closing hands around the object too early or late
- Having little or no elbow bend or "give" after catching.

SOLUTIONS/REMEDIES:

- Use a softer (not bigger) ball
- Begin passing the ball from one person's hands to the others and then gradually increasing the distance between the two people.
- Teaching points such as "hold hands apart at a distance that could fit 2 balls" and encouragement and praise for correct technique regardless of the outcome of the catch (i.e. whether the student caught the ball or not.)

TEACHING THE CATCH

- To allow children to familiarise themselves with the concept of approaching objects, begin by getting them to:
  - experiment with rolling and trapping balls (along the ground or across a table)
  - roll balls at different speeds
  - roll balls directly towards or slightly to one side of a partner
  - move towards the rolling ball

  This will allow students to get the idea of focusing on the object and moving their hands towards the object.
- Progress to using beanbags to catch and then balls.

OTHER ACTIVITIES

- Toss a ball or object in the air and catch
- Bounce and catch a ball
- Catch the ball without letting it touch the body throwing the ball onto a wall and catching the rebound normally/overhead (work in pairs).
- Students use a container to catch objects. They move to meet the object and have the bucket "give" as the object enters, so it won't bounce out. (Quiet bucket)
- Students catch from different positions, for example, standing or in a sitting position using a variety of objects, and balls of different sizes.
- Students catch balls that are rolling and bouncing at varying speeds and heights.
- Students catch balls not directly in line with the body. Proficient students can try catching balls or objects while moving at different angles to the line of flight of the ball

OTHER INFO

Learning to catch using a big object and then progressing to a smaller object may be detrimental to the development of a proficient catching technique. This is because it encourages the use of the chest and arms to help trap the object. This may be difficult to change at a later stage. Furthermore, it has been shown that children catch smaller balls better than larger balls.

The Hop

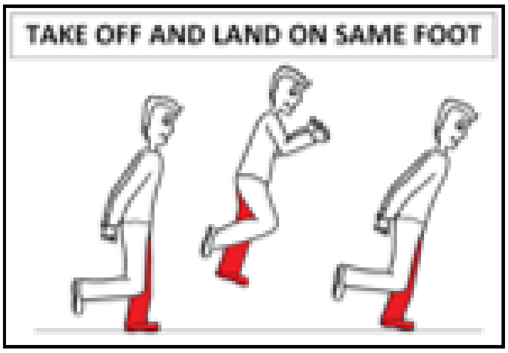
THE SKILL

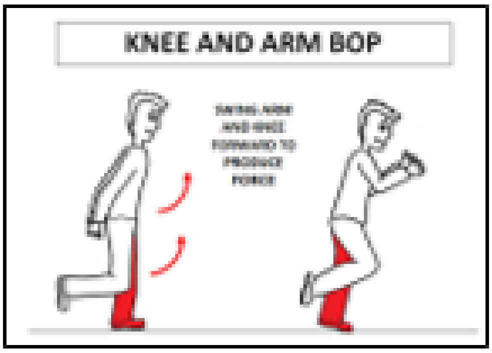
The hop is a locomotor skill which involves jumping off one leg and landing on the same leg. It involves balance, strength, co-ordination and rhythm.

The hop is common to many recreation activities and games such as *hop scotch* and is commonly used in *dance* and *triple jump*.

SKILL COMPONENTS

- Non-support leg swings forward in pendular fashion to produce force.
- Foot of the non-support leg remains behind the body.
- Arms are flexed and swing forward to produce force.
- Takes off and lands 3 consecutive times on preferred foot.
- Takes off and lands 3 consecutive times on non-preferred foot.





HOP

USEFUL TIPS/TEACHING CUES FOR THE HOP

- Bend your leg to push off.
- Find your rhythm.
- Use your arms for balance.
- Swing your arms forward to help you move.
- Bring your knee forward to help you move across.
- Keep your swinging foot behind your leg.
- Keep your heel to your bum.

SOLUTIONS/REMEDIES

- Practice balancing on one leg at a time.
- Do a stationary hop, emphasising that you bend your support leg and extend to jump and bend on landing.
- Do single hops before progressing to a number of consecutive hops.
- Pick a spot in front of the student and tell them to watch the spot. (e.g. "watch the window of the classroom while hopping").

COMMON ERRORS

- Being unable to maintain balance for more than three or four hops.
- Not bending the knees, ankles or hips to absorb force on the landing.
- Allowing support leg to remain bent when pushing off (failure to extend leg and push off ball of the foot).
- Holding non-support thigh parallel to the ground.
- Looking down at the ground or feet.

TEACHING THE HOP

- Begin with basics such as balancing on one leg for 10 seconds. Extend the length of time as children's balance improves. Make sure to do the same activity on both legs to ensure muscles stay balanced. Muscle imbalances may lead to injuries during later years.
- Tell students to hop on the spot, using a chair, the wall or a partner for support.
- Progress to hops on the spot.
- Progress to single hops.
- Progress to a number of consecutive hops.

OTHER ACTIVITIES

- Students hop on one foot and then the other, using sequences, for example, L-L, R-R, L-L, R-R, L-L-L, R-R-R, L-L-R-L-L, R-R-L-R-R, on the spot, then travel.
- Students make hopping patterns by combining hopping in one place with hopping along a straight or curved pathway.
- Hop in different directions, forwards, backwards, sideways, curved paths etc.
- Create a space in the playground to encourage hopping games to be played out of class time (e.g. hopscotch, elastics and skipping).

OTHER INFO

Hopping is very fatiguing, so ensure that opportunities for practice are short and intermixed with other activities. This gives the students a chance to recover adequately between practice sessions.

The Throw

THE SKILL

The throw is a very commonly used skill that involves holding an object (e.g. a ball) in one hand in a position above the shoulder and then projecting it into the air.

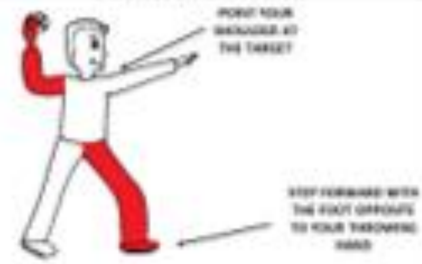
The throw is common to many activities such as *rounders, American football, olympic handball* and is also an important action to master for sports such as *athletics (javelin), tennis, badminton* etc.

SKILL COMPONENTS

- Wind up is initiated with downward movement of hand/arm.
- Rotates hip and shoulders to a point where the non-throwing side faces the wall.
- Weight is transferred by stepping with the foot opposite the throwing hand.
- Follow through beyond ball release diagonally across the body toward the non-

STAND

STEP and TWIST



FOLLOW THROUGH TO OPPOSITE HIP

THROW

USEFUL TIPS AND TEACHING CUES FOR THE THROW

- Look at your target.
- Step and twist so that you are standing side on.
- Bring your arm up and then down and back as you twist.
- Point to the target (with your non-throwing arm).
- Follow through, down and across your body with your throwing arm.
- Throw as hard as you can.

COMMON ERRORS

- Standing front on to the target area as you throw.
- Standing with throwing shoulder closest to target area (as if throwing a dart).
- Stepping towards target area with same foot as throwing arm.
- Hips do not rotate forward during propulsion.
- Throwing arm points to target area after throw, rather than following through down and across body
- Little or no weight transference on to the back foot during preparation.

TEACHING THE THROW

- Use existing playground markings or cones as starting markers. Use a verbal cue, such as: "Step and throw" to prompt the step forward to initiate the throw.
- Use the analogy of a catapult/elastic band to focus on the hip and shoulder rotation to generate force and power in the throw. Ask students to imagine the force that it has as it is released and uncoils. Encourage them to try to mimic this force in the preparation and propulsion phases of the throw.
- Use guided discovery to help the student identify the most effective throwing technique.
  e.g. Ask students to throw the ball in a variety of different ways such as:
  - standing facing towards the target, keeping their hips and feet still
  - stand side-on and rotate hips and shoulders
  - take a small step as they throw to transfer their bodyweight
  - while sitting, kneeling, on one knee, standing etc.
- Allow them to work in groups and to identify the most effective way to throw.
- Ask the students what difference they notice in the distance of the throw.
  What different body parts did they use?
- Ensure that students reset their stance (stand with two feet together, facing forward) before beginning each throw to ensure that the correct technique is practiced on each throw. Use cues such as "**Stand**, step and throw" for this.

IMPORTANT INFO

- Objects need to be thrown with force for the development of correct technique. ***For this reason, it is not advised to teach throwing and catching together.*** Immature techniques can be seen in students who have not had the opportunity to throw frequently and hard when learning the skill.
- To minimise the danger of objects thrown with force, use bean bags, pairs of socks, scrunched up paper or soft foam balls. The objects used for throwing need to be of a size which allows them to be comfortably grasped in the throwers' fingers (not the palm of the hand). If the object is too large it will force the student to resort to an immature throwing technique.
- If students are having problems balancing when throwing, instruct them to raise their non-throwing arm and point it to the target area.
- When focusing on specific components of the throw, ensure that the whole movement is practised. Any pause or breaks in the sequence will cause the development of a robotic, immature pattern.

OTHER ACTIVITIES

Rebound Challenge
Get students to throw the ball of a wall so that it rebounds back off the wall as far as possible. This will ensure that they will throw with force. Mark with a cone where the ball hits the ground on the rebound. Try to beat this with the next throw.

First to 20
Throw to a partner a substantial distance away, remembering to "stand, step, throw and follow through". If you throw with the correct technique, you score a point and if you reach your partner, you also score a point. Your partner scores your technique and must explain what the thrower did incorrectly if they do not award a point for technique. Continue to play until one partner reaches 20 points.

Hit the target
Stand approximately 8-10m from the wall. Pick a target on the wall (e.g. hang a piece of paper/poster on the wall or simply pick a certain brick in the wall or a spot on the wall). Throw a pair of socks and try to hit the target. Make the target smaller or move further back from the wall if it becomes too easy. Remember to "stand, step, throw and follow-through".

The Leap

THE SKILL

The leap is a type of jump. It is characterised by taking off on one foot and landing on the opposite foot, following a prolonged period of time spent in the air.

The leap is common to many recreational activities such as hopscotch and lily-pad leaping. It is also used in many sports such as *dancing, gymnastics* and *athletics* in the *hurdles* and *triple jump* events.

SKILL COMPONENTS

- Take off on one foot and land on the opposite foot.
- A period where both feet are off the ground longer than running.
- Forward reach with arm opposite the lead foot.

USEFUL TIPS/TEACHING CUES FOR THE LEAP:

- Jump off one foot and land on the other.
- Bend knee to take off.
- Reach forward and try to touch your opposite foot.
- Stay in the air as long as you can.
- Leap as far as you can.
- Straighten your leg during the flight.
- Lean your trunk slightly forward.
- Land softly.

COMMON ERRORS

- Insufficient knee bend in take-off leg (resulting in lack of propulsion or forward and upward elevation)
- Taking off and landing on the same foot (hops)
- Short flight time
- Arm opposite the lead leg does not reach forward during flight
- Running over the obstacle with an obvious prolonged flight time

TEACHING THE LEAP

- Begin with basic leaping activities such a leaping out of a hoop from a standing start (i.e. students take off on one leg inside the hoop and land on the opposite foot outside the hoop).
- Increase to longer leaps and then a run up with a leap.
- Use guided discovery to identify the correct technique. Explore different arm positions during the leap such as:
  - -over head
  - -out to the side
  - -both forward
  - -one arm forward
  - -other arm forward
  - -down by the side
- Ask students to explore different ways of pushing off with their take-off leg. They could use marks on the ground to measure the difference between:
  - -taking off with a straight leg from a standing position
  - -using a small slow run-up, with a bent leg on take-off
  - -using a fast run-up, with take-off leg bent and the leading leg stretching out in front.

OTHER ACTIVITIES

<u>How high can you leap?</u>
Use both high and low leaps. Use soft objects or objects which fall apart readily to form slightly higher barriers.

- Use imagery to assist students to practise the leap: e.g. Ask them to leap over a puddle of water, a lake full of crocodiles, a deep dark valley etc.

<u>Leap the lake</u>
Mark a "lake" with two extended ropes. You may not progress to a bigger lake (i.e. make the ropes wider apart) unless you clear the lake with correct leaping technique. Measure the distance of your longest successful leap over the lake and try to beat this the next day.

<u>Musical Leaping</u>
Have students run around a space as music plays. When the music is stopped, the teacher calls a colour. Students must find and leap over a cone of that colour.
Alternatively, run around with music. On hearing a certain word (e.g. "Go" from the Frozen song "Let it Go"), students leap as far/high as they can.

<u>Follow the leaping leader</u>
Students shadow a partner as they move around a grid of cones/obstacle course with leaps.

- Encourage students to develop proficiency in leading with either leg.

The Kick

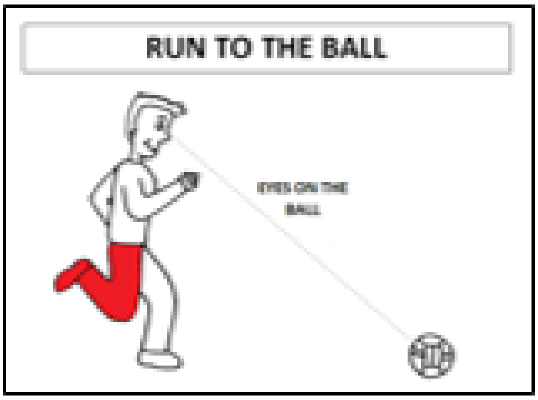
THE SKILL

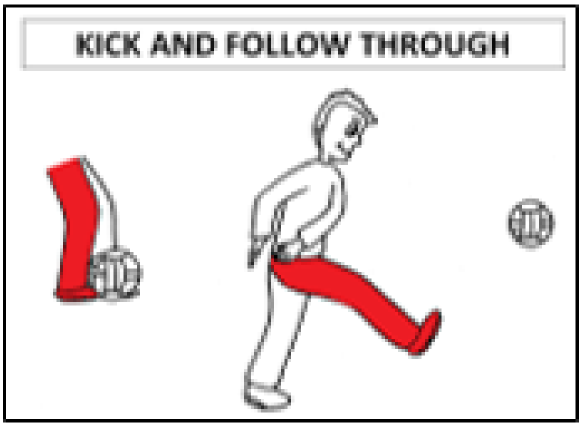
The kick is an object-control skill that involves striking a stationary ball with the foot. It is important for the development of foot-eye co-ordination.

The kick is used in many sports such as Gaelic football, soccer and rugby. It is a very important skill as Gaelic football and soccer are the two most popular extra-curricular sports and physical activities among Irish primary school children (Woods et al., 2010).

SKILL COMPONENTS

- Rapid continuous approach to the ball.
- An elongated stride or leap immediately prior to ball contact.
- Non-kicking foot placed even with or slightly in back of the ball.
- Kicks ball with instep of preferred foot (shoe laces) or toe.





USEFUL TIPS AND TEACHING CUES FOR THE KICK

- Watch the ball at all times.
- Run into the ball.
- Plant your non-kicking foot beside the ball.
- Make your last step towards the ball a long step.
- Try to kick the ball with the top of your foot (i.e. the shoelaces).
- Follow through after the kick.
- Run-up to the ball at a 45-degree angle rather than a straight line

COMMON ERRORS

- Looking at the target rather than the ball
- Non-kicking foot is placed too far behind the ball (i.e. more than one foot behind the ball)
- Poking or pushing at the ball rather than kicking through it (results in no follow-through or straight-legged kick)
- Not elongating the stride prior to kicking the ball

TEACHING THE KICK

- Students hold on to a partner's shoulder or a chair beside them to balance. They place the non-kicking foot beside the ball. They swing the kicking leg back and then forwards to kick the ball.

- Students mark a starting point on the ground about one step away from the ball. They step forward with non-kicking foot, placing it beside the ball. Use verbal cues such as "step forward, kick" to help students develop rhythm and force.

- Instruct students to try kicking the ball in a number of ways, e.g.
  - with a stiff non-bending kicking leg
  - with no back swing
  - with a small back swing from a step-up position
  - from a run-up with a big back swing.

  Ask students which way produced the most force and identify reasons why.

SOLUTIONS/REMEDIES:

- Place a mark on soft large objects such as beach balls, foam-filled balls or balloons. Tell students to:
  - -Watch the mark on the ball as they prepare to kick
  - -Kick with force (as they won't sustain an injury with the soft balls).

- Place a mark on the ground next to the ball. Students should place their non-kicking foot on this mark prior to kicking the ball.

- Encourage the children to kick through so that their foot almost touches their hand.

IMPORTANT INFO

Students should be instructed to kick the ball as hard as possible, concentrating more on velocity than accuracy, and be given plenty of opportunities to practise in order to develop proficiency.

Placing the ball on a low tee or a bean bag can enable students to get their kicking foot under the ball and make contact with their shoelaces or instep.

Beach balls, balloons or foam-filled balls are ideal to use when introducing the kick. They are large and soft and can be kicked forcefully without causing injury or travelling a great distance.

The Strike

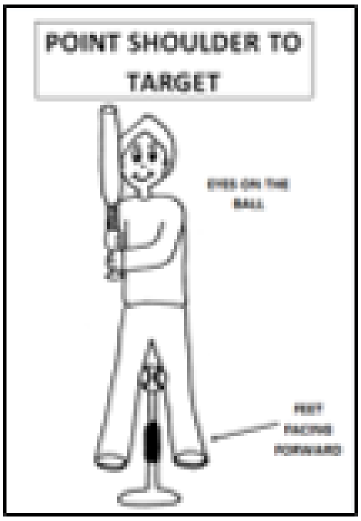
THE SKILL

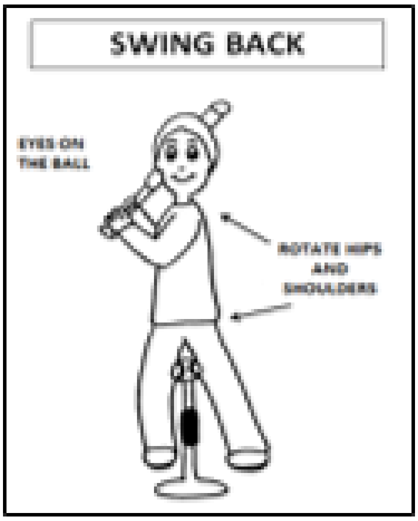
The two-handed strike involves using an implement e.g. a bat to strike a stationary ball. The strike is a very useful skill for developing hand-eye co-ordination, which is important for many physical activities.

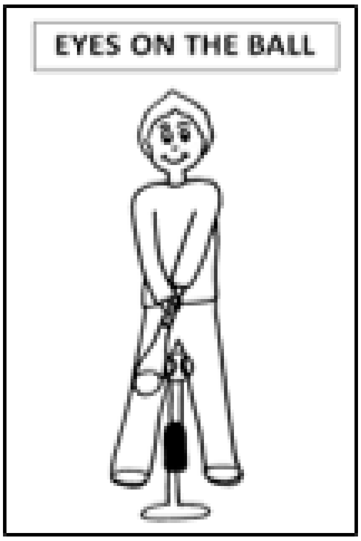
The two-handed strike is used in sports such as *hurling*, *rounders* and *hockey*.

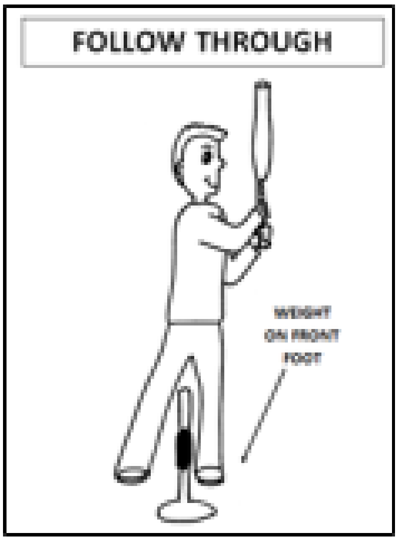
SKILL COMPONENTS

- Dominant hand grips the bat above non-dominant hand.
- Non-preferred side of the body faces the imaginary tosser with feet parallel.
- Hip and shoulder rotation during swing.
- Transfers body weight to front foot.
- Bat contacts ball.









USEFUL TIPS AND TEACHING CUES FOR THE STRIKE

- Stand side-on to your target i.e. point your shoulder to the target.
- Keep your feet in line with your shoulders.
- Keep your two hands together on the bat.
- Watch the ball until the ball has left the striking tee.
- Rotate your hips away from the target before your strike.
- Rotate your hips as you strike.
- Follow through, finishing the swing with the bat at your ear.

COMMON ERRORS

- Looking at the target rather than the ball
- Front shoulder doesn't point to target area
- Weight is not transferred onto back foot during back swing
- No hip rotation during swing
- No weight transferred onto front foot during forward swing

TEACHING THE STRIKE

- Place tape on the ball and instruct children to watch the tape throughout the strike. Place two pieces of tape on the ground to indicate where the feet should be prior to striking. Students use bats made of rolls of newspaper to mirror the stance and rhythm of the strike demonstrated by the teacher. Teachers use verbal cues such as "swing and follow-through" to focus on body movement or rhythm as the students practise the strike.

- Use guided discovery to identify the best way to strike. For example, allow students to explore different ways of swinging such as:
  - swinging with no back swing
  - swinging with a back swing but no hip rotation during the backswing
  - swinging with a back swing and hip rotation during backswing
  - making a half swing with no follow-through
  - trying a full swing and follow-through

OTHER ACTIVITIES

- Allow children to use a range of different bats and ball when practicing striking.
- Hang tennis balls in stockings from an overhead beam for variety.
- Practise the strike in modified games such as "target practice" where students aim to strike the ball through goals for points.

OTHER INFO

Initial instruction should focus on velocity rather than accuracy.

A contributing factor to success with this skill is ensuring the bat is not too long or heavy and the tee not too high.

If younger students are having difficulty, you could commence instruction using the hand as the implement, starting with slow moving objects such as beach balls or balloons. Have students progress to a small, short-handled implement that can be held comfortably in one hand, such as a paddle bat, then on to a longer implement requiring two hands for control.

The Dribble

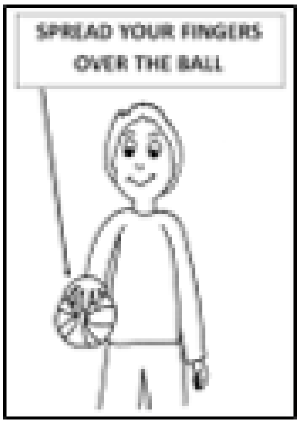
THE SKILL

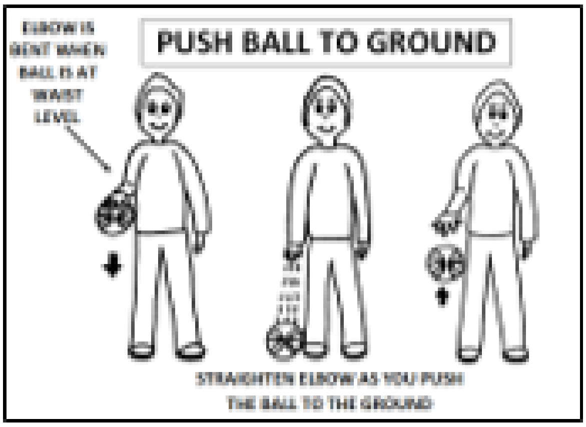
The dribble is an object-control skill which involves bouncing a ball on the ground for a number of consecutive times.

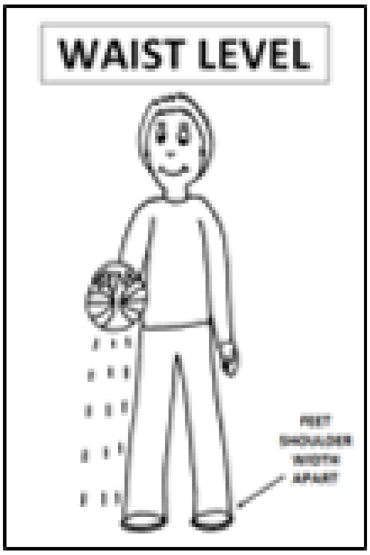
The dribble is used in *basketball* while its technique is also used for the hop in *Gaelic football* and *international rules*.

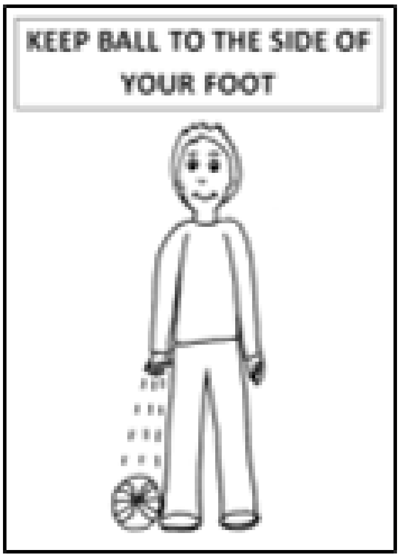
SKILL COMPONENTS

- Contacts ball with one hand at about belt level.
- Pushes ball with finger tips (not a slap).
- Ball contacts surface in front of or to the outside of foot on the preferred side.
- Maintains control of ball for 4 consecutive bounces without having to move the feet to retrieve it.









USEFUL TIPS AND TEACHING CUES FOR THE DRIBBLE

- Watch the ball throughout the dribble (for beginners).
- Spread your fingers over the top of the ball.
- Begin with your elbow bent. Extend your arm while PUSHING the ball to the ground.
- Bounce the ball at the side of your foot.

COMMON ERRORS

- Keeping the arm straight throughout the dribble (instead of a bend-extend-bend-extend series of movements).
- Slapping the ball.
- Moving feet to retrieve the ball.
- Allowing the ball to bounce higher than waist level.

OTHER ACTIVITIES

How many in a row?
Children try to get as many bounces as possible without having to move their feet to retrieve the ball.

Bad hand
When children get good at using one hand, encourage them to practice with their other hand.

TEACHING THE DRIBBLE

- Mark a circle/Place a piece of tape on the ground. Instruct the students to stand to one side of this mark and to bounce the ball on the piece of tape.

- Begin with one dribble, so pushing the ball to the ground and catching again. When this can be performed correctly, perform this twice. Then progress to 2 consecutive bounces and a catch. Continue adding on extra bounces in this way. Progress to dribbling while running when children can perform 5 consecutive stationary dribbles.

- It is important a ball that is an appropriate size for the students. Using a ball that is too big will result in a slapping motion and incorrect technique while a ball that is too small will be extremely hard to control and will not allow for adequate practice of

The Jump

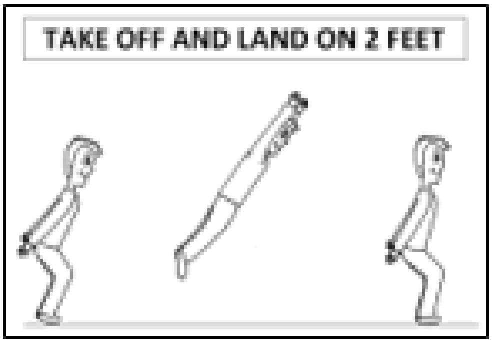
THE SKILL

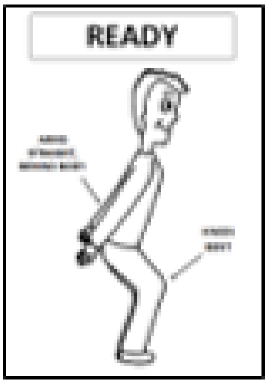
The jump consists of three phases: take-off, flight and landing. The standing broad jump is a jump characterised by taking off on and land on 2 feet simultaneously.

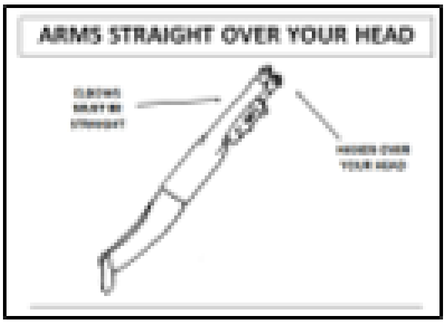
It is used as an indicator of lower body power and its flight and landing phases are used in athletic events such as the long jump and triple jump.

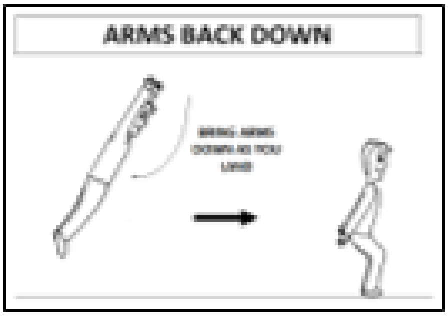
SKILL COMPONENTS

- Preparatory movement includes flexion of both knees with arms extended behind body.
- Arms extend forcefully forward and upward reaching full extension above the head.
- Take off and land on both feet simultaneously.
- Arms are thrust downward during landing.









USEFUL TIPS AND TEACHING CUES FOR THE JUMP

- Bend knees. Have your hands straight behind your body.
- Arms straight over your head/elbows straight.
- Arms back down when you land.

COMMON ERRORS

- Taking off on one foot.
- NOT FULLY EXTENDING ARMS OVERHEAD during the flight phase.
- Swinging arms backwards and around the head (like a butterfly stroke).
- Not thrusting arms down during landing.
- Holding hands in front of the body before take-off (i.e. crouched like a bunny rabbit).

JUMP

TEACHING THE JUMP

- To familiarise the children with the correct arm technique, instruct them to stand with their hands slightly behind their bodies. On the shout "up", they swing their arms forward and up to a position over their head. On "down", they bring them back down. Combine these two movements so that on "Go", children swing their arms up and down (i.e. practicing the correct arm technique without the rest of the jump).

- Next, introduce the preparatory phase of bending the knees with arms extended behind the back. On "ready", children should assume this position and then on "go", jump, extending arms overhead.

OTHER INFO

Initially, the focus is to master the correct technique. Often when children are asked to jump with a goal (i.e. to jump as far or as high as possible), they will use whatever way they are used to, to achieve their goal, very often using the incorrect technique and so it is advised to master the process of performing the skill rather than the product of it. Alternatively, to emphasise the importance of correct technique, only allow jumps to be measured if correct technique is used.

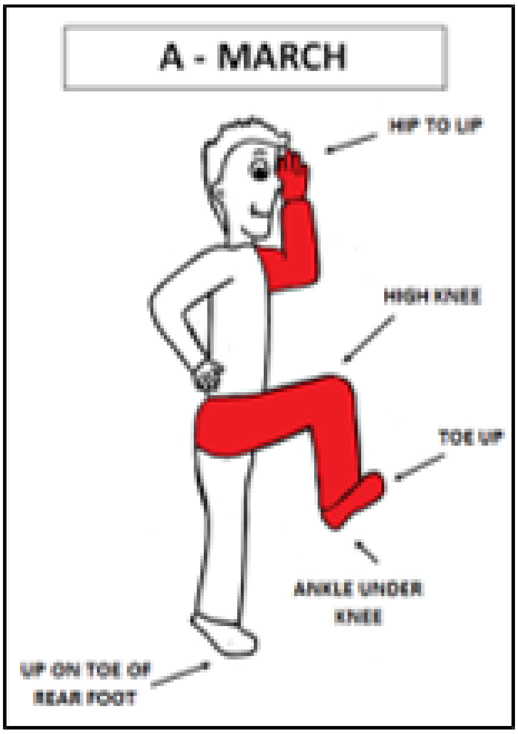
The Run

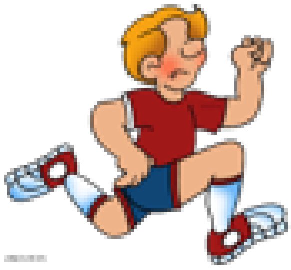
THE SKILL

The run is the most commonly performed skill of all the fundamental movement skills. It is a common recreational activity and is also necessary for many games and sports such as *athletics, GAA, soccer, rugby* etc.

SKILL COMPONENTS

- Arms move in opposition to legs, elbows bent.
- Brief period where both feet are off the ground.
- Narrow foot placement landing on heel or toe (i.e. not flat footed).
- Non-support leg bent to approx. 90° (close to buttocks).





USEFUL TIPS AND TEACHING CUES FOR THE RUN

- Land on the balls of your feet.
- Toes up.
- Hip to lip.
- Elbows at 90 degrees.
- Head up, looking forward.
- Lift your knees.

COMMON ERRORS

- Looking at the ground rather than straight ahead.
- Landing flat footed (rather than on the heel, or ball of the foot/toes)
- Arms and legs not in opposition (i.e. same leg and same arm forward at the same time.
- Arms straight.

TEACHING THE RUN

- <u>A-MARCH</u>
  This is a common drill used by many professional athletes including sprinters as well as team sport athletes such as rugby players. It is a walking drill with some key things to include in the walk such as:
  -up on the toe of the back foot
  -bringing knee up to hip height
  -ankle should be directly under the knee
  -toes pointing up
  -elbows bent to 90 degrees
  -arms move in opposition to legs
  -hands go from hip to lip
  -looking forwards at all times

- <u>RUNNING ARMS</u>
  Allow children to practice the correct arm technique by instructing them to stand and practice (i.e. without running). Emphasise that the hand should go "hip to lip" or "cheek to cheek".

- <u>HIGH KNEES</u>
  This is the same as the A-march but at a faster pace.

OTHER INFO

Emphasis is very often placed on speed when it comes to running. However, technique is equally as important. Improving technique will make the run much more efficient and economical, allowing you to run faster and have more energy when running for longer distances.

Correct technique will also prevent injuries in later years.

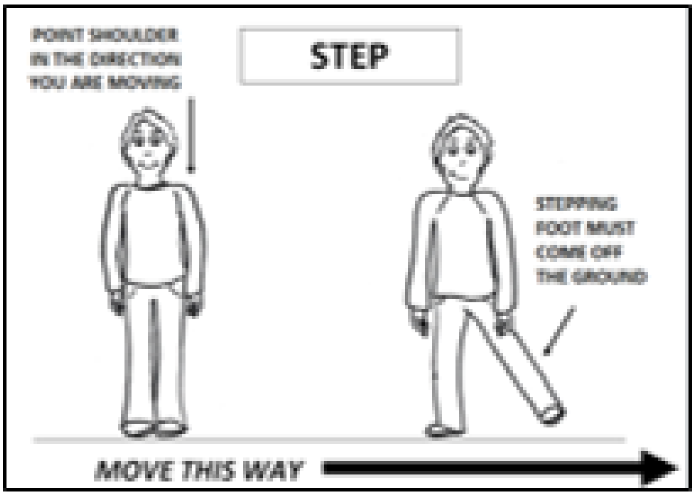
The Slide

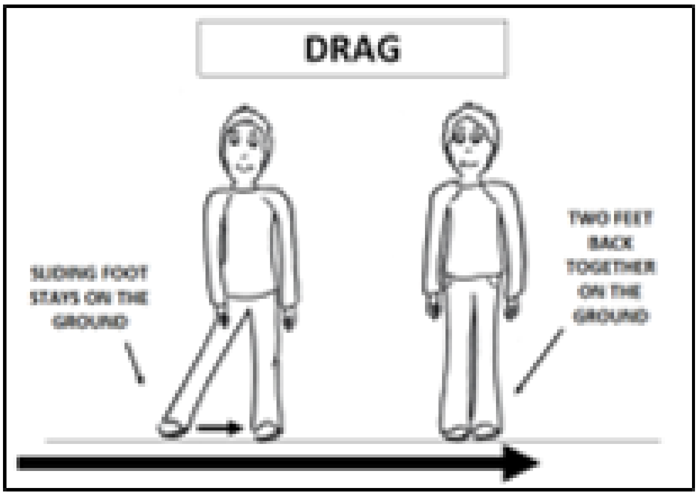
THE SKILL

The slide is a locomotor skill that involves moving in a sideways direction. It is the basis for lateral movement which is important for evasion games such as *GAA, rugby* etc., sports such as *tennis* and *badminton* as well as *dance*.

SKILL COMPONENTS

- Body turned sideways so shoulders are aligned with the line on the floor.
- Step sideways with lead foot followed by a slide of the trailing foot to a point next to the lead foot.
- A minimum of 4 continuous step/slide cycles to the right.
- A minimum of 4 continuous step/slide cycles to the left.





SLIDE

USEFUL TIPS AND TEACHING CUES FOR THE SLIDE

- "Step, drag, step, drag"
- Align your body so that your shoulder points in the direction you are moving.
- Lift your lead foot and step to the side.
- Keep your trail foot on the ground as you slide it to a position next to the other foot.

COMMON ERRORS

- Sliding with the lead foot as well as the trailing foot.
- Not dragging the trail foot along the ground (i.e. stepping with the trail foot).
- Not completing 4 consecutive slides.
- Side skipping.
- Lifting the lead foot before the trail foot has been positioned beside it.

TEACHING THE SLIDE

- Instruct the children to point their lead shoulder in the direction in which they wish to travel.

- Ensure that the step involves taking the foot off the ground and placing it back down a short distance to the side. The trail foot must not leave the ground, but slide along it to a position next to the lead foot. When the two feet are next to each other (with both feet stationary), repeat the movement.

- To ensure that the step/slide cycle is carried out and remembered by the children, instruct the children to say "Step, drag, step, drag" as they slide.

- Allow children to practice moving in both right and left directions.

OTHER INFO

Trying to perform the slide at speed often results in a side skip (i.e. both feet being in the air), rather than the sliding foot coming to a stop beside the stationary lead foot.

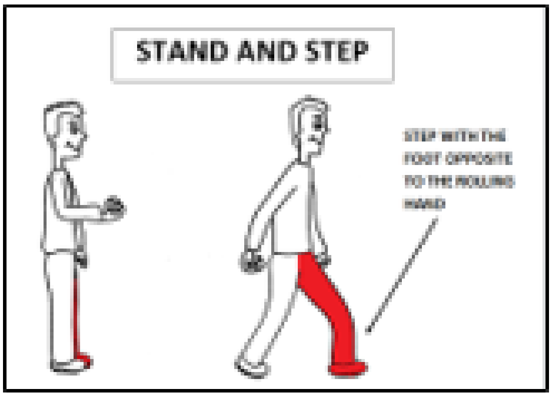
The Roll

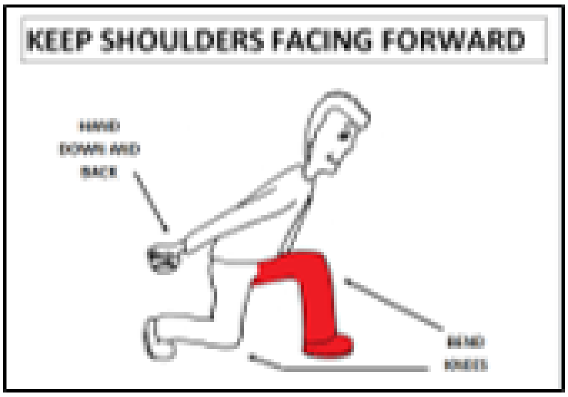
THE SKILL

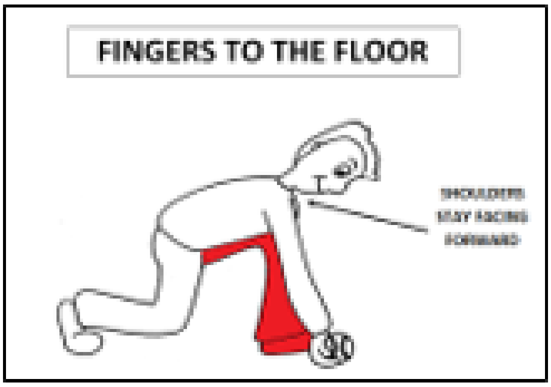
The roll involves releasing a ball low along the ground from the hand. It involves co-ordination and flexibility. The roll is used in activities such as *bowling, boules , boccia* and *bowls*.

SKILL COMPONENTS

- Preferred hand swings down and back, reaching behind the trunk while chest faces cones.
- Strides forward with foot opposite the preferred hand toward the cones.
- Bends knees to lower body.
- Releases ball close to the floor so ball does not bounce more than 4 inches high.







USEFUL TIPS AND TEACHING CUES FOR THE ROLL

- Keep the shoulders parallel to where you are rolling (i.e. keep the body facing forward).
- Step forward with the foot opposite to the rolling hand.
- Bring the hand down and back.
- Bend your knees to get low to the ground.
- "Fingers to the floor" when releasing the ball.
- "Step and roll"

COMMON ERRORS

- Bringing the hand out to the side (as if going to strike a ball with the hand).
- Not keeping the body facing forward.
- Stepping with the foot of the throwing hand.
- Keeping legs straight and bending from the waist to lower the body.
- Not lowering the body.
- Releasing the ball with hand at knee height.

TEACHING THE SKILL

- Get children to line up at a line/markers. On the call "ready", they should hold the ball in their rolling hand and stand with two feet together at the line. On "step and roll", they step forward and roll the ball along the ground.
- *Partner/group work*: Place a hurdle/low bar approximately 3m in front of the roller. Instruct the children to roll the ball under the hurdle/bar. If the ball passes under, the roller gets a point. They get a second point if the other group members agree that they used the correct technique to roll the ball. They must outline what they did not do correctly if the technique point is not awarded.

OTHER INFORMATION

Ensure the children reset before each roll. Very often if children are rolling a number of balls in a row, they stay in the crouched position that they finished in following the previous throw, pick up the ball and roll again (omitting the step and bending of the knees).

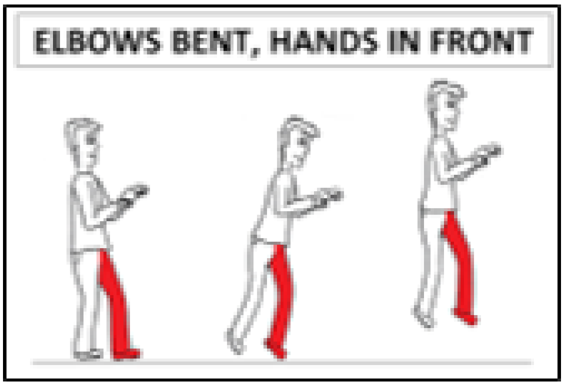
The Gallop

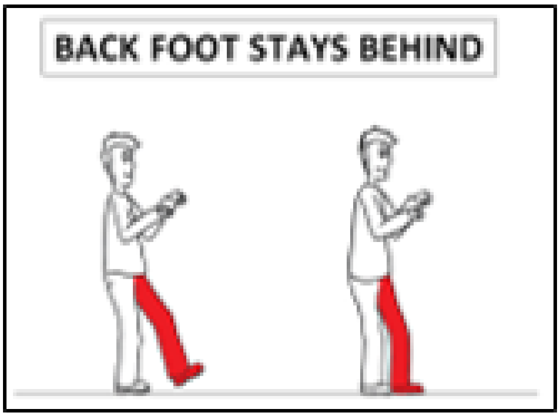
THE SKILL

The gallop is a locomotor skill that involves rhythm and co-ordination.

SKILL COMPONENTS

- Arms bent and lifted to waist level at take off.
- A step forward with the lead foot followed by a step by the trailing foot to a position adjacent to or behind the lead foot.
- Brief period when both feet are off the floor.
- Maintains a rhythmic pattern for 4 consecutive gallops.





GALLOP

USEFUL TIPS AND TEACHING CUES FOR THE GALLOP

- Keep your trail/back foot behind the front foot.
- Bend your elbows, hands out in front.

COMMON ERRORS

- Side skipping
- Skipping
- Placing the trail foot in front of the lead foot on landing.
- Loss of rhythm.
- Arms straight out in front.

TEACHING THE SKILL

- While demonstrations are important for all skills, it is invaluable for the gallop. While demonstrating the gallop, identify the key components of 1) keeping elbows bent and hands in front of the body and 2) placing the trail foot behind the lead foot on landing.

- Incorporate the gallop into games such as groups (e.g. children gallop around an open space and when the teacher/coach calls a number, children must get into groups of that number), coloured corners (e.g. children gallop around an open space and when the teacher/coach calls a colour, they must run to the corner with the cones of that colour) etc.

OTHER ACTIVITIES

Crocodile, crocodile

This is an evasion game. However, it allows children to practice two fundamental movement skills at the one time. It allows the gallop to be performed, without an emphasis being placed on speed or competition.

How to play

2 lines are marked with an open space in the middle. 1 child is the "Crocodile" while the rest of the children are "fish". The fish stand on one line while the crocodile stands in the open space in front of the fish (the water). The aim of the game is for the fish to get to the other side of the water (the second line) without getting caught by the crocodile. To begin, the fish must ask the crocodile to pass saying the following "Crocodile, crocodile may we cross the water, to see your ugly daughter, just like you". The crocodile then replies "Only if you are wearing the colour ______". If the fish are wearing the colour that the crocodile called, they may have free pass across the water (i.e. the crocodile can't catch them as the cross to the other side). However, they must gallop across the water to the other side. *(This is an ideal opportunity for feedback to the individual children on their technique)*. When the children wearing the colour have reached the other side, the whistle is blown and the remaining fish must run to the other side without getting caught by the crocodile. If they get caught, they join the crocodile in the water.

OTHER INFO

Numerous demonstrations of the gallop are necessary while teaching the gallop as it is a hard skill for children to comprehend if you were to talk through it (as rhythm is such as large part of the skill.)

Again, it is important that correct technique rather than speed should be encouraged as galloping at a high speed often results in a loss of rhythm and incorrect technique.

Other useful fundamental movement skills tools and manuals include:

- **KIWIDEX**
http://www.sportnz.org.nz/managing-sport/guides/fundamental-movement-skills

- **GET SKILLED: GET ACTIVE**
http://www.healthykids.nsw.gov.au/downloads/file/teacherschildcare/Get_skilled_get_active_booklet.pdf

- **FUNDAMENTAL MOVEMENT SKILLS IN ACTION**
http://www.curriculumsupport.education.nsw.gov.au/primary/pdhpe/assets/pdf/fms_action.pdf

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Appendix L: Teachers Physical Activity Logbooks

Weekly Physical Activity Log Sheet

Week Ending: ___________________

Activity	Monday				Tuesday				Wednesday				Thursday				Friday			
	Duration (mins)				Duration (mins)				Duration (mins)				Duration (mins)				Duration (mins)			
	5	10	15	20	5	10	15	20	5	10	15	20	5	10	15	20	5	10	15	20
Huff and Puff																				
Learning Games																				
Activity Breaks																				
Other																				
	Tick the box				Tick the box				Tick the box				Tick the box				Tick the box			
Yard	am		pm		am		pm		am		pm		am		pm		am		pm	
Physical Education	yes		mins		yes		mins		yes		mins		yes		mins		yes		mins	
Comments																				

Appendix M: Measurement forms used by the data collectors

BMI

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Class: 1st Class			Tester:					Date:						
2	Name	DOB	Date of testing	Age on testing date	Height	Height	Height	Mean	Mass	Mass	Mass	Mean		Mass in kg	Height in
3	[redacted]	21/07/2009	28/09/2016	7.189596167	124.5	124.5		124.5	23.6	23.6		23.6		23.6	
4		31/03/2010	28/09/2016	6.496919918	117.5	117.4		117.45	19.1	19.1		19.1		19.1	
5		15/12/2009	28/09/2016	6.787132101	114.8	114.8		114.8	21.2	21.2		21.2		21.2	
6		30/09/2009	28/09/2016	6.995208761	123.8	123.8		123.8	28	28		28		28	
7		31/11/2009	28/09/2016	7.214236824	118.8	118.9		118.85	23.8	23.8		23.8		23.8	
8		12/07/2009	28/09/2016	7.214236824	123.5	123.5		123.5	25.9	25.9		25.9		25.9	
9		09/08/2009	28/09/2016	7.137577002	128.5	128.4		128.45	35.1	35.1		35.1		35.1	
10		04/11/2009	28/09/2016	6.899383984	121.6	121.6		121.6	31.7	31.7		31.7		31.7	
11		22/07/2010	28/09/2016	6.187542779	124.4	124.4		124.4	34.7	34.7		34.7		34.7	
12		08/06/2009	28/09/2016	7.307323751	118.9	118.7		118.8	22.4	22.4		22.4		22.4	
13		18/09/2009	28/09/2016	7.028062971	132	132		132	31.7	31.7		31.7		31.7	
14		29/08/2009	28/09/2016	7.082819986	117.4	117.4		117.4	23.2	23.2		23.2		23.2	
15		24/11/2009	28/09/2016	6.844626968	121.2	121.2		121.2	22	22		22		22	
16		22/05/2010	28/09/2016	6.354551677	118.5	118.4		118.45	23.5	23.5		23.5		23.5	
17		06/05/2009	28/09/2016	7.397672827	118.6	118.4		118.5	22.7	22.7		22.7		22.7	
18		12/06/2009	28/09/2016	7.296372348	123.7	123.6		123.65	21.1	21.1		21.1		21.1	
19		20/04/2009	28/09/2016	7.441478439	129.1	129.3		129.2	25	25		25		25	
20		17/11/2009	28/09/2016	6.863791923	122.5	122.5		122.5	23.2	23.2		23.2		23.2	
21		09/03/2010	28/09/2016	6.557152635	119	119		119	22.7	22.7		22.7		22.7	
22		08/05/2009	28/09/2016	7.392197125	118.5	118.5		118.5	26.8	36.8		31.8		31.8	
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	

Waist Circumference (WC)

	A	B	C	D	E
1	**Class: 1st Class**	**Tester:**		**Date:**	
2	**Name**	**Waist**	**Waist**	**Waist**	**Mean**
3	[redacted]	54	54		54
4	[redacted]	46.5	47		46.75
5	[redacted]	51.5	51.8		51.65
6	[redacted]	53	53		53
7	[redacted]	52	52		52
8	[redacted]	50	50		50
9	[redacted]	56	56		56
10	[redacted]	54	54		54
11	[redacted]	55	55		55
12	[redacted]	50	50		50
13	[redacted]	52	52		52
14	[redacted]	54.5	55		54.75
15	[redacted]	51	51.4		51.2
16	[redacted]	54.6	54.6		54.6
17	[redacted]	55	54.5		54.75
18	[redacted]	52	51.6		51.8
19	[redacted]	54.5	54.4		54.45
20	[redacted]	53.5	53.5		53.5
21	[redacted]	52.5	52		52.25
22	[redacted]	59.5	59.5		59.5
23	[redacted]				

... Age, Height and Mass | WC | 550m

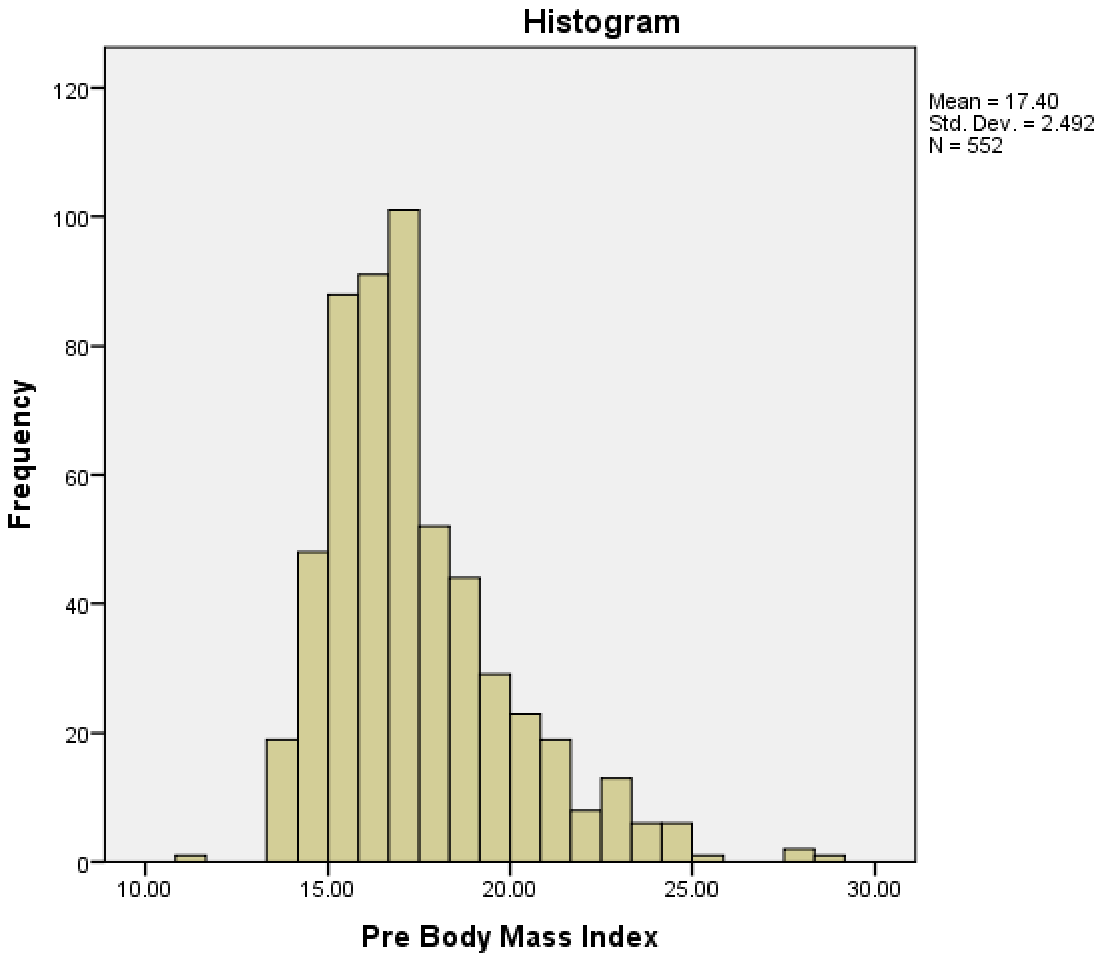
550m run

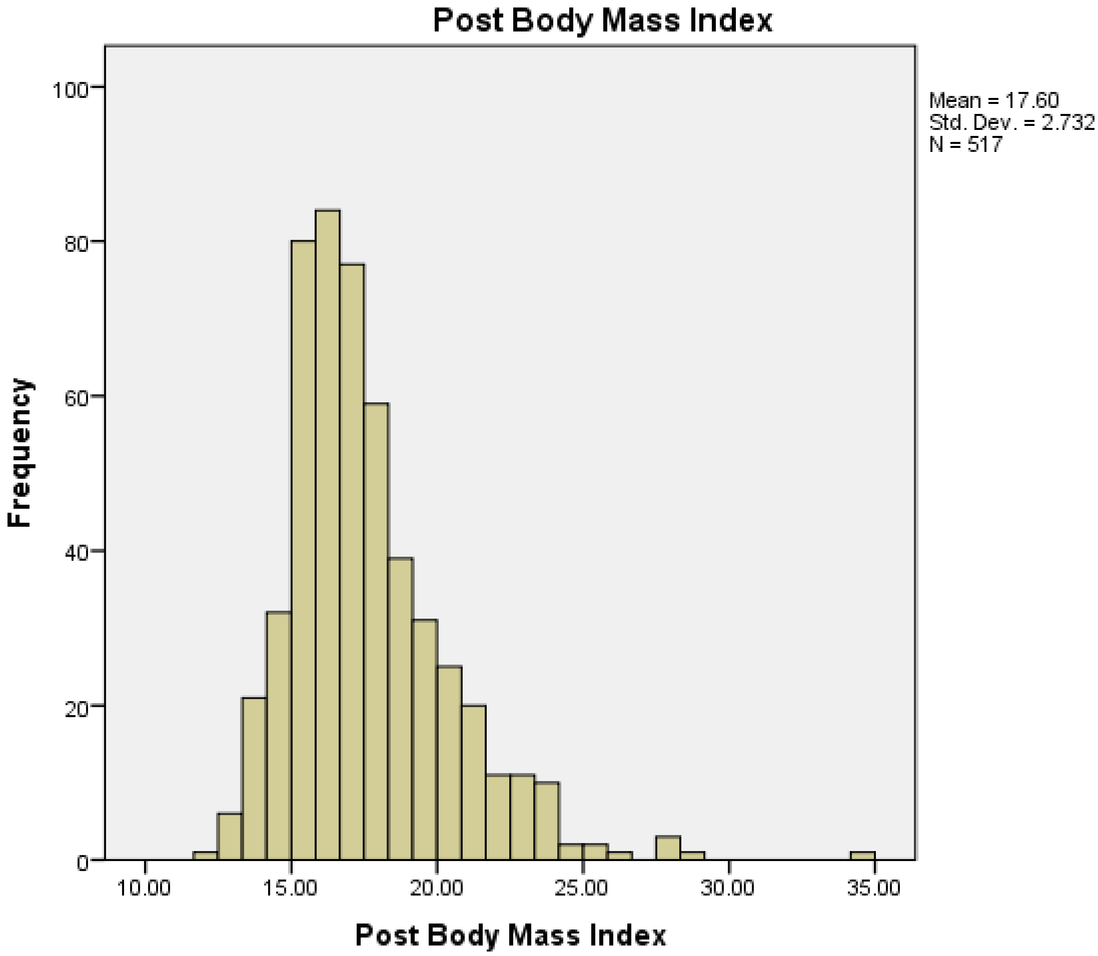
Class: 1st class | Date: | Tester:

Row	Name	LAPS √ 1	2	3	4	Time mins	secs	*Notes*	Time in seconds
4	[redacted]					3	39		219
5						3	33.00		213
6						2	7.00		127
7						3	51.00		231
8						3	64.00		244
9						2	46.00		166
10						4	0.00		240
11						4	64.00		304
12						3	35.00		215
13						3	2.00		182
14						3	35.00		215
15						3	44.00		224
16						3	7.00		187
17						3	38.00		218
18						4	6.00		246
19									0
20						2	23.00		143
21						3	8.00		188
22						3	12.00		192
23						3	44.00		224

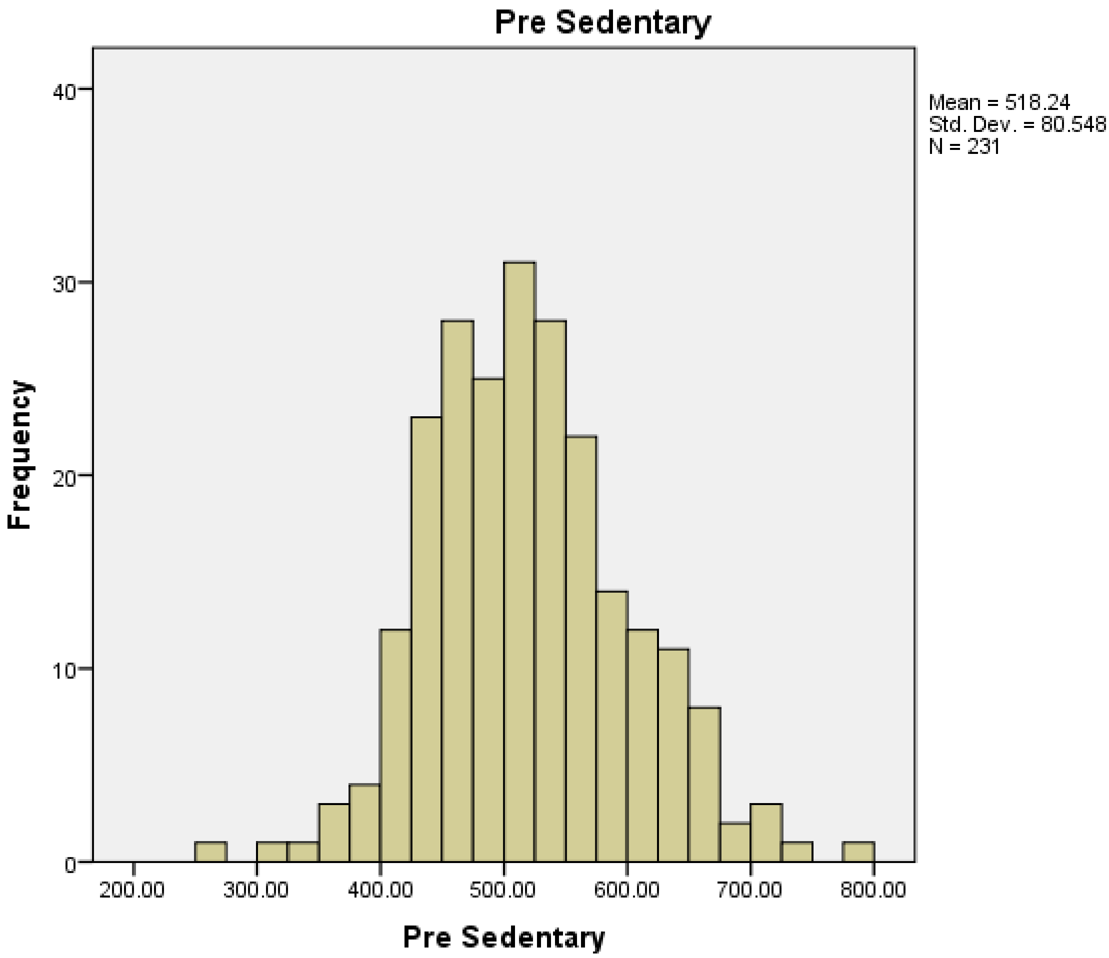
Age, Height and Mass | WC | 550m

Appendix N: Histograms

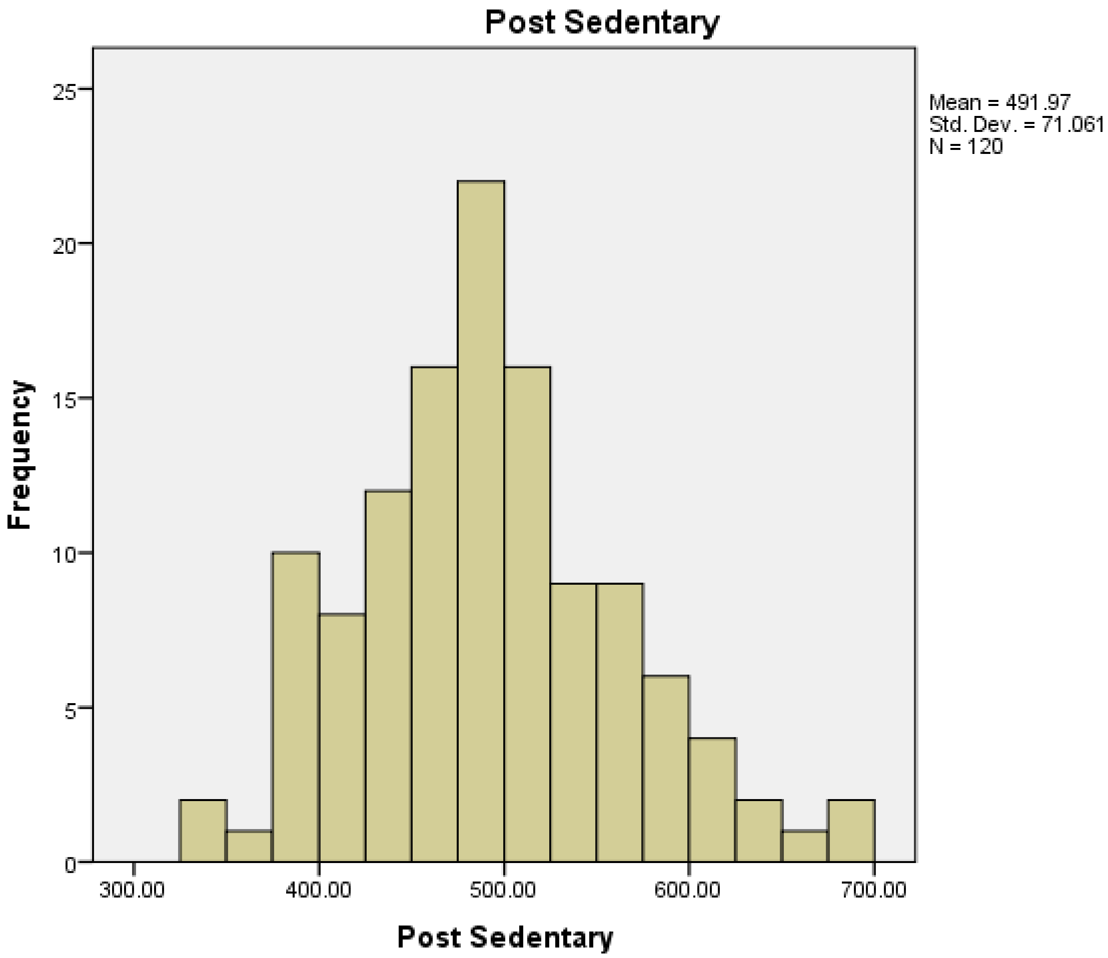


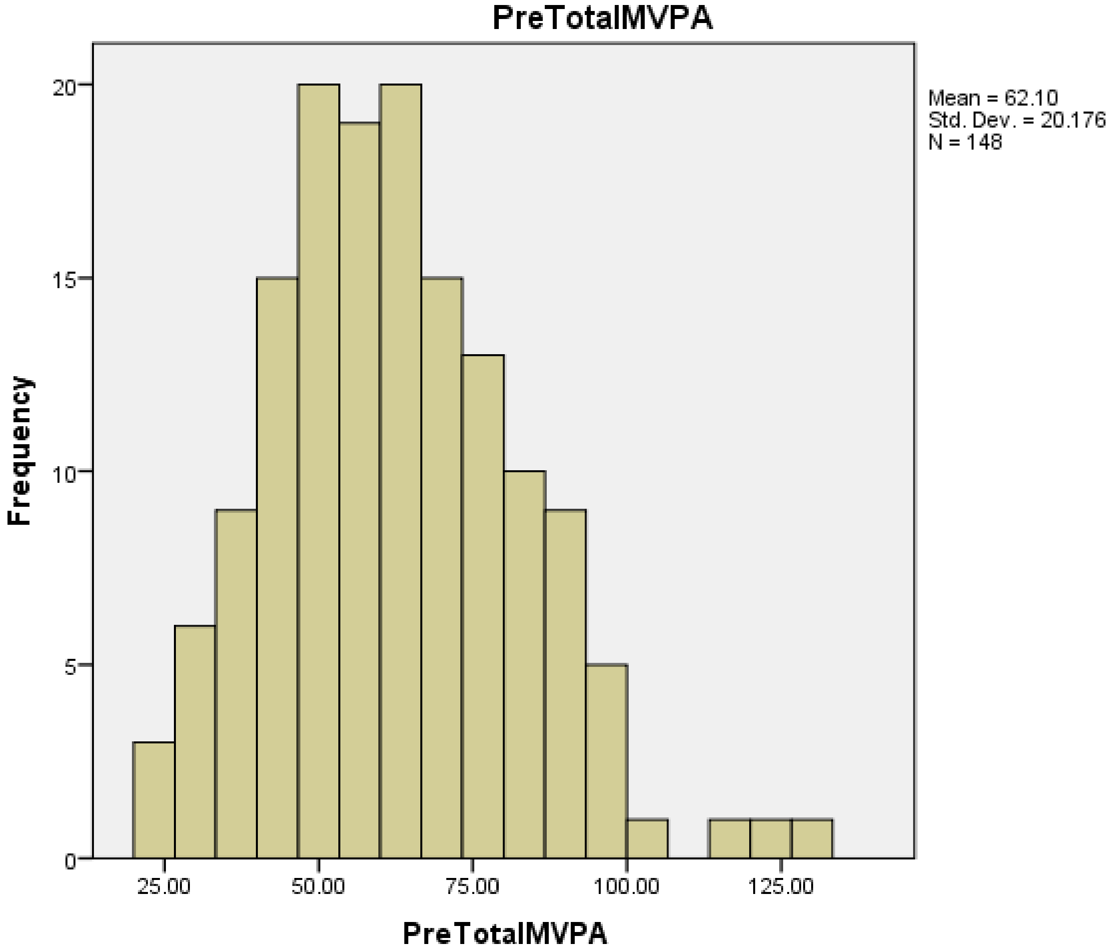


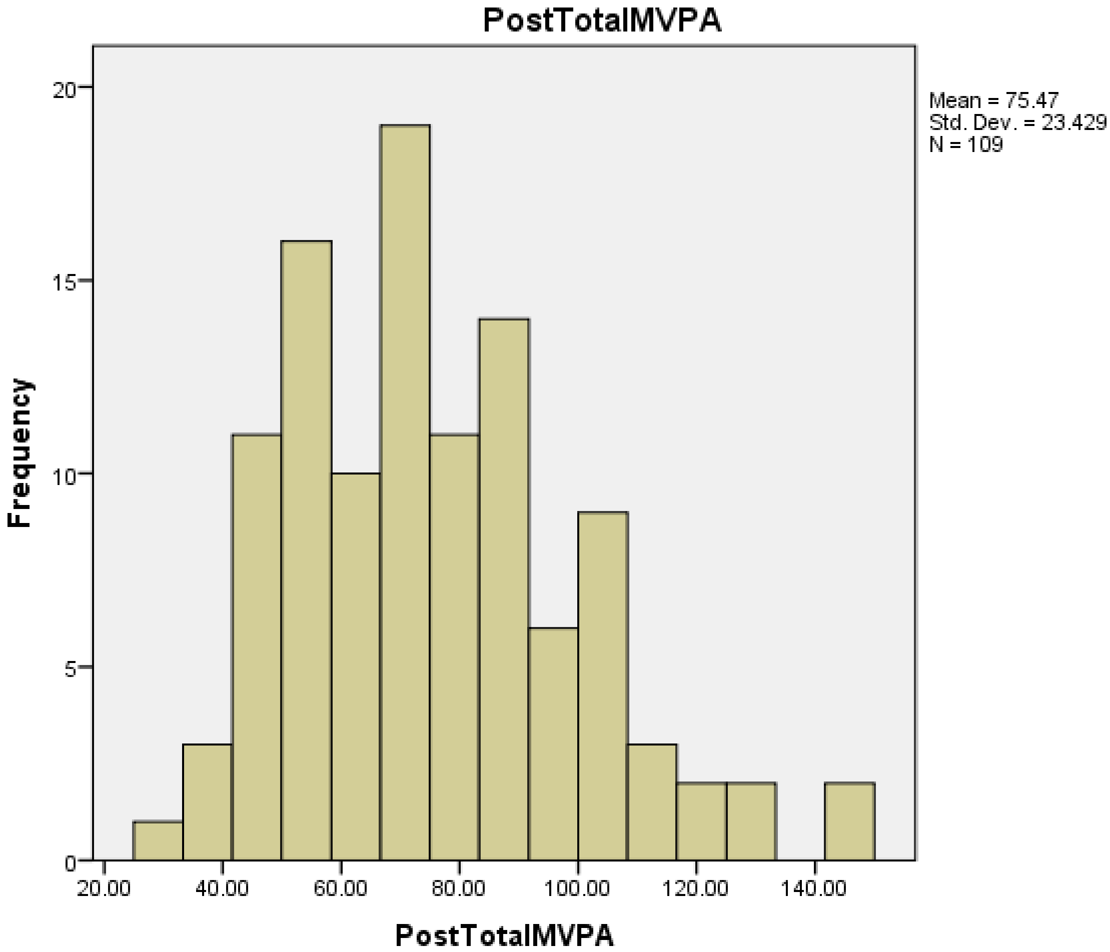
Post Body Mass Index
Mean = 17.60
Std. Dev. = 2.732
N = 517
Frequency
0
20
40
60
80
100
10.00
15.00
20.00
25.00
30.00
35.00
Post Body Mass Index



Pre Sedentary
Mean = 518.24
Std. Dev. = 80.548
N = 231
Frequency
40
30
20
10
0
200.00
300.00
400.00
500.00
600.00
700.00
800.00
Pre Sedentary


Post Sedentary
Mean = 491.97
Std. Dev. = 71.061
N = 120
Frequency
25
20
15
10
5
0
300.00
400.00
500.00
600.00
700.00
Post Sedentary


PreTotalMVPA
Mean = 62.10
Std. Dev. = 20.176
N = 148
Frequency
0
5
10
15
20
25.00
50.00
75.00
100.00
125.00
PreTotalMVPA



PostTotalMVPA
Mean = 75.47
Std. Dev. = 23.429
N = 109
Frequency
20
15
10
5
0
20.00
40.00
60.00
80.00
100.00
120.00
140.00
PostTotalMVPA