



**Kids Active: The Development and Evaluation of an
Active Play and Fundamental Movement Skill
Intervention for Preschool Children**

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A thesis submitted for the award of Master of Science (MSc)

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September 2018

Declaration of Authorship

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Master of Science is entirely my own work, that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

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Acknowledgements

First of all, I would like to thank my supervisors Dr. Sarahjane Belton, Dr. Johann Issartel and Dr. Wesley O'Brien for all of their expertise, input and guidance throughout this journey. Who would have thought during my INTRA in the early days of Y-PATH 2011 that we would find ourselves reunited for a new project five years later! Thank you in particular to Sarahjane for your ongoing encouragement and support. It means more to me than I can express that you believed in me at the times when I did not believe in myself.

To my Albert College family; Cameron, Podge, Donnla, David, Jenny, Jamie, Úna and Stephen. I would have lost my mind many times over if it wasn't for you all creating such an atmosphere of warmth and fun in our office. It made such a difference every day knowing you would be there for chats and putting things back into perspective when it got tough. Thank you for lightening up every day and for keeping me smiling. I will forever be your Office Mom, so you better keep that room clean...

Thank you to the staff, past and current, at Early Childhood Ireland and the Irish Heart Foundation without whom this project would not have been possible, in particular Mareesa O'Dwyer, Ellen McMeel, Lorraine O'Connor and Laura Hickey.

Thank you to the Petherbridge family, whose kindness extended to not only enabling me to support myself throughout the duration of this research, but to offering me space to study, printing and all the little things that made such a big difference.

Gigantic thanks to the Nortons, Gerry, Jennifer, Molly and James for opening up your home to me, giving me daily dinner and chats, and keeping my spirits up over a most enjoyable six months!

A massive thank you to Damon, for continuing to love and reassure me through this whole process. I'm so grateful for your patience and for having you as the voice of reason. Thank you for keeping me laughing and always having the right song to motivate me to *werk*.

Above all, thank you to my parents for supporting me in all of my decisions and encouraging me on this strange path that I'm still navigating, but certain I'm travelling on in the right direction. Thank you for being incredible role models and teaching me to take risks and follow my passions.

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List of Abbreviations

| | |
|--------|---|
| BMI | Body Mass Index |
| CPM | Counts per Minute |
| EC | Early Childhood |
| ECCE | Early Childhood Care and Education scheme |
| ECEC | Early Childhood Education and Care |
| FMS | Fundamental Movement Skills |
| IOM | Institute of Medicine |
| LMVPA | Light-to-Vigorous Physical Activity (TPA) |
| LPA | Light Physical Activity |
| MET | Metabolic Equivalent |
| MNM | Mastery or near Mastery |
| MPA | Moderate Physical Activity |
| MVPA | Moderate-to-Vigorous Physical Activity |
| NASPE | National Association for Sport and Physical Education |
| NCCA | National Council for Curriculum and Assessment |
| PA | Physical Activity |
| SB | Sedentary Behaviour |
| TGMD-2 | Test of Gross Motor Development-2 |
| TPA | Total Physical Activity (LMVPA) |
| VPA | Vigorous Physical Activity |

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Abstract

Title: Kids Active: The development and evaluation of an active play and fundamental movement skill intervention for preschool children

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Introduction: Fundamental movement skills (FMS) are basic movement patterns that form the building blocks of physical activity (PA). The preschool years (ages 3-5) represent an important time for the development of FMS and healthy PA behaviours and the childcare setting plays an important role in this. Low levels of PA and FMS have been demonstrated for preschool children internationally, though research in Ireland has not yet focused on this age group.

Objectives: The main aim of this study was to design and evaluate an educator-led FMS and PA (through active play) intervention for preschool children in services participating in the Early Childhood Care and Education (ECCE) scheme. Additionally, this study aimed to investigate current levels of PA and FMS of preschool children in this setting during ECCE hours.

Methods: The pilot programme was delivered to 42 educators from 18 services. Data were collected by trained researchers from 141 children in 9 preschool services (5 intervention, 4 control) in March 2016 (pre-intervention) and June 2016 (post-intervention). Accelerometry was used to collect PA data and FMS proficiency was measured for four skills using the Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000). All educators who received the programme and those from the control group completed the CAN-Teach questionnaire (Derscheid *et al*, 2014) pre-and post-intervention (n=32) to measure confidence to teach PA.

Results: At baseline, boys aged 3 were the most active with 46.9% meeting PA recommendations. Gender and age influenced PA, with boys more active than girls and younger children more active than older. Mastery or near mastery of FMS ranged from 4.9% (throw) to 88.4% (run). Post-intervention, intervention educators achieved significantly higher confidence scores than control educators. All children decreased sedentary behaviour (SB) and increased PA, with the intervention group significantly decreasing SB (-7 minutes) while the control group increased SB (+2.1 minutes) in hour two of the three-hour ECCE day. Children in the intervention group significantly increased scores in the throw compared to control group (increase of 1.3 vs 0.1).

Conclusion: Increases in educator confidence highlights the potential for increasing educator confidence to deliver PA and FMS opportunities in ECCE services through training. Although PA changes were small, significant differences in the throw show potential for the Kids Active programme over a longer time frame. Further research, including a qualitative component, is warranted to gain greater understanding of how to influence PA behaviour and FMS development in ECCE.

Chapter 1: Introduction to Thesis

1.1. General Introduction

Physical Activity (PA) has been shown to be important at all stages of life for primary and secondary prevention of chronic diseases such as hypertension, Type 2 diabetes cardiovascular disease, osteoporosis and obesity (Warburton, Nicol and Bredin, 2006; Arum *et al.*, 2015; Kyu *et al.*, 2016; de Souto Barreto *et al.*, 2017). Evidence shows that PA habits are established early in life and that young children who have low levels of PA in early childhood (EC) are likely to carry this through to later youth and adulthood (Telama *et al.*, 2014).

For children, the main context for PA is through play, and a natural inclination to move makes this a prime opportunity to encourage active play for health, developmental, social and emotional benefits (Dwyer, Baur and Hardy, 2009). A key predictor of engagement in, and enjoyment of, PA through the lifespan is proficiency in a specific subset of gross movement skills. These skills are known as fundamental movement skills (FMS) and act as the 'building blocks' for PA (Gallahue, Ozmun and Goodway, 2006; Barnett *et al.*, 2013). Evidence shows that individuals with lower FMS proficiency in childhood are at higher risk of inactivity and its associated risks, with a poorer outlook for adolescent and adult health outcomes (Robinson *et al.*, 2015). It is hypothesised that children have the physical capacity to have reached mastery in most of these skills by age six (Gallahue, Ozmun and Goodway, 2006), though research highlights that these skills do not merely develop naturally over time and require targeted teaching, feedback and opportunities to practice (Gallahue, Ozmun and Goodway, 2006; Clark, 2007). While low levels of PA and FMS proficiency have been highlighted for children and youth in Ireland (Woods *et al.*, 2010; Belton *et al.*, 2014) there is a remarkable gap in the literature specific to Ireland for children under six.

Early childhood education and care (ECEC) services in particular have been identified as playing a key role in the development of motor skills and setting the foundations for active lifestyles (Bower *et al.*, 2008; Vanderloo *et al.*, 2014). Ireland now provides universal access to preschool children (aged three to five) for two years through the state-funded early childhood care and education (ECCE) scheme. The term universal in

this context refers to the fact that this initiative is available to all children in the country regardless of family income level, in contrast to targeted childcare funding programmes, such as the Community Childcare Subvention or Training and Employment Childcare schemes, which are means tested (Department of Children and Youth Affairs, 2017). In this way the ECCE scheme provides an ideal and equitable opportunity to promote the development of FMS and positive PA behaviours for all preschool children in the nation.

Despite this, very few ECCE educator training programmes in Ireland provide any form of training in PA for early years (Department of Children and Youth Affairs, 2016). While educators teaching at primary school level are trained to deliver Physical Education as an academic subject with specific learning goals, there is no such equivalent or alternative at preschool level to equip educators with the knowledge and tools to encourage and promote PA and FMS. As a response to this, the 'Kids Active' study was initiated to develop an intervention targeting FMS and PA of preschool children, through the training of EC educators.

1.2. Background

The purpose of this study was to develop and evaluate an early years PA and FMS intervention programme for use by educators in services participating in the Early Childhood Care and Education (ECCE) scheme. The Kids Active programme was initiated by the Irish Heart Foundation, Early Childhood Ireland, Dublin City University and University College Cork, supported by a grant from the Medtronic Healthy Communities Fund. While supported by Early Childhood Ireland and the Irish Heart Foundation administratively (through project management, participant recruitment, procurement for design and printing of resource and the coordination of training) the background research, development and evaluation of the intervention was carried out by the author of this thesis. The Kids Active intervention programme was piloted and evaluated by the author of this thesis (MSc candidate) in a controlled trial between February and June 2016, with key recommendations for improvements to be made in advance of national dissemination in year two of the funding (2017). Findings of this work are presented in Chapter 3 and Chapter 4.

1.3. Terminology

Early Childhood Care and Education (ECCE) and Early Childhood Education and Care (ECEC)

The EC sector in Ireland encompasses a myriad of terms that refer to early years services, including ECEC, ECCE, preschool, childcare and early years services (Pobal 2017; Urban, Robson and Scacchi, 2017). The setting that the research in this thesis pertains to are specifically preschool services that are enrolled in the state-funded “free preschool years” scheme known as the ECCE scheme. While it is acknowledged that the ECCE scheme also extends to childminders who may care for up to five children in their own home (Department of Children and Youth Affairs, 2016), only ECCE services with a manager, at least one other member of staff and at least one ECCE room were included in this research. The terms “ECCE service” and “ECCE setting” will be used throughout this thesis to refer specifically to services participating in the national ECCE scheme in Ireland. The acronym ECEC meanwhile will be used to refer to early childhood education and care in a general sense, including research and programmes related to this sector internationally.

Physical Activity and Active Play

Throughout this thesis, both the terms active play and PA are used. While an overall definition for active play has not yet been established, active play is characterised by a playful context with activity above resting metabolic rate (Pellegrini and Smith, 1998). Active play aids in the progression of essential cognitive, physical, social and emotional contributions to the young child’s development, which are not necessarily achieved through more structured forms of PA (Burdette and Whitaker, 2005). Another characteristic of active play is that it is minimally constrained by adult demands (Pellegrini and Smith, 1998). While this may seem contradictory in an educator-led intervention, the aim of the Kids Active intervention is for educators to recognise and encourage affordances and facilitators for child-led playful PA (active play) and introduce FMS in an enjoyable way so that children will ultimately choose to perform these skills in a playful context. In this way, the intervention aligns with the goals of

Aistear, the Irish EC curriculum framework, which emphasises an emergent child-led curriculum that responds to the needs and interests of the children in the service over structured plans of activities (National Council for Curriculum and Assessment, 2009, 2015). Throughout this thesis, the term active play will be used to describe the type of PA that the intervention aims to increase in the context of ECCE settings, while PA will be used as the outcome measure.

1.4. Aims

The aim of this study is to develop and evaluate an educator-led active play and FMS intervention for children in ECCE services in Ireland. A secondary aim of this study is to use data collected at baseline to investigate PA and FMS levels in a cross-section of children in the ECCE setting.

1.5. Objectives

Study one:

- 1) To measure PA and FMS levels of children aged 3-5 in the ECCE setting
- 2) To investigate PA and FMS levels of preschool children in ECCE services, explore the relationship between these two variables, and assess differences by age, gender and weight status

Study two:

- 1) To measure (pre- and post-intervention) PA and FMS levels of children aged 3-5 in ECCE services and assess ECCE educators' confidence to teach PA and FMS
- 2) To develop an evidence-based active play and FMS intervention which educators can be trained to deliver to children aged 3-5 in the ECCE setting
- 3) To evaluate this programme based on data collected and provide suggestions for future directions

1.6. Thesis Structure

Following this introduction, Chapter 2 critically reviews and evaluates previous literature in the area of FMS, PA and ECEC-based interventions. Chapters 3 and 4 are presented as papers which address the primary and secondary objectives of this thesis. Chapter 3 (study one) utilises baseline data from the Kids Active study to explore current levels, and the relationships between these two variables, in a cross-sectional sample of 3-5-year-old children in ECCE services. Chapter 4 (study two) presents the results of the evaluation of the Kids Active pilot intervention. Chapter 5 will conclude the thesis outlining the practical implications of the research and recommendations for future research.

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Chapter 2: Review of the Literature

2.1. Physical activity and sedentary behaviour

2.1.1. Physical activity

Physical activity (PA) is defined as any bodily movement produced by skeletal muscle that requires greater energy expenditure than resting (Caspersen, Powell and Christenson, 1985). PA has been shown to contribute to both primary and secondary prevention of noncommunicable diseases, including cardiovascular disease, hypertension, type 2 diabetes and osteoporosis (Warburton, Nicol and Bredin, 2006; Warburton and Bredin, 2017). Research has also indicated that individuals who engage in more PA throughout the lifespan tend to have lower rates of all-cause mortality (Arem *et al.*, 2015), cancer (Moore *et al.*, 2016) and depression (Rebar *et al.*, 2015), as well as better sleep quality (Kredlow *et al.*, 2015) and health-related quality of life (Penedo and Dahn, 2005; Physical Activity Guidelines Advisory Committee, 2008). While research investigating the health outcomes of PA for younger children is sparse (Timmons *et al.*, 2007), there is evidence to suggest that the protective effects of PA against noncommunicable diseases may begin early in life, with data from a longitudinal study in Finland (Sääkslahti *et al.*, 2014) indicating that children (n = 155) who engaged in high levels of PA at age 4-7 showed favourable correlations with important health parameters such as lower triglycerides and cholesterol across a three-year period.

A growing body of evidence in neurobiology, developmental psychology, and education highlights that the early childhood (EC) period is crucial to a child's future life health and success (Glewwe and King, 2001; Anderson *et al.*, 2003; Shonkoff *et al.*, 2012). The development of healthy behaviours in EC can have long-term impacts on mental and physical health throughout the lifespan (Fox, Levitt and Nelson, 2010; Fraley, Roisman and Haltigan, 2012). An increased research interest in this area has resulted in a greater understanding of the role that the early years play in shaping PA behaviour through the lifespan. Early PA behaviour has been demonstrated to track through childhood and adolescence, with positive early PA experiences associated with potential long-term impacts on PA participation (Telama *et al.*, 2014; Cooper *et al.*, 2015; Robinson *et al.*,

2015) and early years PA participation associated with future health (Janz *et al.*, 2009, 2010)

For young children, it is recognised that PA at all intensities is important not only for the associated short and long-term health benefits, but also for physical, social and emotional development (Timmons, LeBlanc, *et al.*, 2012; Stanley *et al.*, 2016). The preschool years in particular (the period from age 3-5) have been identified as a “window of opportunity” to influence PA participation and health-related behaviours (Bellows,*et al.*, 2013; Hills *et al.*, 2013), during a period where children are developing formative behaviours and lifelong habits (Bornstein *et al.*, 2011; Becker *et al.*, 2014)

PA occurs at different intensities, including light, moderate and vigorous. Light PA (LPA) is described as PA that does not increase the heart rate, moderate PA (MPA) causes the heart rate and breathing to noticeably increase but not to the extent that a conversation cannot be maintained, while vigorous PA (VPA) increases the heart rate substantially and causes hard, fast breathing (Center for Disease Control and Prevention, 2011). Intensity can also be considered in terms of energy expenditure, which is described using metabolic equivalents (METs). A MET is defined as the resting metabolic rate, or the amount of oxygen consumed at rest, and represents an energy cost relative to body mass (Haskell *et al.*, 2007). For adults, MET values have been established as <3 METS for LPA, 3 to 6 METS for MPA and >6 METS for VPA (Jetté, Sidney and Blümchen, 1990). As there are obvious differences however in body mass between adults and children, these values are not appropriate for this age group (Harrell *et al.*, 2005). Butte and colleagues (2014) have estimated more appropriate MET values for preschool children based on corresponding heart rate for intensity thresholds, which equate to energy expenditure of 1.5-2.7 METs for LPA, 2.8-3.4 METs for MPA and > 3.5 METs for VPA (Butte *et al.*, 2014).

It is well understood that PA at a moderate to vigorous intensity (MVPA) has greater physical health benefits than that at lower intensities (Arem *et al.*, 2015; Howard *et al.*, 2015) and that increased volume of PA yields increased health benefits for children, adolescents and adults (Arem *et al.*, 2015; Kyu *et al.*, 2016). The same dose-response however has not yet been empirically tested or established for preschool children (Reilly, 2008; Skouteris *et al.*, 2012)

2.1.2. Sedentary behaviour

Sedentary behaviour (SB) is generally defined as behaviour requiring minimal movement and low energy expenditure (Tremblay *et al.*, 2011), or more specifically, engagement in activities defined by seating or reclining postures, and energy expenditure at or near resting levels of less than 1.5 METs (Tremblay *et al.*, 2017). Recent evidence has shown that SB, once considered merely the absence of PA, is in fact a distinct separate construct to PA (Saunders, Chaput and Tremblay, 2014). There is growing evidence that SB specifically affects health in negative ways, showing harmful associations with markers of adiposity and cardiometabolic disease risk (Saunders, Chaput and Tremblay, 2014). Specifically, prolonged uninterrupted bouts in SB have been associated with increased insulin sensitivity and triglyceride levels (Saunders *et al.*, 2012). For preschool children, in such crucial formative years, SB may displace time that could be spent engaging in important developmental activities, with potential consequences for executive function, attention span and cognitive development (Christakis and Zimmerman, 2009; Lillard and Peterson, 2011). While studies have shown that higher levels of SB are generally associated with poorer health outcomes (de Rezende *et al.*, 2014; Thyfault *et al.*, 2015), the quality of available evidence makes it difficult to establish a maximum dose of SB for optimum health of children and young people (LeBlanc *et al.*, 2012; Carson *et al.*, 2016). Current evidence also suggests that short repeated bouts of SB may be associated with less adverse health effects than continuous time in SB (Carson, Saunders and Tremblay, 2016; Kolt *et al.*, 2017). Additionally, it has been posited that particular types of SB may be more harmful to health than others, with some evidence suggesting that time spent watching television may be more of a risk factor for cardio-metabolic diseases than time spent using computers (Carson and Janssen, 2011). Further research studies would need to be conducted to determine how different types and patterns of SB affect health, and to determine the maximum dose of SB for optimal health, specifically in relation to children under 6 (LeBlanc *et al.*, 2012).

While SB may potentially displace PA through activities such as television viewing, evidence shows that reducing SB does not necessarily result in increased PA (Pearson *et al.*, 2014) and that the positive health effects of higher intensity PA may be mitigated by

excessive time in SB (Chaput *et al.*, 2014). Research into SB has shown that the determinants and correlates of SB are distinctly different than those of PA and therefore must be targeted specifically (Carson *et al.*, 2016), highlighting the need for interventions to also consider strategies for reducing SB in addition to aiming to increase PA.

2.1.3. Physical activity and sedentary behaviour guidelines

Global PA guidelines for children have been published by the World Health Organisation (WHO), which state that children from age 5-17 should accumulate a minimum of 60 minutes of MVPA every day (WHO, 2010). This guideline, which has been adopted as the national guideline for several countries including Ireland, is evidence-based and was developed with knowledge of dose-response relationships between frequency, intensity, duration and type of PA necessary for health (WHO, 2010). Guidelines specific to SB meanwhile are a more recent addition to public health policy, with the first literature calling for the introduction of guidelines for SB published in 2008 (Hamilton *et al.*, 2008; Stamatkis *et al.*, 2018).

At present, only four countries have national PA guidelines for children aged 5 and under (USA, Australia, the United Kingdom and Canada) and only 2 of these (Canada and the United Kingdom) are officially endorsed by the government (Skouteris *et al.*, 2012). In most cases, these guidelines distinguish between different age groups or abilities (i.e. “infants aged 0-1” or “toddlers not yet walking” and “preschool children aged 3-5”) reflecting the physiological and developmental differences of children at different ages. Guidelines for SB are included as part of the PA guidelines for Canada, Australia, the USA and the United Kingdom (National Association for Sport and Physical Education, 2006; Commonwealth of Australia, 2010; Chief Medical Officers, 2011; Tremblay *et al.*, 2012).

2.1.3.1. *Physical Activity and Sedentary Behaviour Guidelines in the USA*

The USA was the first country to issue guidelines regarding PA specific to children under-5 years of age with the National Association for Sport and Physical Education (NASPE)

‘Active Start Guidelines’, first published in 2002 (NASPE, 2006). While the development of this guideline was carried out by the Active Start committee, which brought together experts in motor development, exercise physiology and medical professionals, a review of data at the time specific to the effect of PA in the early years was found to be inconclusive and these guidelines are based on extrapolations of knowledge of adult guidelines and expert opinion (Skouteris *et al.*, 2012). These guidelines state that preschool children should accumulate 60 minutes of structured PA, as well as 60 minutes (and up to several hours) of unstructured PA per day, and should not be sedentary for more than 60 minutes at a time, except when sleeping (NASPE, 2006)

Although the guidelines succeeded in providing a daily goal for parents and caregivers to ensure younger children achieved daily PA guidelines, an absence of clarification on intensity meant that a unified approach to PA measurement and interpretation had still not been outlined. A lack of consensus as to whether “structured” PA translated to moderate to vigorous PA (MVPA) or any intensity including light, also known as total PA (TPA), is reflected in different operational approaches to the expression of PA measurement within studies from this period (Beets *et al.*, 2011).

Another guideline from the USA, used for the measurement and comparison of children’s PA and SB research, includes the Institute of Medicine (IOM)’s recommendation specific to childcare services (Institute of Medicine, 2011), which advises ensuring opportunities for light, moderate and vigorous PA for at least 15 minutes per hour that children are in care. This publication also recommends limiting sitting or standing to no more than 30 minutes at a time.

While the IOM (2011) recommendation is more up-to-date than the NASPE (2006) guideline, it could be argued that it contradicts the original recommendation by suggesting PA at any intensity, depending on how “structured” PA in the NASPE (2006) guidelines is interpreted (Beets *et al.*, 2011). This highlights the inconsistency in approaches to the development of these recommendations and lack of evidence-based literature regarding PA requirements for positive health outcomes in childhood and later life (Skouteris *et al.*, 2012).

2.1.3.2. Physical Activity and Sedentary Behaviour Guidelines in the UK, Australia and Canada

Between the period of 2010 to 2012, three countries introduced evidence-informed guidelines for children aged younger than 5 years old. Although these guidelines differ slightly in wording and age classification, all three countries specify that young children should be active at any intensity for a total of 180 minutes spread throughout the day. These guidelines also make specific reference to limiting SB and avoiding periods of inactivity to less than one hour at a time (with the exception of sleeping). While this guideline of 180 minutes differs from the NASPE (2006) recommendations, it is similar to the IOM guideline of 15 minutes per hour in childcare if extrapolated over a 12-hour day (Pate *et al.*, 2015).

The only major difference between the guidelines in the three countries is the age classification used. The Australian guideline relates to children aged 0 to 5 inclusive, while the UK and Canadian guidelines specify that they relate to those under 5 (i.e. 0-4). The Canadian guideline also makes reference to the aim of progression towards the guidelines for children (60 minutes of MVPA spread through the day) by age 5. It is suggested that the reason for the difference in these age cut-offs reflects school starting age in these countries, rather than an increased need for PA due to physical growth (Chief Medical Officers, 2011).

2.1.3.3. Ireland

In Ireland, there are currently no PA guidelines specifically for the early years population, instead young children are encompassed in the “children and young people” guidelines which extend from 2-18 years of age (Department of Health and Children, 2009). The guidelines specify that children should accumulate 60 minutes of MVPA throughout the day, every day. The National Physical Activity Plan for Ireland includes the development of guidelines for children aged 0-5 as an action point, with guidelines for this age group planned for 2018 (Department of Health and Department of Transport, Tourism and Sport, 2016). Following other countries such as Australia, the UK and Canada, official

guidelines for this age group may serve to highlight this age group as a target of greater research interest, with the introduction of benchmarks for national surveillance.

2.1.4. Measurement of physical activity and sedentary behaviour

Measurement of PA and SB has become more sophisticated over time with technology allowing for more reliable and valid objective measures (Reilly *et al.*, 2008; McClain and Tudor-Locke, 2009; Pate, O'Neill and Mitchell, 2010; Butte, Ekelund and Westerterp, 2012). The introduction of guidelines specific to the early years in the USA, the UK, Australia and Canada, has sparked a number of studies investigating preschool children's PA to establish prevalence of those meeting these guidelines (Beets *et al.*, 2011; Carson *et al.*, 2013; Pate *et al.*, 2015; Caldwell *et al.*, 2016). However, several issues exist that make the interpretation and comparison of these results often challenging.

2.1.5. Measurement tools

A number of different measurement tools have been utilised to measure the PA levels of preschool children, including both subjective and objective measures. The following four tools for measuring PA will be discussed in this literature review:

1. Questionnaires
2. Direct observation
3. Pedometers
4. Accelerometers

1. Questionnaires:

Self-report questionnaires are a commonly used method of estimating PA volume, frequency and intensity through recall for adolescent and adult populations (Brown *et al.*, 2004; Helmerhorst *et al.*, 2012). Research suggests however that children under the age of 10 do not have the capacity to accurately recall PA patterns (Welk, Corbin and Dale, 2000; Oliver, Schofield and Kolt, 2007). As a result, proxy-report questionnaires, completed by parents or carers on behalf of the child, are far more common in this age group (Sirard and Pate, 2001; Oliver, Schofield and Kolt, 2007).

Chen and colleagues (2002) used proxy-report PA questionnaires in the preschool setting, for which educators reported preferences, frequencies and levels of PA for children over the past week and compared this to objectively measured accelerometry collected in the same week. The authors found that children whose PA was rated as "very often" had a significant higher accelerometer counts per minute, when compared with those whose PA was rated as "not often" ($r=0.72$, $p<0.01$). In other validation studies using accelerometry as the criterion measure, moderate associations were found between reported PA and total accelerometer counts ($r = .33$) using a 3-day checklist (Burdette, Whitaker and Daniels, 2004) and MVPA for a 4-day questionnaire ($r = .53$) (Harro, 1997).

Considerations for questionnaires

Questionnaires and reports are appealing for research due to their low cost for large samples (Warren *et al.*, 2010). A number of limitations exist for questionnaires and proxy reports, including how the questions are interpreted, accuracy of recall and social desirability bias (Sallis and Saelens, 2000).

2. Direct Observation:

Direct observation is a method of monitoring child PA in which a trained observer classifies children's activities by objectively recording their activity behaviour over a predetermined length of time (Loprinzi and Cardinal, 2011). Observational tools have become popular in the measurement of PA and SB as they give information not only about how much PA of different intensities children are accumulating, but also qualitative information such as the specific activity type and the context for the behaviour (Brown *et al.*, 2006). Direct observation has been shown to be a valid and reliable measure for measuring children's PA with inter-observer reliability coefficients greater than 0.84 (McKenzie, 2002).

Two of the most frequently used observational tools include the Observational System for Recording Physical Activity in Children-Preschool Version (OSRAC-P) (Brown *et al.*, 2006), and the Child Activity Rating Scale (CARS) (Puhl *et al.*, 1990). These tools are known as focal child systems as a single child serves as the focus of the observation, and require a researcher to observe a single child over a number of 30 or 60-minute periods,

in intervals of 30 seconds, with 5 or 15 seconds of observation, followed by 15 or 25 seconds of recording the information. In the case of the CARS, this information includes PA intensity, context of the observed behaviour, the type of activity being performed, the presence of interactors and activity-related prompts from interactors (Trost *et al.*, 2003). Similarly, the OSRAC-P also includes separate indoor and outdoor activity categories, information about prompts from initiators and whether the activity occurred alone or in different types of groups.

For both the CARS and OSRAC-P, levels are classified from 1 to 5 based on the type of movement. Level 1 activities are sedentary, level 2 are sedentary but include movement of the limbs or torso and levels 3 to 5 are defined by translocation (i.e. moving the body to another location) with the speed or intensity of the activities determining the level (slow easy movement is classified as level 3, moderate is level 4 and fast is level 5) (Puhl *et al.*, 1990; Brown *et al.*, 2006).

The CARS was designed to categorise the intensity of PA and differentiate between levels of energy expenditure in young children and has been validated against VO₂ and heartrate (Puhl *et al.*, 1990), and accelerometry (Noland *et al.*, 1990; Finn and Specker, 2000). The OSRAC-P was developed using existing direct observation tools (CARS, the Code for Active Student Engagement Revised (CASPER-II) (Brown *et al.*, 1996) and the Observational System for the Environmental Determinants of Physical Activity in Preschool Children Study (Pate *et al.*, 2004))

The OSRAC-P differs from the CARS in that it gives more contextual information and does not focus on the individual child but captures behaviour and contextual information of groups of children, with the observer recording the number of boys and girls present, activity level of each sex, and type of activity the children are participating in, through brief scans of the target area (Loprinzi and Cardinal, 2011).

Considerations for Direct Observation

The main advantage of direct observation is that it provides valuable contextual data to identify other factors related to PA behaviour (e.g. social and environmental factors) and provides information on the type and intensity. Research has also shown that young children are less reactive and less likely to modify their PA behaviour as a result of

observer presence than adults are, meaning that PA can be examined without disturbing a preschool service's daily routine (McKenzie, 2002; Pate, O'Neill and Mitchell, 2010). Well trained observers and the use of video recording equipment to extend the time for PA classification can ensure more accuracy when using this method (Loprinzi and Cardinal, 2011).

The main disadvantage of utilising this tool is the associated high costs, as it requires at least one observer for each subject or group (Finn and Specker, 2000). Quality of the data depends on the skills of the observer and therefore a high level of training is necessary to ensure that researchers have studied the observation manual and memorised codes and categories, as well as practising observation and recording in field settings (Sirard and Pate, 2001). Such assessment is also time-consuming and the accuracy may decrease with longer observation periods (Finn and Specker, 2000). The fact that these measures were also developed using energy expenditure and not PA as a criterion has also been suggested to be a limitation of this method, as energy expenditure is arguably a consequence of PA participation and not a direct measure of PA (Oliver, Schofield and Kolt, 2007).

3. *Pedometers:*

A pedometer is a small device that is mounted at the hip, ankle or wrist that uses mechanical motion sensors to quantify PA in terms of steps accumulated (Oliver *et al.*, 2007). Pedometers are commonly used for assessing the PA levels of children and adolescents and have been shown to be valid and reliable for these populations (Kilanowski, Consalvi and Epstein, 1999; Rowe *et al.*, 2004; Eisenmann and Wickel, 2005).

A number of different brands and type of pedometer exist, though accuracy, sensitivity and quality can vary (Tudor-Locke *et al.*, 2006). The Yamax Digiwalker SW-200 (Yamax, Tokyo, Japan) pedometer is widely used in research studies (Tudor-Locke *et al.*, 2006) and has been validated for use with preschool children against the Actigraph GT1M (Actigraph, Florida, USA) accelerometer, with moderately-high correlations for mean step counts and mean accelerometer counts ($r = .67$), as well as mean step counts and

TPA ($r = .76$), in a sample of 3 to 5 year olds ($n=55$) (Pagels, Boldemann and Raustorp, 2011). However, this study also highlighted that although step counts and MVPA were moderately correlated for 4-5-year olds ($r = .50$), poor correlations were found for 3-year olds ($r = .19$) between step counts and higher intensity PA (Pagels, Boldemann and Raustorp, 2011). Similarly, Cardon and De Bourdeauhuij (2007) found moderately-high correlations between daily step counts and minutes in MVPA ($r = .73$), but this was based on a sample of 4-6 year olds, with a mean age of 5.4. The Actigraph GT1M was also used as a criterion measure to validate the Omron Walking Style Pro (Omron Health Care, Kyoto, Japan) pedometer, with moderately-high correlations between steps and accelerometer counts per minute (CPM) ($r = .65$) and per day ($r = .64$), but again, the preschool participants ($n=41$) were aged from 4-6 (mean age $5.4 \pm .6$) (De Craemer *et al.*, 2015). This suggests that although pedometers may be appropriate for children over age 4, the sensitivity of the device may not be enough to detect the impact of the steps of younger children (Pagels, Boldemann and Raustorp, 2011). Moderately-high correlations for TPA imply that pedometers are still valuable for assessing overall PA across specific time periods. To establish a goal for daily TPA of preschool children measured by pedometer, a daily step counts target for preschool children has been developed based on the 180 minutes of TPA, corresponding to approximately 6000 steps per day (Gabel *et al.*, 2013).

Considerations for pedometers:

While the use of pedometers is advantageous from the point of view of cost effectiveness and ease of use, the main disadvantage of this method of PA measurement is that an overall step total does not give insights into frequency, intensity or duration of PA across the wear period (Oliver, Schofield and Kolt, 2007; Butte, Ekelund and Westerterp, 2012). As demonstrated by Rush and colleagues (2012) pedometers may be useful for identifying less active children when comparing participants across known time periods, such as in the context of a school day. The accuracy of the step total however may also be questionable, given that the device may register less than the actual number of steps during slow walking which would lead to underestimation of steps for younger children (Rowlands, Eston and Ingledew, 1997; Eisenmann and Wickel,

2005). Pedometers also do not record horizontal or upper body movement and so movements that may be part of active play but do not cause movement of the lower body (e.g. digging in a sandpit) will not be registered (Butte, Ekelund and Westerterp, 2012).

4. Accelerometers:

An accelerometer is a small, lightweight, non-invasive and non-intrusive device designed to measure time-varying differences in force or acceleration (Cliff, Reilly and Okely, 2009). The accelerometer device is attached to an elasticated band and attached to the hip, wrist, or ankle. Accelerometers record the frequency and magnitude of the body's acceleration during movement and digitises the acceleration signal to generate an "activity count" (Loprinzi and Cardinal, 2011). Activity counts are summed over a specific time interval, or epoch, and this raw output is then calibrated to a meaningful indicator of PA or energy expenditure by partitioning time into sedentary, light, moderate, and vigorous levels of PA using prediction equations (Cliff, Reilly and Okely, 2009; Butte, Ekelund and Westerterp, 2012). Most accelerometers have the battery and memory capacity to record short epochs (1-60 seconds) over several days or weeks making it an appropriate device for capturing PA over repeated days (Loprinzi and Cardinal, 2011). All accelerometers measure movement in the longitudinal axis (up and down). Utilising just this axis is classified as uniaxial, while biaxial devices also measure movement across the anteroposterior (forward and backward) axis and triaxial axes also includes movement in the mediolateral (side to side) axis (Cliff, Reilly and Okely, 2009). In theory, triaxial accelerometers provide a more comprehensive assessment of movement and have been suggested to be more appropriate for detecting movement of preschool children, though empirical evidence shows little difference in accuracy between triaxial accelerometers and uni- or bi-axial devices (Puyau *et al.*, 2002; Rowlands *et al.*, 2004)

Several different brands and model of accelerometer exist. Considerations for choosing a device include the direct and ongoing costs (including maintenance, repairs, software, and belts), capabilities of the monitor, the appropriateness of the monitor for the research question and population at hand and comparability of the data with other studies. Commonly used accelerometers for research purposes include Actigraph

(Actigraph, Florida, USA), Actical (Mini Mitter Co., Oregon, USA), Caltrac (Muscle Dynamics Fitness, Wisconsin, USA), RT3 (StayHealthy, California, USA) and TriTrac (Reining Ltd, Wisconsin, USA) (Oliver, Schofield and Kolt, 2007). The Actigraph has been relatively well researched and validated for this age group using different criterion measures including direct observation ($r = .52-.87$) (Reilly *et al.*, 2003; Sirard *et al.*, 2005) and VO₂ (.75-.82) (Mciver *et al.*, 2005; Pate *et al.*, 2006)

Considerations for accelerometers

Accelerometry is the preferred method for objective measurement of PA with many researchers considering it a criterion against which other measures of PA can be validated (Boon *et al.*, 2010; Cleland *et al.*, 2014). Accelerometers allow researchers to measure PA intensities and patterns over several days for a large number of subjects (Pate, O'Neill and Mitchell, 2010). However, there are a number of disadvantages and considerations for using accelerometers. Accelerometers have several limitations, including the high cost per device, which limits the potential use for larger studies (Oliver, Schofield and Kolt, 2007) and the expertise and additional hardware and software necessary to analyse data (Tudor-Locke *et al.*, 2002). Accelerometers can only assess movement of the body segment that the device is attached to, so if attached at the hip, movement of the arms will not be recorded, nor will added energy expenditure (such as walking while carrying a load) and non-ambulatory activities (such as cycling) (Cliff, Reilly and Okely, 2009; Butte, Ekelund and Westerterp, 2012). As the accelerometer records data across a set time period, periods of non-wear time may be indistinguishable from inactive time (Bingham *et al.*, 2016).

There are also a number of variables to consider when choosing protocols to capture and process accelerometer data for this age group, and a lack of consistency in approaches to the treatment of data can have major impact on the results, making it difficult to compare results across studies (Senso *et al.*, 2015). These considerations include:

- *Epoch*: Epoch refers to the sampling rate for which an accelerometer records data and usually ranges between 1 and 60 seconds. A number of studies (Timmons, Proudfoot, *et al.*, 2012; Annesi, Smith and Tennant, 2013; Howie *et*

et al., 2013) suggest that lower epochs are more appropriate for this age group, as the PA of preschool children is characterised by intermittent short bursts of activity (Bailey *et al.*, 1995) while higher epochs may underestimate MVPA (Cliff *et al.*, 2011). However, shorter epochs are not always feasible due to device type and memory capacity.

- *Cut points:* In the case of accelerometry, cut points selection can have a major effect on the interpretation of data, as the cut points chosen determine how raw counts per minute of activity are translated to intensities (Hislop *et al.*, 2012). Various cut points exist due to different sample sizes and validation methods used in different studies to estimate what constitutes specific intensities (Cliff, Reilly and Okely, 2009). A number of cut points have been developed specifically for preschool children which vary greatly, with MVPA ranging from activity above 1680 counts per minute (CPM) (Pate *et al.*, 2006) to above 8200 CPM (Puyau *et al.*, 2002), and SB ranging from below 240 CPM (Butte *et al.*, 2014) to below 1590 CPM (Sirard *et al.*, 2005). Cut points with a high SB threshold make it difficult to separate light activity from non-wear time, which can compromise the accuracy of PA data (Kim *et al.*, 2014). A systematic review by Beets and colleagues (2011) found a ten-fold difference between the most extreme differences when comparing the 4 most popular cut points at the time (Freedson, Pober and Janz, 2005; Sirard *et al.*, 2005; Pate *et al.*, 2006; Reilly *et al.*, 2008) applied to the same data, demonstrating that significant variation in results can occur depending on cut points chosen. Some evidence also suggests that using epoch lengths different than those used to validate the activity cut-points may introduce significant error (Banda *et al.*, 2016).

The variety of considerations for accelerometry and lack of consensus regarding protocol makes it difficult to compare results across different studies. As the selection of epoch length, wear time and activity cut points can introduce significant differences in resulting estimates of PA and SB (Banda *et al.*, 2016), a unified approach to reducing and summarising accelerometry data and for operationally defining guidelines for this age group would ensure accuracy and make cross-cultural comparison more reliable.

2.1.6. Preschool Physical Activity Levels

2.1.6.1. Considerations when interpreting preschool physical activity data

Since the publication of specific guidelines for the PA levels of preschool children, a number of studies have been carried out internationally to objectively quantify the amount and intensity of PA of children ages 3-5 years across full days (Beets *et al.*, 2011; Shen *et al.*, 2013; Senso *et al.*, 2015; Larouche, Garrigué and Tremblay, 2017), during childcare hours specifically (Annesi, Smith and Tennant, 2013; Howie *et al.*, 2013; Röttger *et al.*, 2014; Vanderloo and Tucker, 2017), or both (Byun, Liu and Pate, 2013; Soini *et al.*, 2014; O'Neill *et al.*, 2016). Due to the differences in the measurement protocols, and processing of data, it is difficult to compare these results across studies. For example, accelerometer-measured estimates of prevalence of preschool children meeting the 180 minutes per day guideline vary greatly, with reports ranging from 5% of children in Australia (Hinkley *et al.*, 2012) to 84% in Canada (Colley *et al.*, 2013), and 100% in the UK (Hesketh, Griffin and van Sluijs, 2015). These results should be interpreted with caution, as the large differences in results may be at least in part due to differences in data processing such as epoch selection and cut points utilised (Banda *et al.*, 2016). Cut points in particular may go some way towards explaining the stark contrast between the prevalence of children reported to meet the guideline in the Australia and the UK studies above, as these studies utilised cut points developed by Sirard (2005) and Pate (2006) respectively, with the threshold between SB and light PA (LPA) for the Sirard cut points almost double those of Pate.

The guidelines chosen to express estimates of PA levels of preschool children can also have a major impact on the interpretation of results. For example, some sample participants may comfortably meet the 180 minute TPA per day guideline, and 15 minutes TPA per hour IOM (2011) guideline, but fail to meet the 120 minutes of PA NASPE (2006) recommendation, specifically if the “structured” hour of PA in the NASPE guideline is interpreted as 60 minutes MVPA per day (Pate *et al.*, 2015). In addition to this, different approaches in determining whether children “meet the guideline” have been taken in different studies, which can also cause variation in results. For example, Pate and colleagues (2015) highlight two different approaches for determining the

percentage of children who meet the guideline. In one approach, researchers use the mean TPA of each child's overall wear time to determine whether the sample complied with guidelines (Hinkley *et al.*, 2012), while in another, each child is only deemed to be compliant if they met the guideline on *each* day of wear (Gabel *et al.*, 2013). To illustrate the potential difference between these approaches, Gabel and colleagues (2013) found that 92.7% of their sample of 133 preschool children met the guideline when classified as the mean of overall wear time, while only 73% of the same sample met the guideline when classified as meeting the recommendation on each day of wear.

As there is such discord around interpretation of the NASPE guideline (Beets *et al.*, 2011), this review will utilise the more prevalent and up-to-date recommendation of 180 minutes TPA per day for comparison of different studies, and include only studies investigating PA during preschool childcare hours for children aged 3 to 5, since the first publication of the guideline in 2010 (Commonwealth of Australia, 2010). This recommendation may also be extrapolated as 15 minutes TPA per hour based on 12 hours of waking time (aligning with the IOM guideline of 15 minutes per hour in childcare), as has been utilised in a number of studies (O'Neill *et al.*, 2016; Pate *et al.*, 2016; Tucker *et al.*, 2016; Vanderloo and Tucker, 2017). This can also be considered as a percentage of all wear time (Alhassan *et al.*, 2013; Annesi, Smith and Tennant, 2013; Howie *et al.*, 2013; De Craemer *et al.*, 2014; Salazar *et al.*, 2014; Hesketh, Griffin and van Sluijs, 2015; Schlechter *et al.*, 2017), in which case 25% TPA is considered to be meeting the guideline. The following section will investigate levels of PA in preschool children using the guideline of 15 minutes TPA per hour (or 25% of time in care) as a benchmark, based on the mean TPA in minutes per hour or percentage of day, as reported in each study.

2.1.6.2. Levels of physical activity of preschool children (international)

In the USA, two large studies in neighbouring states with more than 300 participants each measured PA using Actigraph accelerometers and found dramatically different results (Annesi, Smith and Tennant, 2013; Pate *et al.*, 2016). Annesi and colleagues (2013) demonstrated that in Georgia, over half of time in childcare was spent in TPA,

with 32% categorised as time spent in MVPA. Pate and colleagues (2016) estimated TPA of 14 mins/hr, and MVPA of 7mins/hr (23.3% TPA and 11.7% MVPA) in South Carolina, which equates to just below the 15 mins/hr (25% of time) guideline with significantly lower MVPA than the findings for Annesi and colleagues. Both studies used the Pate cut points (Pate *et al.*, 2006) and a 15-second epoch length, but suggestions for the differences in these data processing considerations include the amount of wear time, as Pate and colleagues required at least 3 days of wear time for inclusion, while Annesi and colleagues measured PA over a single day. In Massachusetts, Alhassan and colleagues (2012) utilised accelerometers for 5 days at childcare, and found mean levels of TPA above the guideline (26%), with MVPA of 6.4%, and SB of 74% across the day. Accelerometer-measured mean TPA was also found to be above the guideline (30% in TPA) in a sample of 73 children in Kansas who were also measured by observation alongside accelerometry (Schlechter *et al.*, 2017), though this was only measured over two days, with data only included for children who had both accelerometer data and observation data at each time point and therefore may not be representative of typical days. Conversely, figures reported exceptionally low PA in a sample of 158 disadvantaged inner-city children in Michigan (Shen *et al.*, 2012), with mean TPA of only 4 mins/hr, or 6.6% of the childcare day. In this case, accelerometer wear time criteria was set as at least one hour on at least two days as the days and length of time that children spent in the facility varied (overall mean wear time was 2.3 hours and 3.9 days). These low levels of TPA demonstrated by Shen and colleagues for disadvantaged children highlights the extent to which socioeconomic status may affect PA behaviour. It is suggested that socioeconomic status may play a large role in influencing a child's PA behaviour by determining available resources and activities that the child can engage in (Gustafson and Rhodes, 2006; Welk, Wood and Morss, 2003) and may influence PA behaviour into adulthood (Elhakeem *et al.*, 2015). This demonstrates the need for PA to be encompassed in Early Childhood Education and Care to address this inequality.

Direct observation studies have also highlighted levels of TPA below the recommendations (14% of time observed) in a sample of 476 children (aged 3 to 5) in South Carolina (Pate *et al.*, 2008), using the OSRAC-P over 10 days. In this study, TPA overall was 10.7%, with significantly higher MVPA for boys (3.2% MVPA) than girls (2.5%

MVPA) ($p < .05$). Significant differences were also found between boys and girls in Canada, in a sample of 297 children aged 2.5 to 5 years (Vanderloo *et al.*, 2015) with boys engaging in significantly more TPA than girls, though figures detailing these differences were not presented in the literature. Another Canadian study assessing accelerometer-measured PA of 216 preschool children (aged 2.5 to 2.9 years) aimed to assess differences in PA behaviour between children of different weight status, but found no significant differences by weight status, or gender respectively (Tucker *et al.*, 2016). In this case, mean TPA was high at 20mins/hr, with MVPA of 2.7mins/hr (Tucker *et al.*, 2016). Vanderloo and Tucker (2015) used accelerometry to assess PA of 101 preschool children (mean age 3.6 ± 0.9 years) on different days of the week in childcare in Canada, and found Thursday to be the most active day overall (TPA ranged from 26% on Monday to 33% on Thursday), with little variation in MVPA across the week (ranging from 2% on Friday to 2.5% on Wednesday). Overall, levels were enough to meet the TPA guideline across the week, but the 6% variation in TPA across the week highlights how PA patterns can change depending on the day, which is important to consider from both a measurement and an intervention point of view.

Studies in Europe have shown significant differences between time spent indoors and outdoors in terms of PA. A study of 50 children (age 3.3 to 5.6 years) measured by accelerometry in the preschool setting Sweden (where one third of the preschool day is spent outside) showed that indoors accounted for 10.8% of total PA, and outside accounted for 24.9% of TPA, with significantly more MVPA also performed outside than inside (7.3% vs 2.3%) (Raustorp *et al.*, 2012). Similarly, in South Carolina a study of 3 to 5-year-old children in the preschool setting utilised the OSRAC-P to observe children's PE behaviour indoors ($n=476$) and outdoors ($n=372$) (Brown *et al.*, 2009) and found that while children engaged in light, moderate and vigorous PA during only 6% of the observed intervals indoors and 44% of the observed intervals outdoors. Soini and colleagues (2014) also highlighted that in a sample of 81 3-year-olds in childcare in Finland, measured using the OSRAC-P, children were more active outside, with overall TPA through the day changing across seasons from 23% in winter to 29% in autumn. Similar studies have shown slight but significant differences in young children's PA across seasons. For example, Fisher and colleagues (2005a) used accelerometers to

measure PA of 209 children (mean age 4.8 ± 1.2) in Scotland across 3 days with at least 6 hours wear time. While TPA increased from 21.6% of wear time in winter to 25.5% of wear time in summer, it also dropped to 19.7% in autumn (Fisher *et al.*, 2005a). A 2010 study in Canada used proxy reports of PA from parents to estimate PA of 1,715 children aged 4-5 and reported that children spent on average 36.5% of time in TPA during winter and 47.2% TPA in summer (Carson *et al.*, 2010). In this case, the month in which the parent completed the proxy report was used to classify season. These studies indicate that while there may be variations in PA across seasons, this is highly variable and must be considered in the context of different geographical locations, regional climate and culture. Further research specific to early years would be necessary to further investigate the effect of seasons on PA in young children.

As outdoor time has been shown to impact on children's PA (Hinkley *et al.*, 2008), these studies give a more complete picture of PA behaviour across different contexts, which is important to consider when drawing conclusions on PA levels.

2.1.6.3. Levels of physical activity of preschool children (Ireland)

There is a paucity of data regarding the PA levels of children under 6 in Ireland, with the most recent Ireland North and South Report Card on Physical Activity for Children and Youth calling for an increased focus on data with the early years population in PA (Harrington *et al.*, 2016). The Growing up in Ireland (GUI) longitudinal study provides some parent-reported data for 5-year olds (GUI, 2013), indicating that only 42% of children of this age ($n = 7500$) take part in some form of active play (such as chasing, climbing or playing with a ball) every day, and that 22% of parents do PA or sport with their child every day ($n = 9000$). This is concerning, as it suggests that several thousand preschool children may not be being provided with sufficient opportunities to engage in PA, and practice movement skills, or to establish positive PA behaviours. Research capturing PA of older children gives an idea of what to expect for preschool-age children as they grow up, with only 9-19% of primary school children ($n = 625-5397$) (Woods *et al.*, 2010; Hardie-Murphy, Rowe and Woods, 2017) and 4-23% of children aged 10-17 ($n = 625-13,611$) (Gavin *et al.*, 2015; Hardie Murphy, Rowe and Woods, 2017) meeting the

guideline for children of 60 minutes MVPA every day (Department of Health and Children and Health Service Executive, 2009). Furthermore, PA appears to decline with age, with cross-sectional data indicating that while 38% of 11-year olds met the guideline in a sample of 13,611 children, the guideline was met by only 17% of 15-year olds (Gavin *et al.*, 2015).

2.1.6.4. Recommendations for reporting physical activity of preschool children

While the above international studies give a valuable overview of how active each sample is throughout the preschool day, such studies do not accurately capture the proportion of children individually meeting the recommendations, making it difficult to draw conclusions about how active preschool children are during childcare hours. In the majority of the studies discussed, the samples “meet the guideline” based on averages, but this does not necessarily imply that the individual children in the samples are sufficiently active. Future research on PA of children during preschool hours should endeavour to report both time active in minutes per hour or percentage of wear time, as well as percentages of children meeting these guidelines, in order to more accurately assess how active young children are during these hours.

2.2. Fundamental Movement Skills

2.2.1. Introduction to fundamental movement skills

In order to be physically active, it is necessary that a child learns to move in ways that allow him/her to engage in active play, sport and recreational PA (Gallahue and Ozmun, 2006; Haywood and Getchell, 2009). Proficiency in prerequisite skills such as running, jumping and throwing provides opportunities to take part in these activities throughout the lifespan (Barnett *et al.*, 2009; Cliff *et al.*, 2012; Barnett, Salmon and Hesketh, 2016). These prerequisite skills are known as Fundamental Movement Skills (FMS), and are specific patterns of movement that can be combined and altered to produce more complex movements, and are frequently described as the building blocks for more sport-specific and PA-related skills (Robinson *et al.*, 2009). These skills form a foundation for movement, and play a major role in determining PA participation throughout the lifespan (Clark and Metcalfe, 2002). Evidence suggests that the relationship between these two variables is reciprocal in nature, with increased PA providing more opportunities to practice FMS (Fisher *et al.*, 2005b; Colella and Morano, 2011), which in turn increases the likelihood of participating in PA (Robinson *et al.*, 2015).

According to Gallahue, Ozmun and Goodway (2012) there are three categories of FMS. Locomotor skills, which involve moving the body through space (run, hop, jump, slide, gallop, leap), object control skills, which require manipulating and projecting objects (strike, dribble, kick, throw, underarm roll, catch), and stability skills, which are non-locomotor (body rolling, bending, and twisting)

2.2.2. Development of fundamental movement skills

The development of FMS are dependent on underlying neural and physical systems associated with motor development and control (Haibach, Reid and Collier, 2011). While the term 'motor' is indicative of an internal process, movement is a separate but related concept that in this context refers to the observable act of changing the position of the body (Gallahue and Ozmun, 2006; Haywood and Getchell, 2009). Motor development

refers to the development of movement abilities, and is influenced by complex interactions between the individual's physical biology, environment and the task (Gallahue and Ozmun, 2006; Haywood and Getchell, 2009). In order to understand the complex concept of motor development, and the relationship between motor development and movement, a model has been proposed by Gallahue and Ozmun (2006) which likens the process to an hourglass, with four specific phases of development; 1) reflexive movement phase, 2) rudimentary movement phase, 3) fundamental movement phase and 4) specialised movement phase, as in Figure 2.1 below.

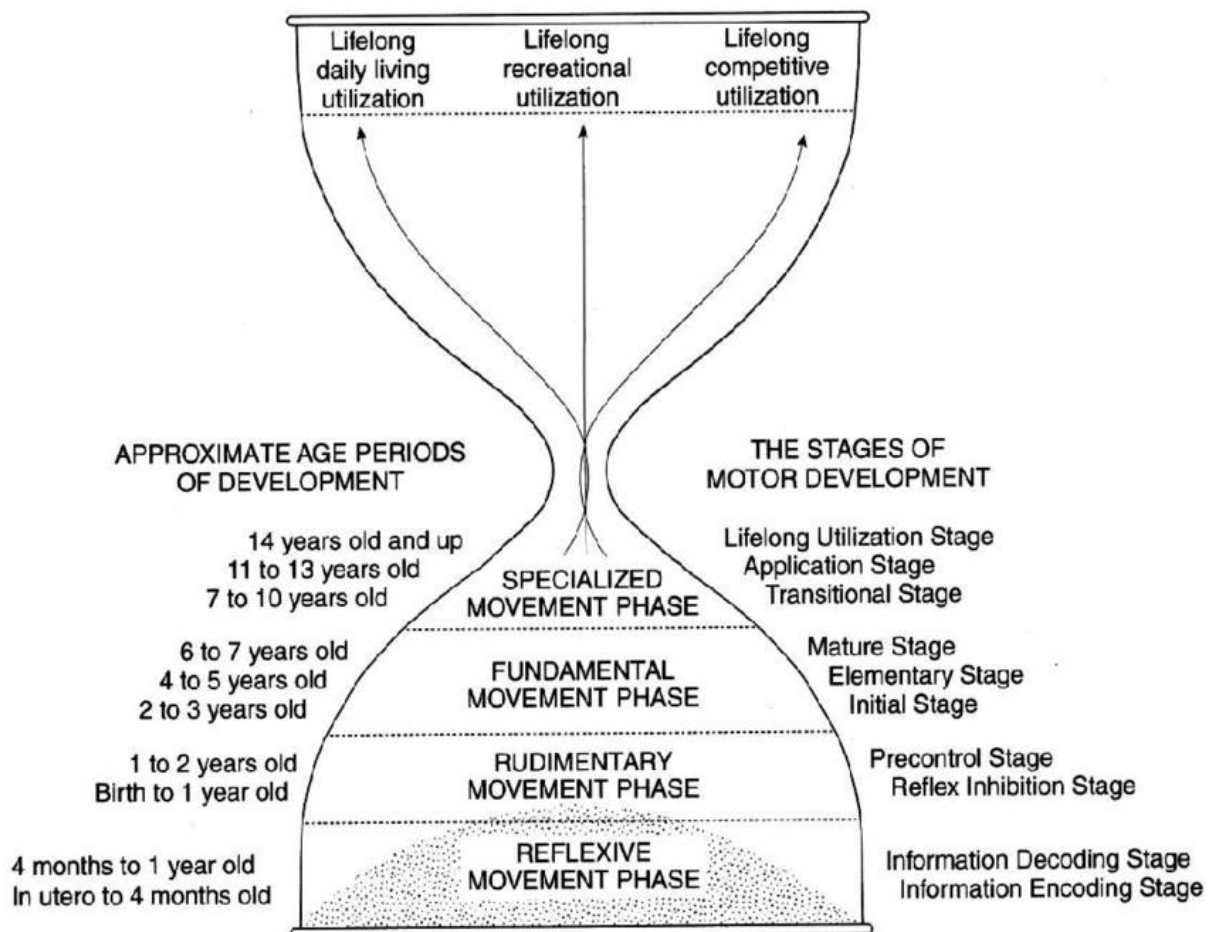


Figure 2.1. Phases of motor development

(Gallahue and Ozmun, 2006)

- 1) Reflexive Movement Phase: Reflexes (sudden involuntary responses to specific stimuli) are the first stages of human movement, occurring from before birth throughout the first year of life (Gallahue and Ozmun, 2006). Primitive reflexes, such as rooting and sucking, occur in order for the infant to obtain nourishment and information about their environment, while postural reflexes, such as stepping, grasping and crawling, serve as precursors to future movements which will be later used with voluntary control. This stage is essential for the child to gather and process sensory stimuli in order to store this information and develop perceptual motor ability (Gallahue and Ozmun, 2006).
- 2) Rudimentary Movement Phase: This phase begins at birth to about age 2, and represents the first stages of voluntary movement (Gallahue and Ozmun, 2006). While there is great variability in the timing of when this occurs, the sequence of appearance of these movements tend to occur in a predictable pattern due to physical growth and maturation, with the gain of control of the head, neck and trunk in the initial stage, progressing to movements with greater precision and control, such as reaching and grasping in the later stage (Gallahue and Ozmun, 2006). Earlier reflexes are inhibited and gradually disappear, replaced by voluntary control, while the rapid development of cognitive and motor processes between the first and second year of life result in rapid gains in movement abilities as the child learns to manipulate objects and move in a variety of ways with increasing proficiency and control (Gallahue and Ozmun, 2006).
- 3) Fundamental Movement Phase: The fundamental movement phase represents a time when the child can actively explore and experiment with the movement potential of their body, learn to respond with motor control to a variety of stimuli, and adapt to changes in the task requirement (Gallahue and Ozmun, 2006). The degree to which FMS develop during this phase is influenced by the conditions of the environment (opportunities, space and equipment to practice movement skills), encouragement, instruction, and the context of the movement

(Gallahue and Ozmun, 2006). Previous research outlines the common misconception that FMS occur naturally through growth and maturation alone (Clark and Metcalfe, 2002; Clark, 2007). This phase occurs across three separate, but overlapping, stages classified as the initial, elementary and proficient stages (Gallahue and Ozmun, 2006). During the initial stage, the child performs the task using crude uncoordinated movements, then progresses to the elementary stage, during which the child gains greater control and coordination. After this, the proficient stage may be reached which is characterised by efficient, coordinated and controlled performances of the skill (Gallahue and Ozmun, 2006). While these stages are age-related, they are not age-dependent, as numerous factors contribute to the maturation of the skill. Variability may also be seen across skills for individual children, who may be in the initial stage of some skills, but the elementary and mature phases of others (Gallahue and Ozmun, 2006).

- 4) Specialised Movement Phase: During this final stage of motor development, FMS are refined, combined and adapted for the increasingly demanding situations of daily living, recreation and sport (Gallahue and Ozmun, 2006). The onset and extent of FMS development within this phase depends on a variety of factors related to the individual, task, and environment. Numerous constraining factors can limit the development of FMS, ranging from body type, height, emotional makeup, culture and peer pressure (Gallahue, Ozmun and Goodway, 2012).

The hourglass model is a heuristic device (a conceptual metaphor), providing a general guideline to describe and explain motor behaviour (Salehi, Sheikh and Talebrokni, 2017). In this metaphor, the “sand” is a combination of both heredity and environment (i.e. elements of both ‘nature’ and ‘nurture’). Importantly, in the hourglass model, progression from one phase to the other does not occur in a linear fashion, or through a continuous process (Gallahue and Ozmun, 2006; Salehi, Sheikh and Talebrokni, 2017). That is to say, though there are phases and stages in the model, these are highly

generalised and there is variability in the age and rate of development among individual children. A child may have reached different movement stages for different individual skills, or even different stages for the different elements within the same skill.

2.2.3. Importance of fundamental movement skills for physical activity

A small number of studies have investigated the association between FMS and PA in EC, specifically to determine how FMS development affects PA participation. A recent review of studies investigating the association between motor skill proficiency and PA in preschool children (Figueroa and An, 2016) found a positive association between FMS and PA in 6 of the 7 studies, though the nature and strength of this relationship varied greatly and differed by gender, intensity and skill type. A positive association between FMS and low intensity PA was found in only one study (Foweather *et al.*, 2015), with higher object control skill ability being associated with more light activity, though generally, children with better overall FMS scores were found to spend more time in higher intensity activities and less time in SB (Williams *et al.*, 2008; Foweather *et al.*, 2015). Cliff and colleagues (2009) identified a similar positive correlation between FMS, and both time in MPA and MVPA for boys, with a stronger relationship for object control than locomotor skills. In this study, however, girls were found to display the inverse, with negative correlations between FMS and time in both MPA/MVPA, and stronger negative associations for locomotor than object control skills. The relationship between FMS and PA has been demonstrated to differ greatly by type of skill, with some studies suggesting that locomotor skills are more strongly associated with PA, than object control skills at this age (Williams *et al.*, 2008), possibly due to opportunities to practice additional locomotor skills such as running and jumping. Barnett and colleagues (Barnett *et al.*, 2015) investigated the relationship between FMS and PA at ages 19 months, 3.5 years, and 5 years, and found that MVPA at 3.5 years was associated with locomotor skill proficiency, suggesting that the influence of FMS in the early years may be essential for participation in higher intensity activity.

It is also worth noting that evidence for bi-directionality of the relationship between FMS and PA, in which FMS influences PA participation and vice-versa, is limited. Although, regression analysis has shown this relationship to be significant in both directions for object control skills, the same has not been demonstrated for locomotor skills (Crane *et al.*, 2015). Stodden and colleagues (2008) suggest that this relationship is stronger for middle childhood (ages 6 to 12) than for EC, and the relationship is unidirectional, where FMS influences PA participation, but not the reverse. It is suggested that this is due to higher levels of FMS competence in middle childhood offering a greater repertoire of activities and allowing children to self-select higher levels of PA, whereas those with lower proficiency will choose not to take part in PA (Stodden *et al.*, 2008). A uni-directional relationship after the age of 6 would suggest that if the preschool years are a window of opportunity for FMS development, perhaps this window closes as the child transitions to middle childhood.

It has been estimated that it takes approximately 10 hours of instruction for most children aged 3 to 10 years old to master one FMS (Booth *et al.*, 1999), and it is well understood that physical maturation and participation in PA alone are not sufficient to reach maturity in FMS, without teaching and feedback (Goodway and Branta, 2003; Zachopoulou, Tsapakidou and Derri, 2004; Gagen and Getchell, 2006). In Australia, a previous study testing FMS over 3 timepoints, at ages 4, 5 and 8 (Zask *et al.*, 2012) found that the children's locomotor skills improved from ages 4 to 5 years old, however, they did not significantly increase from ages 5 to 8 years old. This may suggest that some movement patterns plateau after the preschool years, when the fundamental movement phase is complete.

In addition to skill proficiency, how the individual perceives their ability to perform the skill is also important in determining whether the individual enjoys taking part in activities utilising that skill (Stodden and Goodway, 2007). This perception of ability is known as perceived competence, and research has shown that low perceived competence is associated with lower engagement in PA through the lifespan (Barnett *et al.*, 2009; Jones *et al.*, 2010; Lubans, Morgan and McCormack, 2011). It has been suggested that if a child does not have sufficient actual motor competence, perceptions of competence will drop over time as the child is better able to evaluate his or her

competence level (Stodden *et al.*, 2008). Research has shown that children of preschool age tend to have inflated perceptions of their own motor competence (Horn and Weiss, 1991; Weiss and Amorose, 2005; LeGear *et al.*, 2012) and that beliefs about personal abilities are highly inaccurate until around 7 years old (Horn, 2004; Harter, 2012; LeGear *et al.*, 2012). The transition from early to middle childhood however heralds the beginning of a “period of vulnerability” (Stodden *et al.*, 2008), where perceived competence becomes significant. Therefore, as preschool children have the physical and neural capacity to reach mastery in FMS by age 6 (Gallahue and Ozmun, 2006), the opportunity that these years represent for achieving actual competence in these skills is unique. The preschool years are the ideal time to develop FMS, as they present an opportunity for children to take part in and persist with activities involving these skill regardless of their actual ability (LeGear *et al.*, 2012).

2.2.4. Instruments for the measurement of fundamental movement skills

A review of instruments used to measure motor skills by Cools and colleagues (2009) highlighted that the appropriate choice of measurement tool depends on what aspect of motor development measurement is sought for, as well as the purpose of the measurement; whether it is to diagnose specific delays or impairments, assess differences before and after an intervention, or establish trends in a community sample (Piek, Hands and Licari, 2012). While numerous tools exist that incorporate some aspect of FMS measurement to assess the underlying motor ability at different ages using both process (how the skill is performed; qualitative) and product measures (the result of the skill performance such speed or distance; quantitative), this review will focus on tools that specifically measure FMS, suitable for use with preschool children. This literature review will discuss the following three instruments for the measurement of FMS

1. Test of Gross Motor Development-2
2. The Children’s Activity and Movement in Preschool Study Motor Protocol
3. Movement Assessment Battery for Children-2

1. TGMD-2: The Test of Gross Motor Development second edition (TGMD-2)

The TGMD-2 (Ulrich, 2000) is a process-oriented criterion and norm-referenced instrument, assessing the observed movement performance against a set criteria of specific characteristics, seen in mature patterns of FMS. Process-oriented tools have been suggested to be more appropriate than product-oriented for assessing FMS in this age group, as the movement pattern reflects the developing skill level of the child, rather than the underlying motor development level (Hardy *et al.*, 2010; Logan *et al.*, 2012). The test battery consists of 12 tests, with six locomotor (run, hop, gallop, leap, horizontal jump and slide) and six object control subtests (striking a stationary ball, stationary dribble, catch, kick, overhand throw and underhand roll) (Martin, Rudisill and Hastie, 2009; Valentini *et al.*, 2017). The TGMD-2 has been validated for 3 to 10 year old children (Valentini, 2012), and provides sufficient overall test-retest reliability ($r = 0.98$), as well as for locomotor ($r = 0.88$) and object control ($r = 0.93$) subtests (Ulrich, 2000).

Results may be presented as raw scores (between 0-48 for either subtest) or converted to norm-referenced standard scores, percentiles, or a gross motor quotient (GMQ). The GMQ reflects the basic constructs built into the test, and is a composite score of both subtests (Ulrich, 2000). The norm references for this instrument are based on a representative sample of 1,200 school aged children in the USA, and skill proficiency is classified according to the table below

Table 2.1. Descriptive, standard and percentile scores for the TGMD-2

| Descriptive rating | GMQ standard score | Percentile score |
|---------------------------|---------------------------|-------------------------|
| Very Superior | >130 | 99th |
| Superior | 121-130 | 92-98th |
| Above Average | 111-120 | 76-91st |
| Average | 90-110 | 25-75th |
| Below average | 80-89 | 10-24 th |
| Poor | 70-79 | 2-8 th |
| Very poor | <70 | <1st |

(Ulrich, 2000)

One notable limitation of the TGMD-2 for FMS assessment is the absence of the measurement of stability skills (Cools *et al.*, 2009). Justifications for this include that these skills are factors within other FMS like walking or jumping (Holfelder and Schott, 2014), and that as stability occurs very early in development, ceiling effects may be observed (Hardy *et al.*, 2010). Some authors also argue that stability should be classified as a motor ability, rather than a skill (Burton and Rodgeron, 2001). Rudd and colleagues (2015) assessed if stability skills fit into an FMS model with object control and LOC skills and concluded that stability skills are an independent factor within this model that should be assessed separately to other aspects of movement. While the authors suggest that stability skills will not reach their full potential by practicing locomotor and object control skills alone, it is suggested that stability is better viewed as a separate construct than FMS (Rudd *et al.*, 2015)

The choice of selected skills in the TGMD-2 may also lack cultural relevance to the country in which the test is taking place. For example, striking and overhand throw are demonstrated in baseball, which is strongly linked to sport culture in the US (Morgan *et*

al., 2013). For countries in which other sports are more popular, children may not get the chance to use or develop these skills, and may score lower in these skills compared to that of US children (Cools *et al.*, 2009).

2. The Children's Activity and Movement in Preschool Study Motor Protocol (CHAMPS-Motor Skill Protocol)

The Children's Activity and Movement in Preschool Study (CHAMPS) which took place between 2003 and 2006, aimed to describe PA behaviour in preschool children, specifically to inform the development of policies and practices related to children's PA levels in preschools (Addy *et al.*, 2014). The CHAMPS-Motor Skills Protocol (CMSP) was developed as part of this study to address the need for a valid and reliable tool for use in assessing motor skills in preschool children, in diverse field-based settings that are typical of large, multifaceted epidemiological studies (Williams *et al.*, 2008, 2009). This instrument is based on the TGMD-2 as a prototype, but is adapted to facilitate capturing observational data more efficiently without the need for video recording. It is similar to the TGMD-2 in terms of the number and type of skills it measures, but differs from the TGMD-2, in that it uses a greater number of movement characteristic criteria for each skill and includes a distraction score to account for variations in environment, and (Williams *et al.*, 2009). The distraction score acknowledges that testing may take place in a number of different circumstances other than quiet open spaces, and rates the level of noise and the type and adequacy of testing space (Williams *et al.*, 2008)

As such, the range of possible scores for locomotor skills is 0–73, for object control skills 0–80, and for overall FMS raw score 0–153 (Williams *et al.*, 2008). Reliability estimates for the CMSP range from $r = 0.88$ – 0.97 for all subtests, and construct validity has been demonstrated with significant differences between chronological age (i.e. 4 year olds scored higher than 3 year olds and 5 year olds scored higher than 4 year olds), and a very high concurrent validity exists with the TGMD-2 ($r = 0.94$ – 0.97)(Williams *et al.*, 2009).

Strengths of this tool include the extra clarification of skill criterion descriptions for observation. For example, for the skill of throw in the TGMD-2, “hip and shoulder”

rotation is rated a single criterion item which can make scoring difficult as a child may display hip rotation but no obvious shoulder rotation (Williams *et al.*, 2009). The CMSP addresses this by characterising this criterion as “hip-trunk rotation” and adding a further two additional descriptors of the type of rotation that occurs (i.e. differentiated or block rotation). Similarly the inclusion of a distraction score allows researchers to describe and control for potential influences of the environment on performance outcomes (Williams *et al.*, 2009). A weakness of this tool is that concurrent validity was established by administering the test and the criterion test (TGMD-2) in the same time frame, and it is not clear if the high coefficients would be maintained if the two tests were administered at different time points (Williams *et al.*, 2009)

3. Movement Assessment Battery for Children-second edition (MABC-2)

The Movement Assessment Battery for Children- version 2 (MABC-2) (Henderson, Sugden and Barnett, 2007) provides a global test of motor competence, with assessments of both fine and gross motor coordination (Visser, Geuze and Kalverboer, 1998). The test can be administered to children aged 3 to 16, with age-bands of 3 to 6, 7 to 10 and 11 to 16. This test uses both quantitative and qualitative methods to evaluate a child’s motor competence and contains eight sub-tests which are grouped under three headings: manual dexterity (three subtests; threading beads, posting coins, and drawing a trail), ball skills (two subtests; catching a beanbag and throwing a beanbag onto a mat) and balance (three subtests; one-leg balance, walking heels raised and jumping on mats). The test battery employs different task scoring criteria for children of different age bands. For example, children aged 3 to 4 can use the entire body when catching the beanbag but those aged 5 to 6 must use hands only.

Strengths of this tool include the global measure of motor competence that it provides and the fact that it takes chronological age into account. The test is considered a reliable and valid tool for assessment of movement difficulties among 3-5-year-old children (Cronbach’s alpha of .51 for manual dexterity, .7 for ball skills and .66 for balance) (Ellinoudis *et al.*, 2011). This could also be considered a weakness of the tool however when applied to investigation of FMS. In terms of FMS, this test battery contains only one locomotor (jumping) and two object control skills (throwing and catching), with the

rest measuring fine motor and stability skills (Cools *et al.*, 2009). This test provides a more thorough insight into overall motor competence beyond observable movement skills. As such this tool is more commonly used by health practitioners as a diagnostic tool to identify and describe motor impairments in daily life (Gueze *et al.*, 2001; Cools *et al.*, 2009)

2.2.5. Fundamental movement skill level of preschool children (Internationally)

Proficiency levels of FMS among preschool children have received little focus in the literature, with few studies examining this dimension of motor development.

Hardy and colleagues (2010) addressed the need for basic descriptive information on preschool children's FMS levels, by assessing 4-year-olds in Australia on 8 FMS (n=330; 4 locomotor - run, gallop, hop, horizontal jump; and 4 object control - striking, catch, kick and overhand throw) using the TGMD-2. For locomotor skills, 5.8% of girls and 4.2% of boys had achieved overall mastery, with the highest individual locomotor skill mastery demonstrated in the run (69% of girls and 76% of boys), and the lowest individual skill mastery in the horizontal jump (23% of girls and 21% of boys). For object control skills, 3.3% of both boys and girls had achieved overall mastery, with the highest individual object control mastery level seen for the kick (22% of girls and 44% of boys). While 20-23% of boys had achieved mastery in the other 3 object control skills, only 9% of girls had achieved mastery in the overhand throw, and 6% in the strike respectively. Raw scores from this study also give an indication of the average level of FMS proficiency of 4-year old children in Australia, with both girls and boys scoring a mean total of 42 out of a possible 70, indicating that they are on average about 61% of the way towards mastery.

For an object control skill intervention, Donath and colleagues (2015) used the TGMD-2 to test 5 object control skills in 4-year olds (n=41). At baseline, mean object control skill score for the group translated to proficiency within the 65th percentile (± 25), rated as average according to Ulrich (2000). Raw scores varied between 12 and 16, out of a possible 30, indicating that the 4-year olds in this study were 40-53% of the way towards mastery in object control skills. Similarly, 3-6 year olds in research by Zask and colleagues

(2012) using the TGMD-2 would be classified as average, with a sample of 415 children achieving a mean GMQ of 107 for girls and 104 for boys. As these figures are taken from the baseline results of an intervention targeting FMS, PA and healthy eating, raw scores are not detailed in this research. Another study observed a GMQ of 93.3 at baseline for an intervention study amongst 4-to-6-year olds in Iran (n=147) (Kordi *et al.*, 2012), with no statistically significant differences between boys and girls. In this case, 11.5% of children were rated superior/very superior (GMQ > 120), and raw scores indicated that children were approximately 62% of the way towards mastery for locomotor skills and 53% towards mastery for object control skills.

Low levels of FMS proficiency have been highlighted specifically with regard to weight status. Khalaj and Amri (2014) found that 4-6 year olds who were classified as obese had significantly lower FMS proficiency compared to their normal weight peers, with obese children achieving a GMQ of 85.5 (below average), though results for normal weight participants were not shown in this study.

2.2.6. Fundamental movement skill level of preschool children (Ireland)

Limited data exists for the FMS proficiency levels at any age in Ireland, with no available evidence for preschool children. A study of pre-adolescent children however showed that Irish youth are far below the levels of mastery expected by middle childhood, with only 0.5% of 11 and 12-year olds (n=256) having achieved mastery in the 9 FMS tested, and only 11% displaying near mastery (Belton *et al.*, 2014). More recently, a study of 203 Irish primary school children in senior infants (approximately 6 years old) and fourth class (approximately 10 years old), found that no child had achieved mastery across all 12 FMS tested, with one 10-year-old achieving mastery in 10 FMS and no 6-year-old achieving mastery in more than 6 FMS (Bolger *et al.*, 2018). For locomotor skills, run was the skill mastered by the most children (6-year-olds = 80.4%; 10-year-olds = 77.2%), with a larger percentage of girls achieving mastery in the run than boys (boys = 71.8%; girls = 87.1%) while jump was the lowest mastered FMS (6-year-olds = 10.8%; 10-year-olds = 13.9%) for both boys (11.8%) and girls (12.9%) (Bolger *et al.*, 2018). For object control skills, the kick had the highest level of mastery of both boys (77.3%) and girls (40.9%)

while the roll showed lowest mastery for boys (12.7%) and girls (1.1%). While the run was the only locomotor skill that showed a significant gender difference, for the object control skills a greater proportion of boys achieved mastery for the kick, throw and roll ($p<.05$) (Bolger *et al.*, 2018). Older children had significantly higher mastery levels for both boys and girls for two of the six locomotor skills (gallop and hop) and five of the six object control skills (kick, dribble, catch, throw and roll) (Bolger *et al.*, 2018). This research indicates that for Irish children, there is less variation between age and gender for locomotor skills but large differences for object control skills. It is interesting to note that there were only significant differences between age groups for two locomotor skills as it would be expected that large differences in proficiency would be observed between these age groups, with the age of six often highlighted as a crucial milestone for FMS development (LeGear *et al.*, 2012; Stodden *et al.*, 2008). Coupled with the large differences in mastery between boys and girls for object control skills, this research highlights a need to intervene at an early age to ensure that all children have the opportunity to develop a broad range of FMS regardless of gender.

Interestingly, a lack of competence was found to be the most common reason that Irish children and youth gave up for not participating in PA (Woods *et al.*, 2010), indicating that perceived competence could be a major factor in the physical inactivity levels of Irish children.

2.3. Interventions

2.3.1. Overview of interventions

Numerous ECEC-based intervention studies have been conducted towards increasing PA (Ward *et al.*, 2010; Temple and Robinson, 2014; Finch *et al.*, 2016) or FMS proficiency levels (Van Capelle *et al.*, 2017; Wick *et al.*, 2017). Only a small number however have targeted both PA and FMS together.

To identify interventions which have targeted, and reported results for, both of these variables, two recent systematic reviews specifically assessing and evaluating FMS interventions in the childcare setting were reviewed (Van Capelle *et al.*, 2017; Wick *et al.*, 2017). Both of these systematic reviews included only randomised control trials (RCT) or control trials with a duration of 4 weeks or more. Wick and colleagues (2017) reviewed a total of 30 papers with interventions targeting children aged 3-5, while Van Capelle and colleagues (2017) included 20 papers with interventions targeting children aged 2-6. Wick and colleagues (2017) indicated that 8 of the 30 articles reviewed included an objectively measured PA outcome in addition to FMS measurement. This was compared with the second systematic review and an additional 4 papers were identified in the review by Van Capelle and colleagues (2017) that had not been assessed by Wick and colleagues (2017). Of these 4 studies, none assessed PA in addition to FMS. Of the 8 studies identified in the first review, 1 was excluded for this literature review as the reported tool utilised for FMS measured only stability skills with no locomotor or object control subtests. This left a total of 7 studies that assessed PA and FMS interventions of preschool children in the childcare setting. The PA outcomes reported for these studies differed slightly, with some measuring PA during childcare hours only and others measuring full days of wear including time outside of childcare. While this literature review aims to inform an intervention that will aim to increase PA during childcare hours only, all 7 studies have been included for review, as this does not affect FMS outcomes. Results are however presented in separate tables for studies which measured PA during childcare hours only, and studies which measured PA over full days.

The following tables outline the structure of the seven identified interventions which targeted FMS and PA simultaneously.

- Table 2.2 outlines the four interventions for which PA was measured during time in ECEC only.
- Table 2.3. further details methods and results of the four studies from Table 2.2.
- Table 2.4 outlines the three interventions for which PA was measured for full days (both during ECEC hours and outside of ECEC hours).
- Table 2.5 further details the methods and results of these three studies from Table 2.4.

Table 2.2. Characteristics of interventions targeting FMS and PA (PA measured during ECEC hours only)

| | Adamo <i>et al</i>, 2016 | Alhassan <i>et al</i>, 2012 | Bonvin <i>et al</i>, 2013 | Jones <i>et al</i>, 2016 |
|---------------------------|--|---|---|--|
| Name | Preschoolers Activity Trial | Project PLAY | Youp'là Bouge | Jump Start |
| Country | Canada | USA | Switzerland | Australia |
| Educator Training | 2 x 3-hour workshops (1 st session overview of PA and intervention) 2 nd session: dissemination of resource | 8 hours Encouraged to participate in one of two 30-minute play times daily Lesson plans given in two-week intervals | 5 workshops | 2 x 90-minute workshops (theory and practice); 1 pre- intervention and other halfway through. Researcher facilitated some sessions during first half of intervention as part of ongoing professional development |
| Structure | No structured activity sessions | Daily 30-minute activity sessions | Changes to environment No precise demands regarding daily PA time | 20-minute structured activity sessions 3 times/week and unstructured PA |
| Activities | Suggested weekly schedule of activities to incorporate throughout day | Each structured activity session involved 5 minutes low intensity PA, 20 minutes FMS activities and 5 minutes of extension activities using FMS 30 lesson plans (each taking 2-5 days to implement) Within each 2-week cycle, 1 'free day'. | No structured activity sessions; PA threaded through daily programme | Each structured activity session ('Jump In') focused on one FMS. Also: -Unstructured outdoor PA and FMS sessions with equipment to practice skills through play ('Jump Out') -Energy breaks ('Jump Up') -Activities connecting movement to learning experiences ('Jump Through') |
| Materials | -Healthy Opportunities for Preschoolers (HOP manual) -Equipment -Binder with PA guidelines, recommended weekly activity programme and log sheets | -Lesson plans -Preparation sheets -Equipment for activities | Flyers and documentation for parent sessions \$1500 grant for adaptations to indoor/outdoor play space and equipment | -Programme manuals -workshop booklet -video footage of PA sessions |
| Additional Support | Biweekly 60-90 minute booster sessions with trainer during childcare hours (assistance with implementation, problem solving and using resource kit) | None | Monthly group meetings and coordinator available to answer questions or concerns | Ongoing professional development (described above) |
| Family Component | None | None | Parent sessions organised by services to discuss benefits of PA and FMS how to increase PA at home | 'JUMP Home': Activities provided to parents to encourage practice of gross motor skills within the home environment |

Table 2.3 Results of intervention studies from Table 2.2. (PA measured during ECEC hours only)

| Authors | Year | n | Ages | Duration (weeks) | Measurement | Outcomes |
|-------------------------------|------|-----|-------|------------------|--|--|
| Adamo <i>et al.</i> | 2016 | 83 | 3-5 | 24 | FMS: TGMD2 PA: Accelerometer | Compared with CON, INT showed sig higher GMQ (p=.025) and LOC score (p=.022) at PT Sig dec in CON OC score (p=.043), at PT while INT maintained OC score from baseline to PT |
| Alhassan <i>et al.</i> | 2012 | 114 | 2.9-5 | 24 | FMS: TGMD-2 (LOC only) PA: Accelerometer | No sig diffs between groups for PA at PT Compared with CON, INT showed sig greater inc in leaping score (p=.01) at PT |
| Bonvin <i>et al.</i> | 2013 | 273 | 2-4 | 36 | FMS: Zurich Neuromotor Assessment PA: Accelerometer | No sig diffs between groups for PA or FMS at PT |
| Jones <i>et al.</i> | 2012 | 150 | 3-5 | 20 | FMS: TGMD-2 PA: Accelerometer | No sig diffs between groups for PA or FMS, but Small-medium effect sizes for all FMS, except catch (d=0.19 to 0.58) in favour of INT Medium effect size for inc in INT TPA (d=.23) |

(INT=Intervention group, CON=Control group, LOC=Locomotor skill, OC=Object Control skills, sig = significant, diff = difference, TPA = total PA, inc = increase, dec = decrease, BL = baseline, PT = post-intervention testing (immediately following intervention))

Table 2.4 Characteristics of interventions targeting FMS and PA (PA measured in and outside of ECEC setting)

| | Bellows <i>et al</i>, 2013 | Reilly <i>et al</i>, 2006 | Roth <i>et al</i>, 2015 |
|---------------------------|---|--|--|
| Name | Mighty Moves | MAGIC (Movement and Activity Glasgow Intervention in Children) | PAKT (Prevention through Activity in Kindergarten) |
| Country | USA | Scotland | Germany |
| Educator Training | Training on gross motor development and age-appropriate physical activity (duration not detailed) | 3 training sessions | Not detailed |
| Structure | 15-20-minute structured PA lessons 4 times/week | 30-minute structured activity sessions 3 times/week | Daily 30 minute PA lessons |
| Activities | <p>Total of 72 lessons and 143 possible activities</p> <p>Mighty Moves characters introduced a skill at beginning of each week, movement concepts added as week progressed and skill patterns incorporated into activities later in programme</p> <p>(Also contained nutrition component)</p> | <p>Not described in literature</p> <p>Aimed to meet requirements of the “physical development and movement” component of the nursery curriculum in Scotland.</p> | <p>PA homework cards (1 or 2 per week)</p> <p>Educators were encouraged to adjust the lessons according to the children’s abilities, interests, and ideas.</p> |
| Materials | <p>Kit containing:</p> <p>Educator activity binder, custom music CD, activity mats, flashcards, puppets, scarves, balls, beanbags, and ropes</p> | Posters in service for 6 weeks focusing on PA through walking and play | Collection of games and exercise tasks developed to plan and organize the daily PA lessons as well as a manual including pedagogical, didactical, and methodological background information. |
| Additional Support | None | None | Supervised once per 8 weeks to monitor and assist in implementation |
| Family Component | Educational handouts and copy of Mighty Moves music CD | Resource pack of materials (guidance on linking active play at creche and home; health education leaflets re levels of PA in city and reducing screen time) | <p>1-2 PA homework cards per week and seasonal letters for holidays with ideas for active family activities.</p> <p>Invited to 3 interactive lectures providing info on development of FMS in children, importance of PA and limiting SB. 2 booklets summarised the contents of the 1st 2 meetings</p> <p>Flyers summarising lecture information</p> |

Table 2.5 Results of intervention studies from Table 2.4. (PA measured in and outside of ECEC setting)

| Authors | Year | N | Ages | Duration (weeks) | Structure | Measurement | Outcomes |
|------------------------------|------|-----|------|------------------|---------------------------------|---|--|
| Bellows <i>et al.</i> | 2013 | 263 | 3-5 | 18 | | FMS: Peabody Developmental Motor Scale-2 PA: Pedometers | Compared with CON, INT showed sig greater inc in FMS for both GMQ and LOC (both $p<.0005$) at PT No sig diffs for PA |
| Reilly <i>et al.</i> | 2006 | 545 | 4 | 24 | 30-minute sessions 3 times/week | FMS: MABC PA: Accelerometer | Compared with Con, INT showed sig greater inc in FMS ($p=.0027$) at PT No sig diffs for PA |
| Roth <i>et al.</i> | 2015 | 709 | 4-5 | 11 months | | FMS: Single items (standing long jump, balancing on one foot, jumping sideways and target throwing) Agility obstacle course (climbing over and crawling under bench) PA: Accelerometers | Compared with CON, INT showed sig greater inc in overall FMS ($p=.001$) and all single item skills ($p<.05$) at PT <u>2-4-month follow-up after intervention:</u> Overall FMS still sig higher for INT than CON ($p=.007$) No sig diffs between groups for PA |

(INT=Intervention group, CON=Control group, LOC=Locomotor skill, OC=Object Control skills, sig = significant, diff = difference, TPA = total PA, inc = increase, dec = decrease, BL = baseline, PT = post-intervention testing (immediately following intervention))

2.3.2. Interventions: Key Considerations

Development of Interventions

Many of these interventions (Bellows, Davies, *et al.*, 2013; Bonvin *et al.*, 2013; Jones *et al.*, 2016) were based on the social-ecological model framework, a multi-level approach which acknowledges the role of the individual (children), those around them (educators, support staff and parents), and the environment (built environment, policies and daily structure) by intervening at each of these three levels (Bronfenbrenner, 1979). The Jump Start intervention (Jones *et al.*, 2016) was additionally underpinned by Social Cognitive Theory (Bandura, 1986), which addresses personal factors (through opportunities for educators to reflect on the importance of PA and FMS), behavioural factors (through developmentally appropriate activities for children and self-monitoring strategies for educators) and environmental factors (through modifying existing schedules and the physical environment). This intervention was developed in consultation with educators to ensure that the resources and implementation of the intervention were appropriate for all dimensions of the childcare environment (Jones, Gowers and Stanley, 2017).

The Mighty Moves study (Bellows, Davies, *et al.*, 2013) also engaged extensively with educators as part of a social marketing approach (Kotler and Zaltman, 1971), which utilises principles of marketing theory to impact positive behaviour change. In this case, consultation with educators highlighted that time, space and equipment represented major barriers to creating PA and FMS opportunities for intervention. Engagement with both educators and children led to the decision to use a superhero theme, featuring specially designed cartoon characters to appeal to this age group, and spark excitement about PA (Bellows *et al.*, 2009). Despite the extra costs associated with conducting formative research with educators and other stakeholders prior to intervention design (Gittelsohn *et al.*, 2006), this approach ensures that the programme developed meets the needs of the intended user, and could be a valuable opportunity to ensure optimum programme design (Vastine *et al.*, 2005). While children receiving the Mighty Moves intervention demonstrated significant improvements in FMS (Bellows, Davies, *et al.*, 2013), children who received the Jump Start intervention did not demonstrate significant improvements over the control group in either PA or FMS (Jones *et al.*, 2016). However, small to medium effect sizes were evident for all PA and FMS outcomes

(except catch), showing positive trends in favour of the intervention group in both studies. A larger, 18-month randomised control trial (RCT) for the Jump Start intervention is currently in progress with over 600 participants (Stanley *et al.*, 2016), which may yield more positive results and add weight to the evidence for consultation with educators.

Educator Training

A feature of all these studies mentioned above is that they are all educator-led. While it has been shown that delivery by experts can be more effective in improving FMS (Wick *et al.*, 2017), the long-term sustainability or wider dissemination of this approach would not be feasible for preschool children. A report from the Organisation for Economic Cooperation and Development (OECD) highlights that almost all OECD countries have adopted quality curriculum standards and frameworks for ECEC (OECD, 2012), many of which specifically state the need for ECEC settings to provide PA opportunities for children while they are in care. The importance of ensuring that educators are trained to deliver PA and FMS opportunities cannot be overstated, as despite educators being tasked with ensuring that the need for PA is met, research has highlighted that few educators receive formal training in facilitating PA (Martyniuk and Tucker, 2014) and have low perceived competence in directing these activities, resulting in a tendency to favour free play during outdoor or time scheduled for PA (Bonvin *et al.*, 2013). Free play, although essential for physical and social development in the preschool years, is not alone sufficient to meet the PA needs of young children (Alhassan, Sirard and Robinson, 2007), and does not provide the specific and systematic opportunities to learn the FMS that are needed (Goodway and Branta, 2003; Gallahue and Ozmun, 2006). Training teachers in both the theory and practice of facilitating PA and FMS in ECEC represents an opportunity to increase educator competence and influence PA and FMS levels of the children in their care (Van Cauwenberghe *et al.*, 2013; Kirk and Kirk, 2016; Vinci *et al.*, 2016), though careful consideration should be given to the design of this training to ensure that it meets the needs of the educator and is sufficient to impact change (Bellows *et al.*, 2009). In the case of the MAGIC intervention (Reilly *et al.*, 2006) which achieved a significant increase in children's PA during its pilot study (Reilly and

McDowell, 2003) but not in the RCT (Reilly *et al.*, 2006), the authors highlight that insufficient training may have explained the difference in findings.

For the Jump Start study (Jones *et al.*, 2016), consultation with services prior to the design of the programme (Riethmuller *et al.*, 2009) concluded that effective professional development would need to be structured in a way that complemented the individual setting types, and informed an approach where professional development included on-site facilitation by an early childhood educator, trained by the research team to ensure the educator was supported in applying and adapting activities to their specific setting. A similar approach was utilised in the Preschoolers Activity Trial (Adamo *et al.*, 2016), where biweekly “booster sessions” were available to educators who could receive on-site support from a master trainer in delivering the programme and using the equipment if desired. While the requirement of a master trainer to support educators during the implementation of an intervention may be costly, a strength of the Jump Start intervention was the training of an EC educator to act as Project Manager and provide training and support to educators participating in the intervention. Similarly, the Youp’là Bouge intervention (Bonvin *et al.*, 2013), which was conducted by the health departments at a local government level, trained employees of these government institutions coordinated and organised group meetings for intervention services. These approaches highlight sustainable ways to enhance educator training and provide follow-up support to ensure the specific needs of educators relevant to individual services are met by utilising existing infrastructure and personnel.

Structure of Interventions

Another important consideration is the format of the intervention. All but two of these studies (Bonvin *et al.*, 2013; Adamo *et al.*, 2016) included structured scheduled PA sessions and prescribed activities specified in lesson plans. Strengths of this approach include the assurance of a specific volume of PA in each session; meta-analyses have suggested that sessions of at least 30 minutes duration 4-5 times per week may be necessary to achieve improvements in FMS, and that up to 45 minutes per day 5-6 days per week may be required to increase PA levels in children (Ward *et al.*, 2010; Van Capelle *et al.*, 2017). However, it must also be acknowledged that due to variations in

the timetables, curricula, and access to movement spaces across services, this approach may not be feasible for all services or even culturally transferable, as a number of these studies were conducted in services which had set times for gross motor activities in their existing daily schedules which may not be feasible for all services.

Instead of structured sessions, the Preschooler Activity Trial (Adamo *et al.*, 2016) focused on training educators to create an environment that provides opportunities for daily PA and included weekly recommendations for incorporating PA throughout the day, resulting in an increase in LPA and reduction in SB (Goldfield *et al.*, 2016). This approach also resulted in significant increases in locomotor skills, though object control skills were unchanged. Given that the manual (HOP Manual) included numerous activities that involved using FMS but did not focus on teaching these skills individually, evidence would suggest that an unstructured approach may not be the optimum approach for the development of object control skills, which have been shown previously to require more targeted teaching approaches than locomotor skills (Zask *et al.*, 2012).

In the Youp'là Bouge study (Bonvin *et al.*, 2013), no precise demands were made regarding daily PA or the use of a structured curriculum. Interestingly, the only compulsory aspects of the programme were teacher training and the rearrangement of the PA environment. Even though significant increases in FMS and PA were not detected in this study, the use of process measures allowed researchers to compare groups that utilised different aspects of the intervention programme. Where services offered free access to a movement space, this resulted in significantly higher FMS scores ($p=.02$) and significantly more overall PA ($p=.006$) and MVPA ($p=.005$), pointing to the potential benefits for other approaches other than just structured sessions.

Family Component

Most of the above interventions contained some form of parental element, with only two studies (Alhassan *et al.*, 2012; Adamo *et al.*, 2016) absent of parent involvement. While it may be argued that parental involvement would not be necessary for interventions aiming to increase PA and FMS during preschool hours, parents represent

an opportunity to influence their child's PA behaviour through role modelling, fostering an enjoyment of PA and providing continued opportunities to practise FMS outside of childcare (Loprinzi and Trost, 2010; Mackintosh *et al.*, 2011). Furthermore, parents are believed to be more influential to children's PA in the early years, compared to with older age groups (Carson, 2016).

A recent systematic review and meta-analysis of FMS interventions (Van Capelle *et al.*, 2017) also highlights the importance of parental involvement to ensure correct practice of FMS at home. From a behaviour change perspective, children's development is a bidirectional transaction, with parents influencing children, but also children impacting parents' decisions (Skouteris *et al.*, 2011).

In the Youp'la Bouge intervention (Bonvin *et al.*, 2013), process evaluation data indicated that the inclusion of an optional service-led parental information session resulted in greater increases in FMS proficiency ($p = .02$). In contrast to this, the PAKT study (Roth *et al.*, 2015) offered 3 interactive parent lectures, and despite attendance of over 300 parents in the first lecture, which focused on FMS, substantial decreases were observed in attendance over the following sessions, with a total of just 22 attendees by the third lecture. Regardless of this, the PAKT study was the only study to include a follow-up measure, after cessation of the intervention, showing improvements in motor skills that persisted on testing 2-4 months after the intervention (Roth *et al.*, 2015). These findings might indicate that attendance at the first lecture was enough to influence parental involvement in FMS development. The steady decline in parent attendance over the 3 PAKT lectures indicates an important consideration for the development of a parent component within an intervention, highlighting that such a component needs to meet the needs of parents, and be realistic in the expectation for time commitments.

2.3.3. Conclusions

The above intervention studies highlight several areas for consideration in the development of interventions to increase PA and FMS of preschool children in ECEC. Firstly, in order to affect change, an approach that recognises the role of children, educators, parents, and the childcare environment may be essential. Consultation with educators may provide valuable insights into the barriers and facilitators and could ensure that interventions are designed in response to the specific needs of services.

Secondly, teacher training is a crucial component of such interventions, and careful consideration should be given to the content, duration, and format of this training. Existing personnel and infrastructure within the EC or health promotion sector may represent an opportunity to provide in-service facilitation of intervention elements, and follow-up support after, or as part of, formal educator training without the continued need for researcher involvement.

Thirdly, the format of the intervention, whether structured with a requirement for a specific duration and frequency of PA, or unstructured with PA and FMS opportunities (initiated at the discretion of the educator or in response to environmental facilitators) depends greatly on the existing curriculum, schedule, and practice of individual services. Structured sessions may not be culturally transferable, specifically due to the variations in ECEC regulations, and daily scheduling requirements internationally.

Finally, inclusion of a family component may provide increased reinforcement of positive PA messages and opportunities for children to practice FMS at home. However, this component should be planned carefully to ensure a realistic time commitment for parents, and printed materials may ensure the dissemination of crucial information without the need for parents to attend in-person sessions to receive this information.

2.4. Irish Context

2.4.1. The Early Childhood Care and Education (ECCE) scheme

The EC sector in Ireland has seen major reform in recent years. Traditionally in Ireland, a distinction was made between ‘childcare’ and ‘education’, with childcare evolving in response to the needs of working parents, through a range of community, voluntary and private enterprises (Hayes, 2007). Regulation of the childcare sector was initiated in 1996 with the publication of the Child Care (Pre-School Services) Regulations of 1996, updated in 2006 and 2016 (Department of Children and Youth Affairs, 2016). As the child care and education sectors grew both separately and together, international reports highlighted the low quality, low affordability, and low accessibility of EC services by European standards, and the inequality of access clearly evident due to limited government investment (OECD, 2004; UNICEF, 2008). In response to this, the Early Childhood Care and Education (ECCE) scheme, or Free Pre-school Year, was introduced in 2010, entitling all children aged between 3 and 4.5 years old to a free year (15 hours per week over a 38-week year, with the option to pay for extra hours) of ECCE before starting primary school.

As of September 2016, this scheme has been expanded to 2 years and is open to children between the ages of 3 and 5.5 years old, with a capitation fee (based on the level of qualification of the Room Leader) paid directly to the service for each qualifying child enrolled. The ECCE scheme has uptake on a large scale, with approximately 95% of eligible children participating in the scheme and registrations increasing by 13% between 2015 and 2016 (Pobal, 2016). The ECCE scheme is operated on behalf of the Irish government by Pobal, who fund 31 City and County Childcare Committees that work locally and nationally to assist ECCE services through providing Continuing Professional Development training, support and promotion of the adoption of quality frameworks (Pobal, 2016).

2.4.2. Early Childhood Regulations

In addition to the expansion of the ECCE service, 2016 also saw an update to the regulations for the childcare sector in Ireland. The Childcare Act of 1991 (Early Years Services) Regulations 2016 (Department of Children and Youth Affairs, 2016) set minimum qualifications of QQI Level 5 for employees within the sector (QQI level 6 for those providing the ECCE scheme). Additionally, there are now 21 mandatory policies that services must have in place, as well as new guidelines for garda vetting and child protection, minimum indoor floor space requirements per child and requirements for outdoor space. Regulation of this sector is through Tusla, The Child and Family Agency, under the remit of the Department of Children and Youth Affairs (DCYA), who perform inspections of services guided by the childcare regulations, while the Department of Education and Skills (DES) conduct education-focused inspections in ECCE services, to ensure quality of education provision.

2.4.3. Early Childhood Curriculum Framework

Prior to 2009, the curriculum for EC education and care was largely undirected and unregulated (Flood and Hardy, 2013), and depended on the educational approach used (including Montessori, Steiner-Waldorf, HighScope, Play-based and Naíonra (Irish language groups)) with little standardisation or guarantee of quality (Government of Ireland, 1999; Daly and Forster, 2009). In order to agree on one national approach that honoured the values of different educational philosophies, the National Council for Curriculum and Assessment (NCCA) drew on the existing international research to inform their work in developing a curriculum framework. Aistear, the EC Curriculum Framework (NCCA, 2009) was developed in partnership with the EC sector, and acknowledges that introducing children to formal, direct education at a young age can suppress children's natural enthusiasm for learning. The Aistear framework emphasises enjoyable and challenging learning experiences through play, so that all children can grow and develop as competent and confident learners (NCCA, 2009).

Aistear, the Irish word for 'journey', establishes principles and goals for all EC services in Ireland to work towards. This national curriculum framework is based on 12 principles of early learning and development (concerning children's lives in EC, connections with

others and how children learn and develop) and is divided into 4 inter-connected themes of Well-being, Identity and Belonging, Communication and Exploring and Thinking. Within each theme are 4 aims, and 6 learning goals to achieve each aim. Aistear also describes the types of learning that are important for children in their early years, and offers ideas and suggestions as to how this learning may be nurtured for babies, toddlers and young children (NCCA, 2009).

2.4.4. Opportunities for PA and FMS within the Irish Curriculum Framework

While PA and motor skills are only mentioned briefly within the Aistear curriculum, this framework provides numerous learning goals within all four themes that could be achieved through PA. For example, “learning to work cooperatively with other children” and “understanding rules and boundaries”, within the Identity and Belonging theme, are both implicit within active play. A selection of these learning goals adapted from the National Childhood Network (2016) are presented in Table 2.6. below.

Table 2.6. Aistear learning goals related to PA and FMS

| | |
|---------------------------------|--|
| Well-Being | <p><i>Children will:</i></p> <ul style="list-style-type: none"> • Gain more control of their bodily movements and co-ordination. • Have fun and enjoyment. • Refine their fine and gross motor skills. • Children will develop their hand-eye co-ordination, and strengthen their muscles and bones. • Become more confident in taking risks. |
| Identity & Belonging | <p><i>Children will:</i></p> <ul style="list-style-type: none"> • Build strong relationships with their peers. • Learn to interact and work more co-operatively with adults and other children where they have many opportunities to learn from each other. • Show their increasing confidence and self-awareness. • Have an understanding of rules and boundaries |
| Communication | <p><i>Children will:</i></p> <ul style="list-style-type: none"> • Become more confident in their interactions with other children and adults by being an active listener and taking turns to communicate. • Expand their use of language through hearing and understanding new words. • Use their increasing language to ask questions, influence activities, give and receive information and negotiate with other children and adults, learn to problem solve. and to clarify their thinking, |
| Exploring & Thinking | <p><i>Children will:</i></p> <ul style="list-style-type: none"> • Clarify their thinking in making sense of spatial awareness, timing, and space. • Develop their cognitive skills while experiencing a broad range of physical activities. • Develop their skills and recognise their abilities to work with growing confidence. • Have new opportunities to engage in and explore their environment both indoors and outdoors with their newfound skills. • Work with others to share ideas, solve problems and reason with each other. |

(adapted from National Childhood Network, 2016)

2.4.5. Opportunities for PA and FMS within the Irish Early Years Regulations

Since the update of the childcare regulations in 2016, new ECCE services must ensure as part of Regulation 20(3) that the premises include a suitable, safe and secure outdoor space to which children attending the service have access on a daily basis, or a suitable alternative (DCYA, 2016). This is a positive addition to the regulations, as outdoor time has been shown to be positively associated with PA (Gray *et al.*, 2015; Bingham, Costa, Hinkley, *et al.*, 2016; Larouche, Garriguet and Tremblay, 2017). However, a recent investigation into outdoor play in ECCE settings found that out of a sample of 81 preschool educators in Ireland, only 6% cited insufficient outdoor space as a main barrier, with weather and parental attitudes seen as greater barriers to outdoor play (Murphy, 2015). This indicates that access to outdoor space alone may not be sufficient to impact outdoor play and PA, but shows the potential for policies and parental education to complement this space requirement.

An 'Outdoor Policy' is included as one of the 21 mandatory written policies that services must have (Regulation 10, Schedule 5), which at a minimum should detail the times at which preschool children attending the service have access to outdoor play, and how health and safety is ensured while engaging in outdoor play (DCYA, 2016). This type of policy could be an important opportunity to emphasise the important role of active outdoor play for children's learning and development to parents and staff.

Similarly, minimum requirements for staff qualification are positive, as higher levels of qualification of EC educators has been linked with better outcomes for children's learning and development (OECD, 2012). However, EC educators receive little training in terms of PA and FMS at any level of qualification, and the inclusion of modules acknowledging the importance of these areas vary by institution.

In contrast with other countries, the regulations and guidelines for ECCE services do not specifically require or support practitioners to specifically encourage PA and FMS opportunities. In Northern Ireland, under the 'Minimum Care Standards', EY settings are supported in meeting PA guidelines through training and guides such as the Chief Medical Officer's PA guidelines for the early years (Chief Medical Officers, 2011), and the Department of Education's curricular guidance on physical development and

movement (Institute of Public Health in Ireland and the Centre for Effective Services, 2016). Similarly, in England, the Early Years Foundation Stage was revised in April 2017 to specifically refer practitioners to the CMO guidelines, and emphasises the importance of PA for children, and the need to encourage physically active play (Department for Education, 2017)

2.5. Summary

In this literature review, the importance of PA participation and FMS proficiency in the early years has been explored at length. Globally, low levels of PA and proficiency in FMS have been observed for preschool children and despite evidence of low levels in Ireland for middle childhood and adolescence, levels of PA and proficiency in FMS for the EC population have not yet been measured. A PA guideline specific to children under 6 is needed in Ireland to highlight and clarify the PA needs of this population. Major differences in protocols for the measurement of PA using accelerometry in EC make it difficult to compare results across studies and therefore, standardised processes regarding epochs, cut points, and interpretation of the PA guidelines are needed to ensure comparability between studies internationally.

As this review has shown, the preschool years specifically have been shown to represent an important window of opportunity during which to establish positive PA behaviours and develop essential FMS. From reviewing the literature, it is clear that the ECEC sector provides the ideal context for interventions to ensure that children are provided with opportunities to develop these skills and take part in enjoyable PA that may impact on participation in PA throughout the lifespan. Previous PA and FMS interventions implemented in the preschool setting explored in this literature review highlight the importance of multi-component interventions addressing each level on the social-ecological framework and acknowledging the role of the environment, educators and parents. While there are few direct requirements for PA or FMS in the early years regulations or educator training programmes in Ireland, the Aistear curriculum framework provides numerous opportunities for educators to incorporate PA and FMS throughout day. Training educators in the importance of PA and FMS for health and development, and to recognise opportunities to use active play to achieve Aistear learning goals, may be a feasible approach for a PA and FMS intervention in ECCE services in Ireland.

2.6. References

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**Chapter 3: Physical activity and fundamental
movement skills of 3 to 5-year olds in Irish
Early Childhood Care and Education services**

3.1. Abstract

This study explores levels of physical activity (PA) and fundamental movement skills (FMS) of children aged 3 to 5 years old in Irish preschool services during care hours, and investigates the relationship between these two variables. Data were collected from 141 children (50.3% boys, mean age 3.9 ± 0.5 years) across 9 preschool services. Measurements include PA via accelerometry, and proficiency level in four FMS (run, vertical jump, throw and catch). The recommended guideline of 15 minutes PA per hour was met by 35% of children ($n=44$), with a mean of $13.6 (\pm 3.4)$ active minutes per hour. Significant differences in mean PA per hour were found by gender, with boys (14.2 ± 3 active minutes per hour) more active than girls (13.0 ± 3.5 active minutes per hour) and age groups, with younger children (14.2 ± 3.1 active minutes per hour) more active than older children (12.6 ± 3.4 active minutes per hour). Percentage of children proficient in the run was high (88.4%), but low across the selection of other skills (4.9-18.5%). Significant differences between genders were identified for the vertical jump only (girls raw score of 7.6 ± 1.6 versus boys raw score of 6.7 ± 1.9), and no differences between age groups existed for FMS. Low levels of PA and FMS proficiency highlight a need for a targeted intervention to ensure preschool children develop the skills to participate in PA through the lifespan.

3.2. Introduction

Physical Activity (PA), is defined as any bodily movement produced by skeletal muscle requiring greater energy expenditure than resting (Caspersen, Powell and Christenson, 1985). PA is important at all stages of life for physical and mental health (Penedo and Dahn, 2005; Warburton, Nicol and Bredin, 2006; Haskell, Blair and Hill, 2009; Scarborough *et al.*, 2011). Particularly for young children, PA through active play contributes to the development of cognitive function (Tandon *et al.*, 2016), social skills (Gehris, Gooze and Whitaker, 2015), and self-esteem (Ekeland, Heian and Hagen, 2005), alongside benefiting a range of physical health outcomes (Timmons *et al.*, 2012; Vale *et al.*, 2015; Ghazi *et al.*, 2016).

In Ireland, the PA guideline for children under six is encompassed by the guidelines for children and young people, which recommends that those aged 2 to 18 years achieve a total of 60 minutes of moderate to vigorous PA (MVPA) throughout the day every day (Department of Health and Children, 2009; Department of Health and Department of Transport, Tourism and Sport, 2016). Higher intensity PA such as MVPA, which causes heart rate and breathing to increase (Center for Disease Control and Prevention, 2011), has been shown to be important for older children, adolescents and adults (Arem *et al.*, 2015; Kyu *et al.*, 2016; Poitras *et al.*, 2016) though evidence for specific benefits of MVPA for children under six are lacking (Skouteris *et al.*, 2012; Pate *et al.*, 2013). It is also well understood that PA for young children mainly takes the form of active play, which occurs at all levels of intensity (Timmons, Naylor and Pfeiffer, 2007; Tandon, Saelens and Christakis, 2015). As such, recent specific guidelines for children under six years of age focus on all daily movement, which includes lighter intensity activities (Commonwealth of Australia, 2010; Chief Medical Officers, 2011; Tremblay *et al.*, 2012). National PA guidelines, specifically for children under six years of age have been published in the UK, Australia and Canada recommending that children participate in 180 minutes of PA at any intensity, spread across the day during their early years (Commonwealth of Australia, 2010; Chief Medical Officers, 2011; Tremblay *et al.*, 2012). A guideline of 15 minutes per hour (mins/hr) of PA at any intensity has also been suggested by the Institute of Medicine (IOM), for all hours that children are in childcare (Institute of

Medicine, 2011), which corresponds to the 180 mins/day guideline, extrapolated across 12 waking hours.

Learning to move is a necessary skill underlying PA participation (Stodden *et al.*, 2008; Jaakkola *et al.*, 2016), and as well as the myriad of physical health and developmental benefits, PA provides an opportunity for young children to experience and develop essential gross motor skills (Pica, 2011; Laukkanen *et al.*, 2014; Lin, Cherng and Chen, 2017). In particular, a specific group of basic movement patterns called fundamental movement skills (FMS) have been shown to play a crucial role in PA participation throughout the lifespan, with a reciprocal relationship hypothesised (i.e. more PA provides increased opportunities to develop FMS, leading to mastery in a range of skills which may increase opportunities to take part in PA) (Stodden and Goodway, 2007). FMS are subdivided into categories of locomotor skills (which involve propelling the body through space, such as running and jumping) and object control skills (which require propelling or receiving an object through space, such as throwing and catching), which once mastered can be combined and adapted in different ways to produce more complex movements (Gallahue, Ozmun and Goodway, 2012). These skills are often described as the 'ABCs' or 'building blocks' of movement (Clark and Metcalfe, 2002; Goodway and Robinson, 2006). It has been suggested that children have the capacity to develop most of these skills by the age of six years old (Gallahue and Ozmun, 2006), but while there is a prevalent belief that children develop these skills naturally over time, achieving mastery in these skills requires both teaching and practice (Clark, 2007; Liong, Ridgers and Barnett, 2015; Barnett *et al.*, 2016). Most recent research suggests that failure to reach a sufficient level of proficiency in FMS during childhood can impact negatively on PA participation throughout the lifespan (Robinson *et al.*, 2015).

The preschool years (ages 3 to 5) are emphasised as an essential period for children to practice and learn specific movement patterns through PA (Colella and Morano, 2011; LeGear *et al.*, 2012). This period has been described as a 'window of opportunity' for development of FMS and positive PA behaviours, specifically due to an optimum combination of malleable health behaviour (Skouteris *et al.*, 2012), neural development (Fischer and Rose, 1998; Haywood and Getchell, 2009), and propensity to attempt and persist with activities at this stage of life (LeGear *et al.*, 2012). As such, the important

role of early childhood (EC) care and education services has been highlighted, with this context ideally positioned to both teach and encourage PA and FMS from an early age (Tucker and Irwin, 2010; Goldfield *et al.*, 2012; Hinkley *et al.*, 2016; Lindsay *et al.*, 2017).

In Ireland, there is a paucity of data regarding PA and FMS levels of children in the preschool years, as available research to date has focussed on school-aged children (Harrington *et al.*, 2016). Low levels of PA have been identified for Irish children and young people, with research suggesting that only 19% of primary school children, and 12% of post-primary school children are meeting the national guideline for children and youth of 60 minutes MVPA per day (Woods *et al.*, 2010). Similarly, markedly low levels of FMS proficiency have been identified in Irish primary school children (Bolger *et al.*, 2017) and youth, with a recent study highlighting that only 0.5% of a sample of 256 11-12-year olds achieved mastery, and 11% achieved near mastery in the 9 FMS tested (Belton *et al.*, 2014). As PA and FMS levels tend to track from EC through to middle childhood and adolescence (McKenzie *et al.*, 2002; Jones *et al.*, 2013; Telama *et al.*, 2014), this would suggest that children in Ireland are not developing FMS proficiency and establishing positive PA behaviours from a young age.

Since 2011, children of preschool age in Ireland have been entitled to one year of free early education and care. Universal access is assured through the State-funded Early Childhood Care and Education (ECCE) scheme. Since September 2016, this scheme has been expanded from one to two years, with approximately 95% of eligible children participating in the scheme (Pobal, 2016). As such, the potential for ECCE services to positively influence PA and FMS behaviours through the teaching, facilitation and encouragement of active play and associated skills is pivotal. This paper aims to fill a gap in current knowledge by investigating levels of PA and FMS of children in preschool services in Ireland, and exploring the relationship between these two variables. It will also compare these levels with those of preschool children internationally.

3.3. Methods

3.3.1. Participant Recruitment

This study presents cross sectional data, taken at baseline, from a larger intervention study called 'Kids Active'. Baseline Kids Active assessment took place in March 2016. Ethical approval for the study was obtained from the Dublin City University Research Ethics Committee (DCU/REC/2016/013). All researchers involved in the project completed Garda vetting either through Early Childhood Ireland or Dublin City University in line with Child Protection requirements.

Services offering the ECCE scheme in Dublin were recruited to take part in the physical data element (i.e. measurement of BMI, PA, and FMS) of the Kids Active programme through Early Childhood Ireland. Services that offered the ECCE scheme, had at least one designated ECCE room, and were current members of Early Childhood Ireland were invited to fill out an expression of interest form on the Early Childhood Ireland website in January 2016, which was publicised through their member newsletters and social media. A total of 31 expressions of interest were received, from which 10 were chosen for inclusion in the study. In 2016, the ECCE sector was comprised of 76% private settings and 24% community settings (Pobal, 2017). In an effort to represent this ratio in the Kids Active study, 7 private services and 3 community services were randomly chosen and randomly assigned to the intervention or control group. One intervention service was subsequently unable to take part in the study due to scheduling conflicts, leaving a total of 9 services, with 2 ECCE groups included instead of 1 from an existing intervention services (community service). These services represent a cross section of ECCE types, with a variety of pedagogical approaches including Montessori, High-Scope and play-based. As required for inclusion in the ECCE scheme, all services utilised the Aistear national early years curriculum framework (National Council for Curriculum and Assessment, 2009) which ensured that despite different ethos or approaches, all services followed the same curriculum framework.

After selection, the manager of each participating ECCE service was telephoned by a Research Officer from Early Childhood Ireland to discuss the expectations and timeline for the research in detail, give the manager an opportunity to ask any questions and

confirm participation. Each service was then furnished with a participation pack from Early Childhood Ireland, which included an explanatory cover note outlining the documents that should be distributed to parents/guardians of children in the service and participating staff in the service. For staff, this included a plain language statement and informed consent clearly outlining why the research was being conducted, what it would involve (both completing a questionnaire exploring educator confidence to teach PA and facilitating physical data collection sessions with the children before and after the intervention) and who was responsible for the research, with contact details for the Early Childhood Ireland Research Officer and DCU Principal Investigators.

For each family, this included a cover letter from Early Childhood Ireland and DCU explaining the study and what their child's participation would require, along with a plain language statement and informed consent form which clearly explained all of the physical tests that would be involved and that the signature of a parent or guardian would be required in order for a child to participate in the research. These documents also clarified that participation was not mandatory, children were not obliged to take part in any aspects of the testing that they did not want to and there would be no consequences for opting out of the research. As with the staff informed consent and plain language statement, contact details for the researchers involved and the DCU research ethics committee were provided to ensure that families could contact the researchers at DCU or Early Childhood Ireland if they had any queries or concerns.

On the days of testing, verbal assent was obtained from the children themselves, with some children choosing not to take part in specific elements of the testing on the day.

3.3.2. Measures

Data were collected on-site at each service by two trained postgraduate researchers during ECCE hours. Training for this testing was conducted for a total of four researchers in DCU in February 2016 and overseen by a lecturer with expertise in measurement of PA and motor skills, and a PhD candidate with two years of experience of data collection in the field using the same battery of tests. Height and weight measurements were

practiced on second year physical education undergraduate students over three two-hour practical classes until both inter-rater and intra-rater scores were within 95% agreement. For the TGMD-2 the four researchers were trained to conduct the four skills tests by the PhD candidate over two one-hour sessions. The primary researcher completed a pilot testing session accompanied by the PhD candidate at a local ECCE service to ensure that the TGMD-2 and accelerometer protocols were followed correctly. The four trained researchers completed Garda Vetting through DCU prior to the commencement of their postgraduate studies.

Each testing session lasted approximately 2 hours for BMI and FMS measurement, with accelerometers distributed at the end of the testing session for wear over the following two weeks. A researcher visited the service at the end of the two weeks to collect the accelerometers. Details on all measures taken are given below.

3.3.2.1. Height and Weight

Weight status according to body mass index (BMI) was assessed through measurement of standing height (measured with Leicester Height Measure to the nearest 0.1cm) and weight (measured with Seca mechanical weighing scales to the nearest 0.1kg). Both measures were taken without shoes. BMI was calculated as weight in kilograms divided by the square of the height in metres (kg/m^2).

3.3.2.2. Physical Activity

ActiGraph GT1M and GT3X accelerometers were utilised for measuring PA, and sedentary behaviour (SB), set to record 10-second epochs in order to capture the short sporadic bursts of PA, characteristic of preschool children (Dwyer, Baur and Hardy, 2009). The devices were worn on the hip using elasticated belts for the duration of the ECCE day at the service. A trained researcher fitted the belts to the children, while demonstrating to the educators how to secure the belts, and the exact position to be worn (over the iliac crest of the right hip). Educators were asked to put the belts on each child (with each monitor coded for each individual child) as they arrived in the morning and remove it before they went home. In consideration of the fact that not all children in the ECCE services attended every day, the educator was asked to put the belts on

each child for a total of any five days over a two-week period. At the end of this two-week period, a member of the research team collected the monitors for downloading and data processing.

3.3.2.3. *Fundamental Movement Skills*

Four FMS were assessed consisting of two locomotor skills (run and vertical jump) and two object control skills (catch and overhand throw). Three of these skills were assessed in line with guidelines from the Test of Gross Motor Development-2 (Ulrich, 2000) and the Victorian Fundamental Motor Skills Manual (Department of Education Victoria, 1996). The TGMD-2 provides good test-retest reliability in EC ($r = .88$) (Valentini, 2012), with high internal consistency (Cronbach's alpha .85 to .91) (Cools *et al.*, 2009). Collection of FMS data followed the protocol previously established for a study investigating FMS in Irish children (O'Brien, Issartel and Belton, 2013; Belton *et al.*, 2014). For each testing session, children were divided into groups of 5 (± 1). For each skill, children received a demonstration and a description of the skill to be performed. Participants performed each skill three times which included one practice and two performance trials. No verbal feedback was provided during the testing. Video cameras recorded each participant's performance, for which scoring was completed at a later date. In accordance with the TGMD-2 and Victorian Fundamental Motor Skills Manual (Department of Education Victoria, 1996; Ulrich, 2000), each skill consisted of qualitative performance criteria to describe the movement pattern of the skill. If a child performed a skill correctly, a score of one was recorded, and if performed incorrectly, the score was recorded as zero. This scoring was performed by trained researchers, who achieved 95% inter-rater agreement with an expert scorer, prior to the commencement of participant data scoring. Raw scores of each FMS were obtained by summing the scores of the criterion of the two performance trials (run, vertical jump, catch and overhand throw; maximum scores of 8, 12, 6 and 8 respectively, combined locomotor skills; maximum score of 20, combined object control skills; maximum score of 14, total FMS; maximum score of 34).

3.3.3. Data Processing

BMI percentiles were calculated relative to gender and age using the Centre for Disease Control and Prevention (CDC) Children's BMI tool based on CDC growth charts (Kuczmarski *et al.* 2002). Weight status was classified according to percentile as 'underweight' (<5th percentile), 'normal weight' (5-85th percentile), or 'overweight or obese' (\geq 85th percentile) (Center for Disease Control and Prevention, 2000; Kuczmarski *et al.*, 2002). This approach has been used to classify weight status in similar studies involving the same age group (Trost *et al.*, 2003; Bellows *et al.*, 2013; Pate *et al.*, 2015; Tucker *et al.*, 2016). As results indicated that only two children were classified as 'underweight', therefore, weight status was collapsed into a binary variable of 'not overweight or obese' and 'overweight or obese'. Similarly, the sample contained only two five-year olds (representing 1.2% of the sample; aged 5.1 and 5.3 years), and as a result, age categories were classified as children under-four-years of age, and children four-years of age or older for analysis (<4 or ≥ 4).

Accelerometer data were processed using ActiLife software version 6.13.3. Only data from the y-axis across both accelerometer models (GT1M and GT3X) were used in the study, as it has been shown to be comparable across monitors (Sasaki *et al.*, 2011). Minimum wear time for inclusion in analysis was set at ≥ 150 minutes (2.5 hours out of the 3 hour ECCE preschool day, allowing for time to put on and remove the belts) for a minimum of 3 days. Periods of 60 minutes or more of continuous zeros were considered as non-wear time, and excluded from analysis (Colley *et al.*, 2013; Pfeiffer *et al.*, 2013). Cut points developed for preschool children by Pate and colleagues (2006) were applied to determine minutes of Sedentary (Sed) (0 to 799 counts per minute (CPM)) and PA of intensities light (LPA) (800 to 1679 CPM), moderate (MPA) (1680 to 3367 CPM) and vigorous (VPA) (≥ 3368 CPM). Intensities were also combined to give an overview of total time in higher intensity activity (MPA + VPA = MVPA) and total PA at any intensity (LPA+ MPA + VPA = LMVPA). Average daily minutes per hour (mins/hr) at each intensity were calculated for each participant, taking into account the number of days and total number of hours for which accelerometer data was captured, relative to each participant's wear

time. The proportion of children meeting the IOM guideline of 15 mins/hr was calculated based on mean hourly LMVPA (Institute of Medicine, 2011).

A binary variable called 'mastery and near mastery' (MNM) was also created for each of the four FMS. MNM for each skill represents children who had achieved mastery (defined as correct performance of each skill component on both trials) and near mastery (defined as correct performance of all but one of the skill components on both trials), in line with previous studies (Van Beurden *et al.*, 2003; O'Brien, Issartel and Belton, 2013), to assess the proportion of children proficient in each skill.

All digital data was stored on two designated password-protected external hard drives and hard copies stored in a locked filing cabinet accessible only to the main researchers, in accordance with the data protection protocols of the DCU Research Ethics Committee. Data was saved to the main external hard drive each time processing or analysis took place and backed up to the second external hard drive weekly. All physical data was recorded on pen and paper during testing sessions (or later analysis of videos) and inputted into Microsoft Excel by the main researcher. A second researcher assisted with data verification by choosing 30 ID codes at random from each results sheet and checking that the data in Excel corresponded to that in the originally recorded results.

3.3.4. Statistical Analysis

All data were analysed using IBM SPSS Statistics 23, with alpha set at $p < .05$. Main outcome variables analysed were mean PA mins/hr at each intensity, and FMS proficiency (for each of the four skills individually, for the four skills combined, as well as for locomotor and object control subsets separately). Independent-samples t-tests were conducted to assess the impact of weight status on both mean PA mins/hr and FMS raw scores.

Two-way between-groups ANOVA were computed to explore the impact of the independent variables gender and age on both mean PA mins/hr and FMS proficiency scores. To estimate the ANOVA effect sizes, partial eta squared (PES) were additionally

computed and interpreted according to guidelines by Cohen (1988) of .01 = small, .06 = moderate and .14 or above = large.

Additionally, categorical dependent variables were analysed which included the proportion of children meeting the IOM guidelines and proportion of children achieving MNM for each of the four skills. Chi-square tests for independence were used to examine whether differences existed by independent variables age and gender for percentage of children meeting the IOM guideline, or achieving MNM for each of the four individual FMS.

Pearson correlations were used to test for associations between each of the FMS variables (raw skill scores individually, total FMS gross score, locomotor and object control subset scores) and mins/hr PA at different intensities. This was repeated for the sample overall, then split by each variable of age, gender and weight status. Associations between raw BMI score, PA mins/hr, and FMS proficiency scores were also investigated using Pearson correlations overall, by age and by gender. Strength of any significant correlations were classified according to Evans (1996), as very weak ($r = 00$ to $.19$), weak ($r = .20$ to $.39$), moderate ($r = .40$ to $.59$), strong ($r = .60$ to $.79$) or very strong ($r = .80$ to 1.0)

3.4. Results:

From a potential sample of 216 children, a total of 141 participated in the Kids Active research, with an overall response rate of 65.3%. There was a slightly higher response rate from intervention services overall (72.2% versus 60.3% for control services) but this was mainly due to a high response from two small intervention services. Response rates by service are presented in Table 3.1.

Table 2.1. Response Rates from the selected ECCE services

| | | Service Type | Number of children in selected ECCE rooms | Number of children who participated in Kids Active research | Response rate |
|---------------------|-----------------------------|--------------|---|---|---------------|
| Control | Control service 1 | Private | 27 | 14 | 56.0% |
| | Control service 2 | Private | 25 | 15 | 60.0% |
| | Control service 3 | Community | 24 | 15 | 62.5% |
| | Control service 4 | Private | 25 | 16 | 64.0% |
| | Control service 5 | Private | 25 | 16 | 64.0% |
| | Control services total | | 126 | 76 | 60.3% |
| Intervention | Intervention service 1 | Community | 40 | 24 | 60.0% |
| | Intervention service 2 | Private | 20 | 14 | 70.0% |
| | Intervention service 3 | Community | 15 | 13 | 86.7% |
| | Intervention service 4 | Private | 15 | 14 | 93.3% |
| | Intervention services total | | 90 | 65 | 72.2% |
| Overall | Total | | 216 | 141 | 65.3% |

As there is a specific age criteria for eligibility for the ECCE scheme, all children enrolled in this scheme were between 3 and 5 years old at the time of testing. Census data indicates that in Ireland, there is a small proportion more boys than girls aged 0-9 years, with approximately 1020 boys per 1000 girls in this age group (Central Statistics Office, 2017). For representativeness, this is reflected in the Kids Active sample with a proportion of 50.4% boys and 49.6% girls. Similarly, the sample initially aimed to reflect the proportion of private and community services in the ECCE sector (74% private, 26% community) (Pobal, 2017), though extra participants from one community service (Intervention service 1 above) were recruited after a private service was unable to take part. As a result 36.9% (n = 52) of the sample were from community services with 63.1% (n = 89) from private services. Due to the age of the children, some participants did not want to take part in all elements of the testing, with numbers included in each analysis

varying (anthropometric data n = 141; PA data n = 126 and total FMS data n = 124). A total of 19.1% of the sample were classified as overweight or obese. Average wear time for accelerometers was 5.1 ± 2 hours per day. Independent-samples t-tests indicated no significant differences between children who were overweight or obese, and children who were not overweight or obese for any of the PA or FMS variables. Participant characteristics are presented in Table 3.2.

Table 3.2. Characteristics of the Study Sample (Mean \pm SD)

| | Total (141) | Boys (71) | Girls (70) |
|--------------------------------|--------------------|------------------|-------------------|
| Age (years) | 3.9 (.47) | 3.9 (.46) | 4 (.48) |
| Height (m) | 1.02 (.05) | 1.03 (.05) | 1.01 (.05) |
| Weight (kg) | 16.7 (2.4) | 17.3 (2.6) | 16.1 (2.2) |
| BMI (kg/m²) | 15.9 (1.6) | 16.2 (1.9) | 15.7 (1.2) |
| Not overweight or obese | 80.9% | 76.1% | 85.7% |
| Overweight or obese | 19.1% | 23.9% | 14.3% |

3.4.1. Physical Activity

The mean minutes per hour of PA at each intensity, and the percentage of children who met the IOM guideline of 15mins LMVPA/hr during standard ECCE hours are presented in Table 3.3, with results of the two-way (age, gender) ANOVA and chi-square test for independence.

Table 3.3. Mean (\pm SD) PA mins/hr and percentage of children meeting the PA guideline

| | Boys | | Girls | | Sig. | Effect Size |
|----------------------------|--------------|--------------|--------------|--------------|----------------------------|--------------|
| Age | <4 | ≥ 4 | <4 | ≥ 4 | <i>p</i> | PES |
| <i>N</i> | <i>N</i> =32 | <i>N</i> =27 | <i>N</i> =33 | <i>N</i> =34 | | |
| Mins/hr Sed | 45.1 (2.9) | 46.5 (3.0) | 46.5 (3.3) | 47.7 (3.7) | (age) .029* (gen) .030* | .039 .038 |
| Mins/hr LPA | 6.3 (1.0) | 5.8 (1.0) | 5.9 (1.3) | 5.4 (1.1) | (age) .016* | .046 |
| Mins/hr MPA | 5.4 (1.2) | 4.8 (1.2) | 4.9 (1.3) | 4.3 (1.4) | (gen) .031* (age) .013* | .037 .050 |
| Mins/hr VPA | 3.3 (1.0) | 2.9 (1.1) | 2.7 (1.0) | 2.6 (1.6)) | (gen) .044* | .033 |
| Mins/hr MVPA | 8.6 (2.1) | 7.7 (2.1) | 7.6 (2.2) | 6.9 (2.7) | (gen) .028* | .039 |
| Mins/hr LMVPA | 14.9 (2.9) | 13.5 (3.0) | 13.5 (3.3) | 12.4 (3.7) | (gen) .030* (age) .029* | .038 .039 |
| Meeting 15min/hr guideline | 46.9% | 29.6% | 36.4% | 26.5% | .328 | |

Note: gen = main effect for gender; age = main effect for age; PES = partial eta squared * $p < .05$

Results of the two-way between-groups ANOVA exploring the impact of gender and age on mins/hr of PA indicated no statistically significant interaction effect between gender and age at any intensity. Statistically significant main effects were found for age at Sed [$F(1, 122) = 4.9, p = .029$], LPA [$F(1, 122) = 5.9, p = .016$], MPA [$F(1, 122) = 6.4, p = .013$] and LMVPA [$F(1, 122) = 4.9, p = .029$] with small effect sizes of PES between .039 and .05. Overall, children in the younger age group were generally less sedentary, and more active than those in the older group for Sed, LPA, MPA and LMV, but not VPA or MVPA.

Statistically significant main effects were also found for gender at Sed [$F(1, 122) = 4.8, p = .030$], MPA [$F(1, 122) = 4.8, p = .031$], VPA [$F(1, 122) = 4.1, p = .044$], LMVPA [$F(1,$

122) = 4.8, $p = .030$] and MVPA [$F(1, 122) = 5.0, p = .028$] with small effect sizes of PES between .033 and .039. Overall, boys were less sedentary and more active than girls at all intensities except LPA.

In terms of meeting the 15 mins/hr guideline, boys in the younger age category were the most active group, with 46.9% meeting the PA guideline, compared to only 26.5% of girls in the older age group. Despite this, chi-squared tests for independence revealed no significant association between meeting the PA guideline by age and gender [$\chi^2(1, n = 126) p = .328, \phi = .165$].

3.4.2. Fundamental Movement Skills

Mean FMS raw scores (SD) and percentage of children achieving MNM for each of the four skills by age and gender are presented in Table 3.4. Results of the two-way between-groups ANOVA exploring the impact of gender and age on FMS raw score indicated no statistically significant interaction effects for any of the skills individually or combined. There was a statistically significant main effect for gender for the skill of vertical jump [$F(1, 120) = 6.7, p = .011$] with a small effect size (PES = .53). In this case, when not classified by age group, girls achieved a higher raw score for vertical jump (7.6) than boys (6.7).

Percentage MNM for the full sample was found to be 88.4% for run, 5.7% for vertical jump, 4.9% for throw and 18.5% for catch. Chi-squared tests for independence indicated no significant association between MNM by age or gender for any of the four skills.

Table 3.4. Mean (\pm SD) raw FMS scores and percentage of children achieving MNM

| | Boys | | Girls | | Sig. | Effect size |
|---|-----------|------------|------------|------------|----------------|-------------|
| Age | <4 | ≥ 4 | <4 | ≥ 4 | <i>P</i> | PES |
| <i>N</i> | 41 | 30 | 39 | 28 | | |
| Run raw score (maximum score 8) | 6.9 (1.0) | 7.1 (1.0) | 7.0 (1.3) | 6.6 (1.3) | .169 | |
| Run MNM | 82.9% | 93.3% | 89.7% | 89.3% | .572 | |
| <i>N</i> | 41 | 30 | 41 | 29 | | |
| Jump raw score (maximum score 12) | 6.7 (1.8) | 6.7 (1.9) | 7.1 (1.8) | 8.0 (1.4) | (gen) .011* | .053 |
| Jump MNM | 7.3% | 3.3% | 2.4% | 10.3% | .476 | |
| <i>N</i> | 40 | 29 | 43 | 32 | | |
| Throw raw score (maximum score 8) | 2.6 (1.6) | 2.7 (1.7) | 2.6 (2.1) | 2.7 (1.9) | .884 | |
| Throw MNM | 2.5% | 3.4% | 7% | 6.3% | .763 | |
| <i>N</i> | 42 | 29 | 42 | 32 | | |
| Catch raw score (maximum score 6) | 2.1 (1.3) | 2.6 (1.4) | 2.1 (1.3) | 1.9 (1.4) | .888 | |
| Catch MNM | 22% | 15.6% | 16.7% | 19.4% | .893 | |
| <i>N</i> | 40 | 28 | 42 | 30 | | |
| Object control raw score (maximum score 14) | 4.8 (2.0) | 5.3 (2.6) | 4.7 (2.9) | 4.7 (2.9) | .460 | |
| <i>N</i> | 40 | 29 | 39 | 27 | | |
| Locomotor raw score (maximum score 20) | 13.9 (3) | 18.8 (3.5) | 14.1 (2.1) | 14.5 (2.0) | .395 | |
| <i>N</i> | 38 | 25 | 38 | 23 | | |
| Total raw score (maximum score 34) | 18.6 (3) | 18.8 (3.5) | 19.0 (3.9) | 18.8 (2.3) | .774 | |

Note: gen = main effect for gender; PES = partial eta squared **p* < .05

3.4.3. Relationship between Fundamental Movement Skills and Physical Activity

Significant weak negative correlations were found between total FMS score and both MPA ($r = -.205$) and LPA ($r = -.219$) for the full sample. Significant weak negative correlations were also found for boys between catch and LPA ($r = -.292$), and for three-year olds between total FMS score and both LPA ($r = -.295$) and LMV ($r = -.282$), with weak positive correlation for total FMS score and Sed ($r = .282$).

3.5. Discussion

Overall, only 35% of children met the guideline of 15 mins/hr LMVPA during ECCE hours. In contrast to this, a recent study in the UK (Hinkley *et al.*, 2016) indicated that 99.1% of a sample of 731 children met the guidelines on an average day during care hours. In this study, Hinkley and colleagues objectively measured PA with ActiGraph accelerometers, but a cut point of 100 CPM was utilised to distinguish SB from PA. This is a significantly lower threshold than the <799 CPM used to classify SB in the current study, indicating that SB may have been underestimated, in comparison with our results.

The absence of differences in PA behaviour by weight status reported in this sample is similar to a recent Canadian study in which no differences for PA during preschool hours were found between overweight and non-overweight children in a sample of 216 children (Tucker *et al.*, 2016). In contrast with this, Trost and colleagues (2003) in the USA identified significant differences in PA by weight status for 3 to 5 year old boys only, with overweight boys significantly less active than their normal weight peers, though this was before the introduction of the 180 minutes LMVPA guideline specifically for early years, and as such PA was defined as MVPA with no analysis of LMVPA.

The results of this study indicate differences in PA behaviour by gender, with boys appearing to be significantly more active than girls. Similar results have been found in numerous studies of children aged 3 to 5 years old, with boys participating in significantly more LMVPA (Hesketh *et al.*, 2014; Rice and Trost, 2014; Caldwell *et al.*, 2016) and MVPA (Vale *et al.*, 2010; Hinkley *et al.*, 2012; Rice and Trost, 2014) than girls.

Interestingly, a study in the UK (Hesketh, Griffin and van Sluijs, 2015) found that objectively measured PA was comparable between boys and girls during time at home, but boys were significantly more active than girls during time in the preschool setting. Hesketh and colleagues (2015) suggest that this is indicative of children's innate preferences for different types of activities, as the regulatory standards for EC services in the UK emphasise a child-led approach and children are encouraged to self-select activities. Evidence confirms that boys tend to engage in more high intensity activities like rough-and-tumble play, and girls tending to favour light intensity activities like playing with dolls (Pellegrini and Smith, 1998; Barbu, Cabanes and le Maner-Idrissi, 2011). As these tendencies are most likely influenced by inadvertent stereotyping of activities (Hinkley *et al.*, 2012; Hesketh, Griffin and van Sluijs, 2015; Morley *et al.*, 2015), the important role of parents and carers in addressing this trend is emphasised to ensure that all children are encouraged to partake in different types of active play regardless of gender.

In terms of age, previous evidence (Rice and Trost, 2014) has pointed to older preschool children being more active than younger children. Results of our study, however, show that younger children were significantly more active than older children overall, which was influenced by the difference between ages for LPA and MPA, with no differences in the higher intensities of VPA or MVPA. Research has shown that high intensity activity accounts for only a small proportion of preschool children's activity, with as little as 1.8% of time in VPA, and 5.5% of daily activity in MVPA. (Pate *et al.*, 2008; Bornstein *et al.*, 2011). The present results concur with these findings, as the data suggests that younger children may engage in more PA overall through lighter intensity activities. While MVPA is highlighted as the target intensity for school-age children, adolescents and adults, PA at any intensity is beneficial for children of this age, in line with previous guidelines for early years PA (Chief Medical Officers, 2011). It is suggested that future studies investigating PA of children in ECCE should compare PA levels of 3, 4 and 5-year-olds to explore if this finding of PA decreasing for older preschool children extends to other studies or is unique to this sample.

Previous research has highlighted differences in FMS by gender, with studies utilising the TGDM-2 for preschool children in Australia indicating that girls tend to outperform

boys in locomotor skills (Cliff *et al.*, 2009; Hardy *et al.*, 2010) and boys tend to score significantly higher than girls in object control skills (Hardy *et al.*, 2010). In Iran however, no significant differences were found between boys and girls for locomotor or object control skills using the same instrument (Kordi *et al.*, 2012). While differences were not found for gender overall in the current study, the finding that girls scored significantly higher in the vertical jump is in keeping with the literature, even if the magnitude of this difference was not enough to influence overall locomotor differences. The fact that only one of the four FMS tested showed significant differences by gender may more strongly reflect societal expectations than physical abilities, as it has been suggested that biological differences between genders that may impact on skill performance are not prominent before puberty (Malina, Bouchard, and Bar-Or 2004). Therefore a child's FMS development may depend on societal and environmental factors such as gender stereotyped games and social expectations which (Saraiva *et al.* 2013) which may not be ingrained at this early age.

When analysed by age, these FMS results indicate no significant differences for any of the four FMS tested, contrary to the research that older children achieve higher proficiency in FMS than their younger counterparts (Williams *et al.*, 2008).

These findings are concerning, as it highlights that preschool children in this setting are not improving in their FMS during the years that are considered the 'window of opportunity', and adds weight to the argument that FMS do not just emerge naturally over time (Clark, 2007). In order to reach sufficient proficiency in FMS to allow children to take part in, and enjoy PA throughout their lives, interventions at this age are warranted, while this 'window' is still metaphorically open (LeGear *et al.*, 2012). Compared to the other skills, a high proficiency level was identified for the run, reflective perhaps of this being a skill that children get more opportunities to engage in, and practice through active play.

In comparing raw FMS scores to those presented for preschool children internationally, the current sample achieved similar results for throw (raw score 2.7) to a sample of 41 children in Switzerland (raw score 2.8) (Donath *et al.*, 2015), though lower on the catch (Irish sample scored 2.2 while the Swiss sample scored 3.4). Mean raw score for run (6.9) was also slightly above results of a study in the USA, in a sample of 71 children who

achieved a mean raw score of 6.3 (Alhassan *et al.*, 2012), but were lower than an Australian sample of 425 four-year olds who achieved a mean score of 7.4 (Hardy *et al.*, 2010). Results from the research by Hardy and colleagues (2010) also indicates higher mean scores than the Irish sample for throw (3.5 vs 2.7) and catch (4.0 vs 2.2), while girls in the Irish sample scored higher in the throw than a sample of 54 girls in the USA (2.6 vs 0.32) and slightly lower results for catch (2.0 vs 2.5) (Veldman *et al.*, 2017). This shows that there is a need for targeted intervention in the early years, as Irish children are already falling behind their international counterparts in FMS proficiency. ECCE is an ideal setting to intervene as research consistently shows that intervention in the early years is a worthwhile investment (Nores and Barnett, 2010; Barnett and Nores, 2015; Tanner, Candland and Odden, 2015). The availability of two free ECCE years in Ireland means that FMS intervention at this level could potentially reach all children in Ireland.

Previous studies investigating the relationship between PA and FMS for preschool children have shown mixed results, with some evidence of a link between higher intensity (MVPA) activities and object control skills (Cook, 2012), locomotor skills (Williams *et al.*, 2008) and FMS overall (Williams *et al.*, 2008). In the current sample, some significant correlations were found indicating that higher FMS proficiency may be weakly associated with less time in LPA and MPA, though no corresponding relationship between FMS and higher intensity activity was identified. The proposed nature of this relationship is captured in a study by Barnett and colleagues (2016), in which children's PA and FMS data were measured at ages 19 months, 3.5 and 5 years. In this case, MVPA at 3.5 was associated with locomotor skills at age 5, with the conclusion that previous time in PA may be more important to current skill level than current PA. Similarly, Williams and colleagues (2008) found correlations between total FMS and PA for 4-year olds but not 3-year olds. Stodden (2008) hypothesises that FMS and PA are weakly related in EC, and the strength of the relationship between these two variables increases as children age and develop, with research indicating that FMS developed in childhood are important for participation in PA in adolescence (Robinson *et al.*, 2015). While a reciprocal relationship between PA and FMS are proposed, the uni-directional relationship (i.e. increased PA leads to the development of FMS) may be a more important focus for young children, as PA provides the context and opportunity to

practice and increase proficiency in FMS (Colella and Morano, 2011). It is expected that the relationship in the other direction (i.e. higher FMS proficiency enabling greater participation in PA) would strengthen in middle childhood, and beyond (Logan *et al.*, 2015).

This is an important consideration, as it indicates that while proficiency in FMS may facilitate participation in PA in later years (Robinson *et al.*, 2015), participation in PA in the early years is essential for practicing and refining these FMS (Lopes *et al.*, 2011). That is to say, although there is no clear relationship between PA and FMS for the current sample at this timepoint, it could be hypothesised that high levels of PA at this age would be associated with greater FMS proficiency at later ages, due to increased opportunities to learn and use these skills. Mutually, higher proficiency in FMS at this timepoint could be associated with greater PA participation in later years, though a lack of evidence exists for this relationship, and longitudinal studies are warranted to investigate how this relationship develops over time. Interventions targeting both PA and FMS simultaneously would be worthwhile for this population to ensure that all children get the opportunity to reach their physical potential. While a focus on PA mainly would be justified based on these findings, it is suggested that FMS is also incorporated into the preschool learning environment to ensure that learning of FMS is supported.

3.6. Conclusion

The low proportion of children meeting the guidelines for PA during ECCE hours and alarmingly low FMS proficiency indicates that children, in the ECCE setting in Ireland, are insufficiently active for health, movement and developmental benefits. As research indicates that FMS do not emerge naturally, teaching, feedback and opportunities to practice are essential to achieve mastery in these skills. Therefore, an intervention is warranted in this population to ensure that children achieve proficiency in FMS through PA in the form of active play, while they are still in the prime stage of life to develop these skills.

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Chapter 4: Kids Active: Evaluation of an educator-led active play and fundamental movement skill intervention in the Irish Early Childhood Care and Education setting

Manuscript submitted as:

Duff, C., Issartel, J., O'Brien, W. Belton, S. (*European Early Childhood Education Research Journal – Submitted for Review*). ***Kids Active: Evaluation of an educator-led active play and fundamental movement skill intervention in the Irish preschool setting.***

4.1. Abstract

The Kids Active programme aims to increase Physical Activity (PA) and Fundamental Movement Skills (FMS) levels of children in preschool services in Ireland through training educators to encourage active play opportunities. This study evaluates the impact of a 6-week pilot programme on educator confidence as well as children's PA levels and FMS proficiency. Educators' (n = 32) confidence to teach PA was measured through questionnaire, while data (BMI, PA via accelerometry and proficiency in four FMS; run, vertical jump, overhand throw and catch) was collected from 141 children (mean age 3.9 ± 0.5 years; 50.3% boys, 49.7% girls) in 5 intervention and 4 control services. Educators in the intervention group achieved significantly higher confidence scores at post-testing in comparison to the control group. All children decreased sedentary behaviour (SB) and increased active minutes at post-testing, with the intervention group significantly decreasing SB (-7 minutes) while the control group increased SB (+2.1 minutes) in the second hour of the three-hour ECCE day. Children in the intervention group significantly increased scores in the overhand throw (mean increase of 1.3; maximum score of 8) in comparison with control group (mean increase of 0.1). Increases in educator confidence highlights the potential for increasing educator self-efficacy and confidence to deliver PA and FMS opportunities in ECCE services through training, while significant increases in overhand throw proficiency of the intervention group shows potential for the Kids Active programme to increase FMS proficiency over longer periods.

4.2. Introduction

Physical activity (PA) is any bodily movement produced by skeletal muscle that results in energy expenditure (Caspersen, 1985). Low levels of PA are a major risk factor for numerous chronic diseases and conditions, such as Type 2 diabetes and coronary heart disease (Scarborough *et al.* 2011). PA plays a vital role in the health, development and learning of children (Roth *et al.* 2010), and evidence has shown that early intervention through the continuous promotion of PA throughout childhood is essential (Bürge *et al.* 2011). Physical activity in childhood is often referred to as physically active play, or active play. Although active play has been defined in various ways, including play that is distinguished by the characteristics of a playful context combined with a dimension of physical vigour (Pellegrini and Smith 1998) and play activity that is significantly above resting metabolic rate (Simons-Morton *et al.* 1990). For the purpose of this study, active play is defined as any non-sedentary activity in which the child uses movement of the body to play at light, moderate or vigorous intensity.

Early childhood (EC), from birth to 6 years old, represents a critical period for general motor development (Hardy *et al.* 2010), as innate primitive reflexes are replaced with independent movement and basic coordination patterns are learned. Fundamental movement skills (FMS), movement patterns involving various body parts that are the precursor to more complex and sport-specific skills, are considered to be the building blocks for PA throughout the lifespan (Barnett *et al.* 2009). While proficiency in FMS is positively associated with PA participation (Cliff *et al.* 2009; Fisher *et al.* 2005), failure to develop these fundamental skills can lead to lower levels of PA through the lifespan (Larsen *et al.* 2015). Although FMS begin to develop in EC through structured and free play (Colella and Morano 2011), studies have shown that competence in these skills does not merely develop naturally, but requires elements of teaching, practice and reinforcement (Logan *et al.* 2012; Adamo *et al.* 2016). As such, the EC education and care environment provides an ideal opportunity to develop solid foundations for improving children's PA and FMS (Adamo *et al.* 2014).

The recent Ireland North and South Report Card on Physical Activity for Children and Youth (Harrington *et al.* 2016) highlights that there is a gap in PA data for the early years

population, as almost all investigations into childhood PA in Ireland have focussed on children from the age of 7 onwards. Although, as yet, no specific PA guidelines exist for EC in Ireland, other countries including Canada (Canadian Society of Exercise Physiology 2012), Australia (Commonwealth of Australia and Commonwealth of Australia Department of Health and Aging 2010) and the United Kingdom (Chief Medical Officers, 2011) have set specific evidence-based PA guidelines for babies, toddlers and children under 5. These guidelines state that children under 5 should be active every day for 180 minutes spread throughout the day, at any intensity, which includes light, moderate and vigorous (Chief Medical Officers, 2011). Despite a paucity of research into PA of children under 7 years old in Ireland, national research indicates that children and young people in Ireland are insufficiently active, with only 23% meeting the national guidelines (Gavin *et al.* 2015). Coupled with data showing that 25% of children in Ireland are obese or overweight by age 3 (Williams *et al.* 2013) it can be deduced that children in Ireland are insufficiently active from a young age.

As of September 2016, the universal Early Childhood Care and Education (ECCE) programme in Ireland (under which all children in Ireland are entitled to 3 hours of free preschool education, 5 days a week for the school year, with the option to pay for extra hours) has been expanded to 2 years, and children can now be enrolled on the scheme from the age of 3 to 5.5 years (Department of Children and Youth Affairs, 2015). As more young children now have access to quality early years care and education, this represents not only a movement towards equity in education, but an opportunity to improve the physical health of children by creating supportive environments that promote PA and the development of healthy behaviours from an early age (Bower *et al.* 2008).

The Kids Active intervention aims to increase PA and FMS levels of children within the Irish EC setting, specifically through training preschool educators to deliver PA, FMS and active play opportunities in their service throughout the day. This programme (managed by Early Childhood Ireland and the Irish Heart Foundation) sees staff in each service trained by specialists to deliver PA and FMS activities. This approach was chosen to ensure sustainability of the programme, with similar approaches being shown to be

effective in other studies within this population (Van Cauwenberghe *et al.* 2013; Williams *et al.* 2009; Adamo *et al.* 2016)

This study represents a pilot evaluation of the Kids Active intervention for children aged 3 to 5, using an experimental randomised controlled trial design, with two specific research questions; i) Are preschool educators more confident in providing active play opportunities in their schools following Kids Active training? and ii) Does the implementation of Kids Active over a six-week period result in an increase in PA accumulation and FMS proficiency level in young children?

4.3. Methods

4.3.1. Participant Recruitment

Services with a manager and at least one other member of staff offering the ECCE scheme in Dublin and the midlands were invited to take part by Early Childhood Ireland in January 2016 through an online expression of interest form. A total of 40 expressions of interest were received that met the inclusion criteria of being located in one of three geographical areas (Dublin, Athlone and Tullamore) and having at least one designated ECCE room. Of the services in Dublin, 10 were randomly chosen for collection of children's data, while all educators from the remaining services were invited to attend Kids Active training and take part in the educator evaluation. Written consent for participation was obtained from managers for all preschool services involved in the children's research. Informed consent was also obtained from the selected educators involved, as well as from parents or guardians for children's participation, along with assent from the children themselves. Ethical approval was granted by Dublin City University Research Ethics Committee (DCU/REC/2016/013). Further details on recruitment and ethics are detailed in Chapter 3 (section 3.3.1) The services involved in this research represented a cross-section of childcare types, including both private and community (not-for-profit), with a range of approaches including Montessori, HighScope and Play-based. Though these approaches differ slightly in their philosophies, all ECCE services follow the Aistear curriculum framework.

4.3.2. Study Design

There were two key aspects to the evaluation, the first phase involving the educators, and the second phase involving the children. Educators from all services who completed the training were invited to participate in the educator evaluation ($n = 55$). For the children's aspect of the research, 10 services from the Dublin region were randomly allocated to the control ($n = 5$) or intervention arm ($n = 5$), with data being collected on two occasions immediately before and after the 6-week intervention period. Using a wait-list control design, control groups were requested to continue their usual preschool curriculum and would receive Kids Active programme training and resources following completion of data collection. One intervention service was unable to take part in the educator training or post-intervention testing, and therefore data from four intervention services were included in final analyses.

4.3.3. The 'Kids Active' Intervention Programme

The Kids Active pilot programme consists of educator training and a resource pack. The programme focuses on training educators to integrate PA opportunities in the preschool environment throughout the day, and to help children improve performance of four specific FMS (Run, Vertical Jump, Catch and Overhand Throw). The intervention was designed with the needs of the ECCE educator in mind; the training required a relatively short time commitment to make it accessible, training was hands-on to ensure so educators could explore how they would use the specific equipment and other resources they had within their service for the activities and the Kids Active resource was user-friendly (with clear illustrations and reference to the Aistear curriculum framework).

Each intervention service was invited to send two educators to in-service training which was led by an Early Years Trainer from Early Childhood Ireland. Training consisted of two 2-hour sessions and took place in North Dublin, South Dublin and Birr, Co. Offaly. An additional 4-hour weekend session took place in Dublin for those who could not attend the originally scheduled trainings. The first session aimed to increase educators'

awareness of the importance of PA for the health, development and wellbeing of children and addressed the barriers to PA in the ECCE setting. The second session covered the Kids Active programme and resources, as well as FMS in much greater detail. Educators were given the resource at end of the second session.

The resource pack contained 6 A4 activity cards, each with a different theme (see Appendix H). Aistear learning goals for each activity were included on each activity card to ensure that they were user-friendly for educators and could be integrated easily in line with the curriculum. The double-sided activity cards featured an illustrated overview of each activity and how each activity linked to Aistear with the back of the card containing suggestions for equipment and layout, as well as how to adapt or progress the activity for different ages and abilities. Each activity card contained 6 activities, 2 of which specifically incorporated FMS. The resource pack also contained 4 specific A4 FMS cards which were duplicated on A3 posters for display in the ECCE service (see Appendix G). The FMS cards and posters featured different characters demonstrating an action that represented the four targeted FMS (Run, Vertical Jump, Overarm Throw, and Catch), with the reverse of the cards also containing advice for creating opportunities to practice the skill and how the skill may look at the early stages of development. Educators were asked to choose one card a week, from which they would complete a minimum of 3 activities including 2 FMS-specific activities.

All activities in the programme aligned with the themes and principles of Aistear, the Irish national curriculum framework for children from birth to 6 years (NCCA, 2009). All equipment required for implementation of the Kids Active programme were low cost, recycled and homemade, in order to remove the potential barrier of equipment costs by demonstrating alternatives to purchasing equipment.

4.3.4. Measures

4.3.4.1. *Educator Data*

Both control and intervention teachers were asked to complete an adapted version of the Confidence about Activity and Nutrition Teach (CAN-Teach) questionnaire

(Derscheid *et al.* 2014) immediately before and after the 6 weeks of Kids Active intervention rollout. The CAN-Teach Questionnaire was developed to measure preschool educators' self-efficacy and knowledge of healthy nutrition and PA practices for preschool children, and has been previously validated against expert ratings of how difficult it would be for educators to complete each activity ($r = -.67$, $p < .001$), with high internal consistency (Cronbach alpha = .98) (Derscheid *et al.* 2014). For this study, the questionnaire was adapted by omitting the questions that focussed solely on nutrition. A total of 28 items from the original 46 items were included in the final questionnaire for this study, maintaining high internal consistency with a Cronbach alpha coefficient of .95. The questionnaire remained divided into its original 5 sub-sections, which include 4 sections relating to self-efficacy (Best practice for preschoolers = 5 questions with Cronbach alpha of .84; Curriculum for large motor activity = 8 questions with Cronbach alpha of .94; Daily activities with PA = 4 questions with Cronbach alpha of .89; Community involvement = 7 questions with Cronbach alpha of .93), with each question using a 7-point Likert scale (1 = Not Confident, 7 = Highly Confident). Furthermore, there was one 'Readiness to Learn' section, comprised of 4 questions with Cronbach alpha of .82 using a 5-point Likert scale (1= No Interest, 5 = Already Learning). Biographical information such as gender, age, level of qualification, current position and years working in the sector were also included. Educators had the option of completing the survey either online (SurveyMonkey) or in hard copy format.

4.3.4.2. *Children's Data*

All children's data were collected on site at each of the 9 services, by 2 trained researchers, on two occasions; prior to and immediately following the 6-week intervention period. The testing protocol, which involved measurement of Body Mass Index (BMI), FMS, and PA, took approximately two hours to complete. Details on each specific measure are given below.

BMI: All physical measurements were taken without shoes. Weight was measured to the nearest 0.1kg, using a Seca mechanical dial weighing scales. Standing height was measured to the nearest 0.1cm using a Leicester Height Measure. BMI status and classification was calculated using the Centre for Disease Control and Prevention (CDC)

Children's BMI tool for schools based on CDC growth charts (Kuczmarski *et al.* 2002). This approach has been used to classify weight status in similar studies involving the same age group (Trost *et al.*, 2003; Bellows *et al.*, 2013; Pate *et al.*, 2015; Tucker *et al.*, 2016).

Accelerometry: PA was measured using ActiGraph GT1M and GT3X accelerometers, set at 10-second epochs to capture bursts of PA with short duration and frequent changes, characteristic of preschool children (Dwyer *et al.*, 2009). Educators were shown how to attach the belts in the correct position (over the iliac crest of the right hip), and were asked to put the belts on the children each morning, and to remove the belt before they went home for a total of 5 school days. The monitors were collected at the end of the 2-week period by a member of the research team for download and data processing.

Fundamental Movement Skills: Four FMS were assessed in conjunction with the guidelines from the Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000) and the Victorian Fundamental Motor Skills Manual (Department of Education Victoria, 1996). The 4 skills consisted of 2 classified as locomotor skills (run and vertical jump) and 2 classified as object control skills (overhand throw and catch). The TGMD-2 provides good test-retest reliability in EC ($r = .88$) (Valentini 2012) with high internal consistency (Cronbach's alpha .85 to .91) (Cools *et al.* 2009). During the data collection, children were divided into groups of 5. A trained researcher provided each group of 5 participants with an accurate demonstration and description of the skill to be performed. No verbal feedback was given to children during the testing. Participants performed each skill 3 times, which included 1 familiarisation practice and 2 performance trials. Video cameras were used to record each participant's performance of each of the skills and the FMS scoring process was completed in a lab on a later date. As per the TGMD-2 and Victorian Fundamental Skills Manual, each skill has performance criteria of 3 to 6 parts to describe the movement pattern of the skill (Ulrich, 2000; Department of Education Victoria, 1996). If the child performed a criterion correctly, a score of 1 was recorded and if performed incorrectly 0 was recorded. Scoring was performed by trained researchers who achieved 95% inter-observer agreement with an expert scorer. Raw scores of each FMS were obtained by summing the scores of the criterion of the 2 performance trials (run, vertical jump, catch and overhand throw; maximum scores of 8, 12, 6 and 8

respectively, combined locomotor skills; maximum score of 20, combined object control skills; maximum score of 14, total FMS; maximum score of 34).

4.3.5. Data Processing and Analysis

All data were analysed using IBM SPSS Statistics 23, with alpha set at $p < 0.05$. CAN-Teach data raw scores were calculated for each of the 5 sub-sections of the educator questionnaire, as well as total score for the questionnaire overall. Two (factor group; intervention vs. control) x two (time pre-vs. post) repeated measures mixed between-within participants' analyses of variance (ANOVAs) were computed to assess significant differences between groups over time.

Accelerometer data were processed using ActiLife software version 6.13.3. Data from the y-axis was used as it has been shown to be comparable across monitors (Sasaki *et al*, 2011). Wear time criteria of at least 150 minutes (2.5 hours out of 3-hour preschool day) for a minimum of 3 days was applied to capture PA close to the typical hours of an ECCE setting, allowing for time to put on and remove the belts. Periods of 60 minutes or more of continuous zeroes were considered non-wear time. Cut points developed for preschool children by Pate and colleagues (2006) were applied to determine minutes of Sedentary, Light, Moderate and Vigorous activity (Sedentary = 0-799 Counts Per Minute (CPM), Light = 800 – 1679 CPM, Moderate = 1680 – 3367 CPM, Vigorous ≥ 3368 CPM). Intensities were also combined to give an overview of all 'non-sedentary' time of PA at any intensity (i.e. Light + Moderate + Vigorous = LMV).

PA was analysed overall for the 3-hour period at each of the 5 intensity classifications. Further analyses were carried out to consider the three separate hours of the ECCE period classified as hour 1 (between the hours of 9:00-9:59, 9:15-10:14 or 9:30-10:29, depending on service), hour 2 (between the hours of 10-10:59, 10:15-11:14 or 10:30 to 11:29, depending on service) and hour 3 (between the hours of 11-11:59, 11:15-12:14 or 11:30-12:29, depending on service).

FMS was analysed as raw scores (total score achieved in both trials) for each of the 4 skills individually, for the 4 skills combined, as well as for locomotor skills and object control skills separately.

Literature has consistently shown gender differences in preschool children for both PA (Trost *et al.* 2002) and FMS (Hardy *et al.* 2010). With this in mind, independent t-tests, with gender as the independent factor, were conducted for both PA and FMS to determine if there were significant differences between genders at baseline. For PA, significant differences at all intensities were found between genders over the 3-hour period and at each time point and therefore two (intervention vs. control) x two (time pre-vs. post) x two (male vs. female) ANOVAs were conducted to assess any significant differences between groups or genders for PA at pre-and post measurement periods. T-tests also indicated significant differences between age groups (i.e. 3-year olds vs 4-5-year olds) at baseline, though this was not included as a factor in analysis due to changes in chronological age between pre-and post testing. For FMS, independent t-tests showed no significant differences overall between genders or ages at baseline. Therefore, gender was excluded from the analysis and two (intervention vs. control) x two (time pre-vs. post) ANOVAs were conducted to assess significant differences between groups across the 2 time periods. To estimate effect sizes, partial eta squared (PES) were computed and interpreted using guidelines set by Cohen (1988) of .01= small, .06 = moderate and .14 = large.

4.4. Results

4.4.1. Educator Data

A total of 58% of educators (n = 32; 10 control, 22 intervention) completed the questionnaire at both pre-and post. All but one of the participating educators were female, with age ranging from 18 to 63 (mean = 34.04 ± 10.3 years). In terms of position held within their service, 61.8% of participants classified themselves as an “educator” or “teacher”, with a further 16.4% in “supervisory roles”, and 21.8% in a “management position”.

Table 4.1 displays the total and subsection scores for the CAN-Teach Questionnaire for control and intervention teachers, at both pre-and post-intervention.

Table 4.1. Mean (\pm SD) ECCE Educator CAN-Teach Scores (n = 32)

| | Control | | Intervention | | Effect | Effect size |
|--|-------------|------------|--------------|------------|--------------------|-------------|
| | Pre | Post | Pre | Post | <i>p</i> | PES |
| Total | 164 (15.5) | 157 (21.8) | 141 (22.8) | 156 (25.8) | (t*g) .002 | .271*** |
| Self-efficacy | 147 (14.3) | 140 (21.2) | 124 (22.3) | 138 (24.8) | (t*g) .003 | .257*** |
| Best Practice | 32 (3.0) | 30 (3.9) | 25.67 (5.5) | 30 (4.3) | (t*g) <.001 | .375*** |
| Curriculum for large motor activity | 51.85 (4.0) | 50 (6.3) | 43.62 (8.3) | 48 (8.3) | (t*g) .019 | .169*** |
| Daily activities with PA | 25.15 (2.7) | 25 (3.8) | 22.71 (3.9) | 25 (3.5) | (t*g) .024 | .159*** |
| Community Involvement | 38 (8.8) | 36 (10.4) | 32 (8.7) | 36 (11.1) | (t*g) .033 | .143*** |
| Readiness to learn total | 17 (2.4) | 17 (1.8) | 17 (1.4) | 18 (1.4) | (t) .020 | .167*** |

(Note: t=time, t*g = time*group interaction effect; Effect Size * = small, ** = moderate, *** = large)

Significant time*group interaction effects were found for overall scores, [Wilks' Lambda = .73, $F(1, 30) = 11.2$, $p = .002$], self-efficacy [Wilks' Lambda = .74, $F(1, 30) = 10.36$, $p = .003$], best practice for health and development [Wilks' Lambda = .63, $F(1, 30) = 18.0$, $p < .001$], curriculum for larger motor activity [Wilks' Lambda = .83, $F(1, 30) = 6.10$, $p = .019$], daily activities with PA [Wilks' Lambda = .84, $F(1, 30) = 5.7$, $p = .024$] and community involvement [Wilks' Lambda = .86, $F(1, 30) = 5.0$, $p = .033$]. A significant main effect for time was found for readiness to learn [Wilks' Lambda = .83, $F(1, 30) = 6.0$, $p = .020$].

4.4.2. Children's Data

A total of 141 children (50.3% male, 49.7% female) took part in the Kids Active research, with a mean age of 3.9 ± 0.5 years. Response rates are detailed in Table 3.1 in Chapter 3 (Section 3.4). Baseline BMI measurements ($n = 141$) showed that 79.4% of children were within the "normal" weight category, with 1.4% "underweight", 12.1% "overweight" and 7.1% obese.

Only those who had full datasets for each PA variable across both time periods were included in the final analysis ($n = 76$ (control = 38, intervention = 38)). For FMS, numbers varied by skill, as some children did not want to take part in testing for certain skills both at pre-and post-testing. A total of 88 children performed all 4 skills (control = 47, intervention = 41) at both pre-and post.

4.4.2.1. Physical Activity

Although significant differences were found by gender at baseline for nearly all PA intensities over the 3-hour period and individual hours, results of the 2x2x2 ANOVA indicated an absence of gender effects across all measures from pre-to post. Table 4.2 outlines the mean minutes for each group at different intensities, with an overview of findings from the ANOVA. No significant time*group interaction effects were found for the overall 3-hour period at any intensity. Time was found to be the main factor behind all changes, with significant main effects for time for Sed [Wilks' Lambda = .77, $F(1, 74) = 22$, $p < .001$], LPA [Wilks' Lambda = .94, $F(1, 74) = 4.84$, $p = .036$], MPA [Wilks' Lambda = .91, $F(1, 74) = 7.0$, $p = .012$], VPA [Wilks' Lambda = .94, $F(1, 74) = 5.03$, $p = .028$], MVPA [Wilks' Lambda = .90, $F(1, 74) = 8.14$, $p = .006$ and LMVPA [Wilks' Lambda = .90, $F(1, 74) = 7.96$, $p = .006$], with decrease in SB and increase in PA between pre and post testing for both groups over this period.

Table 4.2. Mean minutes (\pm SD) PA at different intensities for the 3-hour ECCE period (n = 76)

| Intensity | Control | | Intervention | | Effect | Effect Size |
|------------------|--------------|--------------|--------------|--------------|------------------|-------------|
| | Pre | Post | Pre | Post | <i>p</i> | PES |
| Sedentary | 140.8 (24.5) | 125.1 (13.1) | 131.1 (20.9) | 122.2 (10.2) | (t) <.001 | .205*** |
| Light | 18.0 (3.9) | 19.0 (3.4) | 16.5 (3.7) | 17.75(3.1) | (t) .036 | .060** |
| Moderate | 14.0 (4.0) | 15.2 (3.7) | 14.1 (4.0) | 15.4 (3.6) | (t) .012 | .085** |
| Vigorous | 7.5 (3.4) | 8.8 (3.1) | 9.6 (4.8) | 10.5 (4.0) | (t) .028 | .066** |
| MV | 21.5 (7.1) | 24.0 (6.2) | 23.7 (7.6) | 26.0 (7.0) | (t) .006 | .099** |
| LMV | 39.4 (10.6) | 43.0 (8.8) | 40.2 (10.5) | 43.5 (9.3) | (t) .006 | .096** |

(Note: t=time, Effect Size * = small, ** = moderate, *** = large)

Results of the analysis when data were broken down into the 3 separate ECCE hours are presented in Table 4.3. No significant interaction effects for time*group were found during Hour 1, though a significant large main effect for time was found for Sed [Wilks' Lambda = .79, $F(1, 79) = 21.56$, $p < .001$, PES = .214]. During Hour 2, significant moderate to large interaction effects were found for time*group for Sed [Wilks' Lambda = .61, $F(1, 74) = 47.12$, $p < .001$, PES = .389], LPA [Wilks' Lambda = .90, $F(1, 74) = 8.5$, $p = .005$, PES = .104], MPA [Wilks' Lambda = .86, $F(1, 74) = 11.84$, $p = .001$, PES = .138], MVPA [Wilks' Lambda = .92, $F(1, 74) = 6.37$, $p = .014$, PES = .079] and LMVPA [Wilks' Lambda = .90, $F(1, 74) = 8.47$, $p = .005$, PES = .103]. The control group decreased LPA (-1.7 mins), MPA (-1.8 mins), MVPA (-2.4 mins) and LMVPA (-3.1 minutes) significantly more than the intervention group who had small decreases (<0.5 minutes) for each intensity during Hour 2. Significant small to moderate interaction effects were found for time*group during Hour 3 at Sed [Wilks' Lambda = .96, $F(1, 75) = 6.03$, $p = .016$, PES = .074] and LPA [Wilks' Lambda = .89, $F(1, 75) = 9.32$, $p = .003$, PES = .111]. Hour 3 showed decreases in sedentary time for both control and intervention groups, with the control group significantly decreasing sedentary time by 3.7 minutes compared to the intervention group who decreased their sedentary time by 1.3 minutes.

Table 4.3. Mean minutes (\pm SD) PA at different intensities for Hour 1, Hour 2 and Hour 3 of the ECCE period (n = 76)

| | Intensity | Control | | Intervention | | Effect | Effect Size |
|--------|-----------|------------|------------|--------------|------------|----------------------|-------------|
| | | Pre | Post | Pre | Post | <i>p</i> | PES |
| Hour 1 | Sedentary | 48.5 (4.4) | 45.7 (5.9) | 42.2 (7.1) | 38.4 (7.5) | (t) <.001 | .214*** |
| | Light | 5.1 (1.5) | 5.2 (1.8) | 4.8 (1.6) | 4.6 (1.6) | | |
| | Moderate | 3.7 (1.4) | 3.9 (1.7) | 4.0 (1.8) | 3.97 (1.6) | | |
| | Vigorous | 2.0 (1.1) | 2.3 (1.3) | 2.4 (1.2) | 2.5 (1.4) | | |
| | MV | 5.7 (2.4) | 6.1 (3.0) | 6.5 (2.9) | 6.2 (2.7) | | |
| | LMV | 10.7 (3.8) | 11.3 (4.6) | 11.3 (4.4) | 10.8 (4.1) | | |
| Hour 2 | Sedentary | 43.8 (4.7) | 45.9 (5.5) | 46.2 (4.9) | 39.2 (6.6) | (t*g) <.001 | .389*** |
| | Light | 7.1 (1.5) | 5.4 (1.6) | 5.8 (1.5) | 5.6 (1.7) | (t*g) .005 | .104** |
| | Moderate | 5.8 (1.8) | 4.0 (1.6) | 4.8 (1.5) | 4.7 (1.6) | (t*g) .001 | .138** |
| | Vigorous | 3.0 (1.7) | 2.4 (1.3) | 3.0 (2.4) | 2.9 (1.2) | | |
| | MV | 8.8 (3.3) | 6.4 (2.8) | 7.8 (3.5) | 7.6 (2.4) | (t*g) .014 | .079** |
| | LMV | 15.9 (4.3) | 11.8 (4.2) | 13.6 (4.6) | 13.2 (3.8) | (t*g) .005 | .103** |
| Hour 3 | Sedentary | 45.9 (6.4) | 42.2 (7.0) | 42.4 (5.3) | 41.4 (5.0) | (t*g) .016 | .074** |
| | Light | 5.3 (1.4) | 6.0 (1.6) | 5.8 (1.5) | 6.3 (1.2) | (t) .003 | .111** |
| | Moderate | 4.2 (1.6) | 4.7 (1.6) | 5.3 (1.8) | 5.5 (1.3) | | |
| | Vigorous | 2.3 (1.4) | 2.8 (1.4) | 4.1 (2.8) | 3.6 (1.6) | | |
| | MV | 6.5 (2.9) | 7.5 (2.8) | 9.4 (3.8) | 9.2 (2.6) | | |
| | LMV | 11.8 (4.1) | 13.5 (4.2) | 15.1 (4.6) | 15.4 (3.4) | | |

(Note: t=time, t*g = time*group interaction effect; Effect Size * = small, ** = moderate, *** = large)

4.4.2.2. *Fundamental Movement Skills*

Table 4.4 displays the FMS mean raw scores, individually and combined, for control and intervention groups, at both pre-and post-intervention, along with results of the 2x2 ANOVA. Overall, increases in raw scores were achieved for both groups at post testing. A significant small time*group interaction effect was found for overhand throw [Wilks' Lambda = .96, $F(1, 106) = 3.96$, $p = .009$, PES = .036)]. Time was found to have a significant moderate to large effect for catch [Wilks' Lambda = .83, $F(1, 102) = 20.3$, $p < .001$, PES = .17] and vertical jump [Wilks' Lambda = .99, $F(1, 101) = 21.28$, $p < .01$, PES = .174)], as well as overall FMS [Wilks' Lambda = .62, $F(1, 86) = 53.07$, $p < .001$, PES = .382], combined object control skills [Wilks' Lambda = .813, $F(1, 96) = 22.13$, $p < .001$, PES = .187] and combined locomotor skills [Wilks' Lambda = .81, $F(1, 97) = 22.65$, $p < .001$, PES = .189] though no significant differences were found over time for run.

Table 4.4. Mean raw FMS scores (\pm SD) pre- and post-intervention

| | Control | | Intervention | | Effect | Effect Size |
|--|------------|------------|--------------|------------|-------------------|-------------|
| | Pre | Post | Pre | Post | <i>p</i> | PES |
| Total FMS Score (maximum score 34) | (n=47) | | (n=41) | | | |
| | 18.7 (3.3) | 21.2 (2.8) | 18.5 (3.4) | 22.4 (3.5) | (t) <.001 | .382*** |
| Locomotor (maximum score 20) | (n=54) | | (n=45) | | | |
| | 14.2 (1.9) | 15.3 (1.8) | 13.8 (2.4) | 15.4 (2.4) | (t) <.001 | .189*** |
| Object Control (maximum score 14) | (n=52) | | (n=46) | | | |
| | 4.6 (2.5) | 5.8 (2.2) | 4.9 (2.6) | 6.9 (2.4) | (t) <.001 | .187*** |
| Run (maximum score 8) | (n=58) | | (n=45) | | | |
| | 6.9 (1.1) | 7.1 (0.9) | 6.8 (1.1) | 7.2 (1.2) | | |
| Vertical Jump (maximum score 12) | (n=57) | | (n=46) | | | |
| | 7.4 (1.5) | 8.2 (1.6) | 6.9 (2.1) | 8.2 (2.0) | (t) <.001 | .174*** |
| Catch (maximum score 6) | (n=55) | | (n=49) | | | |
| | 1.9 (1.3) | 2.9 (1.1) | 2.4 (1.3) | 2.9 (1.1) | (t) <.001 | .166*** |
| Overhand Throw (maximum score 8) | (n=57) | | (n=51) | | | |
| | 2.6 (1.7) | 2.8 (1.8) | 2.5 (1.9) | 3.8 (2.0) | (t*g) .049 | .036* |

(Note: **t**=time, **t*g** = time*group interaction effect; Effect Size * = small, ** = moderate, *** = large)

4.5. Discussion

Results show that educators in the control group scored higher on the full CAN-Teach questionnaire and all self-efficacy subsections at baseline and significantly decreased over time, while the intervention group increased significantly or maintained scores for all sections over time. Results of the ANOVA show that significant interaction effects for time*group were found for all self-efficacy subsections, with the intervention group scoring higher after the 6-week intervention and the control group scoring lower after the same 6-week period. These results indicate that educators who received the 6-week Kids Active intervention significantly increased their scores for the self-efficacy and readiness to change measures, in comparison to educators who did not receive the intervention. This is a positive result for the intervention, suggesting that the Kids Active preschool PA and FMS intervention can positively influence educators' self-efficacy, confidence to teach, organise and schedule PA and FMS throughout the day. For the subsection of self-efficacy, the greatest effect sizes were found for 'Best Practice' and 'Large Motor Activity', which included questions about recommending changes within the service, as well as teaching different skills, designing and planning PA opportunities; all of which were addressed in the Kids Active training and resource. While very few preschool educator training programmes in Ireland include children's PA as part of their course of study, the increase in these scores after the intervention highlights that even short training programmes for preschool educators can be effective in increasing confidence to teach PA. Research has shown that short programmes can be efficacious within the early years setting, as highlighted by Martyniuk and Tucker (2014) who found that educators who had completed even one course devoted to PA had significantly higher self-efficacy to instruct and facilitate PA for preschool children.

In terms of sedentary behaviour, both the overall 3-hour period and Hour 1 showed decreases in sedentary minutes for both groups across the time periods. Hour 2 showed the most significant changes in sedentary time, with a significant large interaction effect (time*group) indicating the significant differences between the intervention and control group in favour of the intervention group may be attributed to the Kids Active intervention. Although these changes in sedentary behaviour are small, and a corresponding increase for LMV was not recorded for the intervention group during

Hour 2, decreases in sedentary time are worth noting, as research increasingly emphasises the separate nature of sedentary and physically active behaviours (Latomme *et al.* 2017; Marshall and Ramirez 2011), with sedentary behaviour considered a risk factor for non-communicable diseases independent of PA (Saunders, Chaput, and Tremblay 2014).

For PA, the overall 3-hour period showed an increase in LMV for both groups between pre-and post testing. Hour 2 showed significant large time*group interaction effects for light and LMV, again indicating significant difference between the control and intervention groups. These significant interaction effects imply that the increase in active time, and the previously mentioned decrease in sedentary time, across the two time points may be attributed to the prescription of the Kids Active intervention. While the intervention group had a negligible decrease in LMV (0.4 minutes) at this hour, the control group's significant decrease of 4.1 minutes LMV highlights that the intervention may have mitigated a decrease in activity at this hour.

The control group at the post-intervention phase show similar minutes at each intensity for hours 1 and 2, with an increase in LMV at hour 3, while LMV for the intervention group increases steadily across each of the 3 hours. This increase by hour is similar to findings by van Cauwenberghe and colleagues (2012), who found that PA of children in preschool services increased each hour between 9am and 12pm. Senso and colleagues (2015) found 10am to be most active hour in US preschool children, while studies of Australian and Finnish children (Soini *et al.* 2014) also found significant peaks in PA during the preschool day at the hour of 10am.

The findings of the present study may indicate that the third hour of the ECCE day (beginning at 11am, 11:15 or 11:30), as the most active hour for both groups at post-testing, represents a window for PA opportunities. While the significant interaction effects found for Hour 2 are encouraging, the positive results highlighted during this hour are not apparent when analysed overall as a 3-hour preschool day. This may indicate that the activities associated with the intervention were utilised during this time of the day, or that the intervention group's increase in this hour was overshadowed by an increase in the control group's PA during the other 2 hours. Van Cauwenberghe and colleagues (2012) emphasise the value of analysing PA for preschool children by hour in

order to highlight patterns of PA that may not be detected when analysed as average PA across whole days, allowing researchers to identify critical windows for intervention.

In line with the recommendation of 180 minutes of PA at light, moderate or vigorous intensity every day for children under 6, any non-sedentary time is worth noting, and an increase in PA at any intensity represents desirable results (Adamo *et al.* 2014). Although these changes are relatively small and only reflect a snapshot of the preschool day, the gains of the intervention group that could be attributed to the Kids Active programme are favourable.

While increases in overall FMS were not significantly different between groups, a significant difference was found between the control and intervention group post-intervention for overhand throw. A significant moderate time*group interaction effect was found for this skill, with the score of the intervention group increasing significantly more than the control group. This may be attributed to the Kids Active programme and indicates that the intervention may have positively influenced this skill specifically, demonstrating that a short intervention can significantly improve performance in individual FMS.

As biological changes occur rapidly in the early years, physical growth and development would be expected to positively influence FMS performance over time, independent of external factors (Piek, Hands, and Licari, 2012). Interestingly in this sample, no significant differences were found between 3-year olds and 4-5-year olds at baseline, which is contrary to the expectation that the older children would demonstrate more advanced skill development, adding weight to the argument that FMS do not just develop 'naturally' and physical maturation alone is not sufficient to impact changes without teaching and practice (Clark 2007). Raw scores for individual FMS and combined skills did however increase for both groups from pre-to-post testing, with a significant main effect for time, indicating that all children improved their FMS performance over the 6-week period regardless of group. It is also possible that children in the control group may have experienced a familiarisation effect from performing the skills during pre-intervention testing (Tomic and Hraski 2016). It is worth noting, that while both age groups in the intervention group and 3-year olds in the control group all increased scores in overhand throw over time, 4-5-year olds in the control group showed no change in

scores for this skill (data not shown). Considering that younger children in the control group improved overhand throw scores by 15% and older children in the intervention group improved by 66%, the fact that older children in the control group had no increase in scores highlights that while physical growth and maturation may contribute to small gains in FMS over time, there may be an age above which these gains plateau and targeted intervention is necessary to achieve proficiency. Gallahue suggests that children have the potential to master most FMS by age 6 or 7 (Gallahue and Ozmun, 2006), but without appropriate reinforcement and opportunities mastery might not be reached (Malina, 2004). Further research is warranted to investigate the effect of interventions at different ages in EC and deduce how interventions can be designed to optimise windows of opportunity in terms of physical development.

The relative absence of gender effects for FMS in this study is corroborated by Donath and colleagues (2015) who emphasise that the effects of gender should not be overrated in this age group in terms of promoting FMS. Previous studies have found significant differences between boys and girls of this age (Zask *et al.* 2012; Kokštejn, Musálek, and Tufano 2017; Iivonen, Sääkslahti, and Nissinen 2011) though it has been suggested that since biological differences between genders (such as body type and composition) are not remarkably different prior to puberty, differences in FMS scores for young children are more likely to be associated with social and environmental factors, such as opportunities to engage in FMS activities, gender stereotyped games and parental and social expectations, than biological factors (Saraiva *et al.* 2013; Malina, Bouchard, and Bar-Or 2004).

It has been posited that for children of this age, 6 weeks during preschool hours may not be enough to impact FMS or PA behaviour. In a recent meta-analysis of FMS interventions in preschool children (Van Capelle *et al.* 2017) the mean duration of the 20 studies analysed was 21 (\pm 17) weeks, and that those which demonstrated the greatest increases involved structured sessions of 30 minutes or more 4-5 days per week. Considering the short duration of this intervention and the fact that the programme did not involve structured sessions, the significant increase in overhand throw proficiency of the intervention group and slight increases above the control group in the second hour of the ECCE day is encouraging.

4.6. Limitations

For the educator questionnaire, the control group sample size was small, as control services were only recruited as research sites for the children's data collection phase. Incomplete wear times due to children finding the accelerometer belts uncomfortable, varied service hours, and different drop off/collection times and days of attendance for of children in the services also made it difficult to standardise wear times and analyse full hours of wear. Information was not collected on the daily routines of each of the services and therefore information is lacking regarding the activities that may have resulted in higher SB during specific part of the day (e.g. nap time or meal times). The time of year must also be considered, as baseline testing took place in March and post-testing took place in June. Literature has shown that play is highly correlated with outdoor play time, and that seasonal variation can be a major factor in PA and sedentary behaviour (Shen *et al.* 2013).

4.7. Conclusion

Favourable overall results for the educator data verify that training educators can increase their self-efficacy and confidence to deliver PA and FMS opportunities in preschool services. Significant differences between groups in PA during the middle hour of the 3-hour ECCE day and a significant increase in overhand throw score for the intervention group over the 6 weeks show the potential for the Kids Active programme in EC settings in Ireland. Further data over a longer intervention period, including retention testing, are warranted to support these initial positive findings, and further explore the potential of the Kids Active programme.

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Chapter 5: Conclusions and Recommendations

5.1. Implications of this research

5.1.1. Study one (Chapter 3)

The objectives of the first study were to gather and explore FMS and PA data from a cross-sectional sample of children aged 3-5 in ECCE services in Ireland. The majority of children in this sample did not meet the recommended levels of 15 minutes per hour of any intensity PA during ECCE hours. This is concerning, as evidence suggests that the early years are crucial for the development of healthy PA behaviours and failure to establish sufficient levels of PA at this age may have consequences for development and future health and wellbeing.

While this study did not find significant differences by age or gender in terms of percentage of children meeting the PA guidelines, average PA participation (in minutes per hour) and FMS raw scores showed significant differences for age and gender. As demonstrated in other studies, boys were more active and less sedentary than girls, indicating that active play opportunities may be more appealing to boys than girls. It has been suggested that this could be due to inadvertent gender stereotyping by adults, and demonstrates an important consideration for parents and carers for the encouragement and facilitation of a variety of types of active play, regardless of gender.

Surprisingly, this study found that younger children were more active than older children and indicates a possible trend towards inactivity as children get older, something which could be addressed at this age through early intervention to minimise further declines in PA throughout early and middle childhood.

In terms of overall FMS scores, gender differences were not found in this study, though for individual FMS, girls scored higher in the vertical jump, again indicating a possible preference for different play types for girls than boys. Overall proficiency in this study was far higher in the run than the other three skills tested, which may perhaps be indicative of the run being a skill that children have more frequent opportunities to use and practice through play. Concerningly, older children did not show higher levels of proficiency in any of the skills than younger children and suggests that intervention is

warranted to ensure that children in the early years receive appropriate instruction, feedback and opportunities to practice FMS in order to achieve mastery by middle childhood.

This study showed weak correlations between overall FMS scores and PA of lighter intensities, and suggests that the strength of the relationship between PA and FMS is low in EC, though may strengthen as the children age.

5.1.2. Study two (Chapter 4)

The objectives of the second study were to develop and evaluate a pilot FMS and active play intervention for preschool children in ECCE services, which could be delivered by trained EC educators. This intervention, known as the Kids Active programme, was delivered to educators in a total of 30 services. Training consisted of two two-hour sessions, with one mainly theory and reflection and the other practical and hands-on. Educators also received a Kids Active resource pack with skill cards and posters of the four FMS as demonstrated by appealing cartoon characters, and six double-sided activity cards detailing suggested activities incorporating FMS. All activities chosen required only low cost, recycled or homemade materials to demonstrate alternatives to purchasing equipment.

At the end of the 6-week pilot intervention, educators who received the Kids Active training and resource maintained or significantly increased their confidence to teach PA scores compared to a control group of educators, whose confidence scores decreased across the same time-period. This study highlights that even a short training programme for preschool educators can have a measurable positive impact on educators' confidence to design and plan PA and FMS opportunities.

For children, overall PA across all wear time was not significantly different between control and intervention groups from pre-to-post intervention. Further analysis in this study focused on the 3-hour ECCE period specifically and found an overall increase in PA for both control and interventions groups. The second hour of the ECCE day showed a decrease in PA for both groups, with the control group decreasing significantly more than the intervention group. This could be attributed to the prescription of the Kids Active intervention and demonstrates that the intervention may have mitigated against a more significant decrease in overall PA during this hour. High levels of overall PA during the third hour for both groups indicated that this hour of the ECCE day may be the preferred time of educators and children for active play activities. This study also demonstrated a significant increase in overhand throw score for the intervention group

above the control group and demonstrated that a short intervention can significantly improve performance in individual FMS.

5.2. Recommendations for the Kids Active Intervention

In light of results of the Kids Active evaluation and informal educator feedback, the following recommendations are suggested:

- 1) Expansion of the resource to cover more themes and activities would provide educators with further options for active play. If themes common to the ECCE setting which practitioners regularly use are incorporated, with explicit links to the Aistear curriculum, this could cut down on planning time for educators who can use the themes as a guide for incorporating PA into their daily and weekly plans. For an intervention such as this to be disseminated widely and sustained over time, it must meet and support the needs of both teachers and children in the services
- 2) In order to ensure that children get the opportunity to develop a wide range of FMS, it is suggested that the Kids Active resource is expanded to include all FMS, following the same presentation of cartoon characters specific to each skill. Appealing characters demonstrating different movements were a successful feature of the Mighty Moves study and seek to capture children's imaginations and inspire engagement in dramatic play (Bellows *et al.*, 2009). While balance and stability skills are arguably not strictly FMS, consideration should be given to including these skills as an important component for young children's development.
- 3) The production of videos demonstrating the performance of each FMS and what might be expected for each movement at different stages of development are suggested for educators to refer to. This would allow educators to continue learning about each of the skills and provide an opportunity to refresh memory after the in-person training has been completed. The on-line Aistear Toolkit supports the implementation of the Aistear curriculum framework with free access to video clips, photos, podcasts and audio presentations, as well as

leaflets and hand-outs for educators (Murphy, 2014). This would be an ideal place to host these videos and other supporting materials for Kids Active

- 4) As a long-term goal, further optional training could focus on teaching educators to assess FMS using a tool such as the TGMD-2 or CHAMPS Motor Skill protocol. This may help educators to gain an understanding of the different elements of each movement and stages of development. This could also be beneficial for informing practise for teaching FMS as educators would gain a greater understanding of children's current FMS proficiency and be able to tailor their instruction appropriately. Additionally, this could help educators recognise movement difficulties that may be indicative of wider motor control issues and require specialised intervention.
- 5) A parent and guardian information session would be a valuable component to ensure that parents understand what FMS are, why they are important and how to encourage, teach and practice FMS with children. The Youp'la Bouge intervention empowered ECEC services to engage with parents and provided the tools to organise these, with those that held a parent session showing greater increases in FMS (Bonvin *et al.*, 2013). As part of the intervention, tools for services to self-organise a parent event (including templates for posters and letters home, a session plan, PowerPoint presentation, discussion points and energisers for a physical component) could be developed. Additionally, videos that parents and guardians can access online in addition to leaflets and take-home activities are suggested. Educating parents and guardians around PA and FMS is important to ensure buy-in from and to give parents the tools and knowledge to strengthen the message that PA and FMS are important and enjoyable.
- 6) As part of documenting learning in ECCE (a requirement for DES inspections), many services keep learning journals or folders for each child with photos and descriptions of activities children have taken part in, what they learned from it and how it aligns with Aistear learning goals (NCCA, 2016). These are sent home

periodically for parents to see their children's progress and given to families as keepsakes at the end of the preschool year. Consideration should be given to ways that the Kids Active intervention can be integrated into learning journals. This could include specific Kids Active templates for sections in learning journals or folders to ensure that PA and FMS activities and progress are documented to increase parent/guardian awareness of how PA and FMS are integrated throughout the day and document their children's achievements.

- 7) In light of gender differences in PA and FMS, it is not suggested that the Kids Active intervention should target boys and girls differently. Parent/guardian communication however should acknowledge this finding and highlight the role that adults play to ensure children are not inadvertently encouraged to partake in gender-specific activities (Langlois and Downs, 1980; Eccles and Harold, 1991). This gender gap should be addressed through challenging traditional gender-roles and gender-norms (Chick, Heilman-Houser and Hunter, 2002).
- 8) For the success of this intervention, buy-in from the whole service including management and all staff is necessary (Lindsay *et al.*, 2017). Sharma and colleagues emphasise that for change to happen in an ECEC organisation, there must be readiness to change at both the management and staff level and preparation must include resources, organisational operations and work culture (Sharma *et al.*, 2014). Consideration should be given to strategies for ensuring dissemination of training through services from those who received the training. This could include briefing documents, infographics, information packs and videos outlining the need for PA, what FMS are and how Aistear learning goals can be met through PA. All staff need to be informed of the benefits and necessity of PA and FMS to achieve buy-in and reflect on their own attitudes.
- 9) Policies play a crucial role in clarifying the mission, values and beliefs of a service. Evidence has shown that having a PA policy in an ECEC service is associated with greater participation in PA (Dowda *et al.*, 2009; O'Neill *et al.*, 2017) and indicates support at the organisational level for PA (Sharma *et al.*, 2014).

It is advised that the Kids Active intervention should require services to develop a PA policy as part of the intervention, to highlight the commitment by services to increase PA provision in all aspects of practice. A PA policy should describe the service's goals related to PA and SB and the practices that are employed to achieve these goals (Trost, Ward and Senso, 2010). Templates for PA policies as part of the Kids Active training and resource pack would ensure that services reflect on their beliefs and practice.

- 10) In order to address each level of the social-ecological model, the ECCE environment must be considered. The use of environmental audit tools for services as part of the Kids Active intervention would give managers and educators the opportunity to assess aspects of indoor and outdoor environments that facilitate or create barriers for PA in their own service. Valid and reliable tools have been developed for this purpose from previous interventions such as the Environment and Policy Evaluation and Observation Self-Report Instrument (EPAO-SR) (Ward *et al.*, 2015), the Nutrition and Physical Activity Self-Assessment for Child Care (NAP SACC) (Benjamin *et al.*, 2007) and the Movement Environment Rating Scale (MOVERS) (Archer and Siraj, 2015, 2017). All of these tools are designed to be administered by service staff and management. The EPAO and NAP SACC instruments also assess policies of the service and highlight the importance of both the physical and social environment. Encouraging self-audit as part of the intervention could initiate staff to critically reflect on opportunities for, and barriers to, PA and FMS in their service in order to achieve buy-in.

5.3. Future Research Recommendations:

While positive impacts of the Kids Active intervention were demonstrated, retention testing to assess and evaluate the long-term impact of the intervention is warranted. Additionally, accelerometer data for full days of wear would be valuable to gain a clearer understanding of preschool children's PA behaviours during ECCE and at home, and investigate if a compensation effect occurs for high activity in ECCE when at home and vice versa.

Cross sectional research such as that of Chapter 3 is essential to gain a baseline picture of PA behaviours and FMS levels of a population that has not previously been investigated and can act as a platform to influence policy, regulations and norms outside of the care and education sectors alone. Additional information should be sought in future cross-sectional research including measures of socio-economic status to ascertain how this affects FMS and PA levels in the ECCE setting. More detailed cross-sectional research with larger sample sizes could act as a starting point for informing future experimental and longitudinal research. Researchers should aim to ensure that a balanced number of children of ages 3, 4 and 5 are included in ECCE PA research to explore differences in PA behaviour across preschool ages and aim to investigate the nature of these differences. Longitudinal studies to explore how PA and FMS levels track into middle childhood and beyond would be valuable to understand the correlates of these variables at different stages of life and assess how to intervene appropriately at different ages.

To shape future PA and FMS interventions, qualitative data from educators would be valuable to gain insights into barriers to PA and FMS, and assess how interventions of this sort can be tailored to ensure they meet the needs of those who will be implementing it. Process evaluations for future interventions should be conducted to understand how educators are implementing the intervention and assess required minimum dosage to affect change. A qualitative portion to evaluation should also be utilised through feedback forms or focus groups to ensure that the intervention content is relevant and realistic for educator needs.

While accelerometry is the ‘gold standard’ measure for objectively measuring PA, one disadvantage of using this method is that it does not give insight into what sort of PA occurred or why. Future studies should consider qualitative measures of PA in addition to accelerometers, such as the Children’s Activity Rating Scale (CARS) (Puhl *et al.*, 1990) or the Observation System for Recording Physical Activity in Children—Preschool (OSRAC-P) (William *et al.*, 2006), to gain a greater understanding of what sort of PA children of this age take part in and why. While it is acknowledged that such tools are time-consuming to administer and only assess smaller sub-samples or individual children, valuable knowledge regarding the contexts in which PA occur and how PA is initiated can be gained. A further suggestion is to use objectively measured accelerometry data such as that of the Kids Active cross-sectional study, to distinguish the services with the highest and lowest PA levels and collect qualitative PA data from these sites to determine what facilitates or hinders PA participation, and what can be learned from these services. Qualitative data in this case could include observational PA data, as well as environmental and policy audits to better understand how the preschool service affects PA behaviour at all levels of the social-ecological model. This information would be valuable to create case studies of best practice and to inform future intervention strategies.

5.4. References

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Appendix A

CAN-Teach Questionnaire

Preschool Physical Activity Survey

Section 1: Physical Activity Confidence

The following questions deal with how confident you feel regarding a variety of physical activity practices and tasks.

Please read each statement; choose the number from 1 to 7 (1=Not confident;7=Highly confident) that best represents your degree of confidence in doing that task, whether or not it is part of your current job responsibilities.

* 1. Please enter your unique ID code

* 2. Rate your degree of confidence that you can do the following health and development practices:

| | Not confident | | | Moderately confident | | | Highly Confident |
|---|-----------------------|-----------------------|-----------------------|-------------------------|-----------------------|-----------------------|-----------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Screen children for physical health problems | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Monitor children's health status | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Ensure safe areas for children to engage in large muscle movement | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Recommend policy change or organizational change to promote children's health | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Continue your own professional development to teach physical activity topics | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

* 3. Rate your degree of confidence as an educator to do the following:

| | Not confident 1 | 2 | 3 | Moderately confident 4 | 5 | 6 | Highly confident 7 |
|---|-------------------------------|-----------------------|-----------------------|--------------------------------------|-----------------------|-----------------------|----------------------------------|
| Instruct children on physical skill development to maintain healthy lifestyle | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Design play or physical activity opportunities | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Teach dance and free movement activities as part of classroom free play and structured group time | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Plan structured physical activity for preschoolers for at least 60 minutes during the day | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Teach locomotor skills, traveling actions (jumping, galloping, hopping) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Teach object control (ball skills) skills | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Teach play skills (bike riding, sliding, swinging, climbing) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Teach rhythm skills | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

* 4. Rate your degree of confidence completing the following daily activities with physical activity:

| | Not confident | | | Moderately confident | | | Highly confident |
|---|--------------------------|-----------------------|-----------------------|---------------------------------|-----------------------|-----------------------|-----------------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Limit children's sedentary behaviors to less than 60 minutes at a time except when sleeping | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Schedule daily large motor/muscle activity time (indoor or outdoor) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Model appropriate physical activity/ movement behaviors | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Make good use of the environment and available equipment for play and physical activity | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

* 5. Rate your degree of confidence with involving community members with children's health goals:

| | Not confident | | | Moderately confident | | | Highly confident |
|---|--------------------------|-----------------------|-----------------------|---------------------------------|-----------------------|-----------------------|-----------------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Engage parents as partners in children's physical activity education | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Educate parents about healthy habits | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Educate parents about appropriate and safe levels of physical activity | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Make health education activities available to parents for home use | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Incorporate external input on physical activity issues through a health council or advisory board | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Include health information with parent handbook materials | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Refer children and their families to health or social services | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

* 6. How would you rate your readiness to learn new information on the following topics to help with your teaching:

| | No interest | I probably should, but am not sure about it | Some interest to learn new things | Yes, ready to learn and practise | Already learning |
|---|-----------------------|---|--------------------------------------|-------------------------------------|-----------------------|
| Integrate 'best practices' in your preschool setting | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Develop and deliver curriculum for large motor activity | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Implement daily activities to promote children's health/wellness | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Involve community members with children's health goals | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Preschool Physical Activity Survey

Section 2: Biographical Information

* 7. What position do you hold in the service you currently work?

* 8. What is the highest level of education you have completed?

Other (please specify)

* 9. How many years have you been working in the Early Childhood sector?

* 10. In what year were you born? (enter 4-digit birth year; for example, 1976)

Appendix B

Expression of Interest form

The latest news and information



Kids Active Expression of Interest

A new and exciting physical activity programme for early childhood care and education settings

At Early Childhood Ireland, we recognise the importance of promoting physical activity from early on in life. We believe that young children should engage in physical activity in a fun, meaningful and playful way, every single day! Unfortunately, this isn't the case and research tells us that more and more children are becoming more and more inactive.

Early Childhood Ireland in partnership with the Irish Heart Foundation, Dublin City University and Medtronic are working on an exciting new programme called Kids Active. This new programme is the first of its kind in Ireland and is being designed to support educators promote physical activity in their settings. The Kids Active Programme will build on the resources and knowledge already acquired through the development of the Bizzy Breaks resource (<http://shop.earlychildhoodireland.ie/resources/131-bizzy-breaks-a->

physical-activity-break-for-under-5-s.html). The programme will also be evaluated and the information gathered will be used to develop and improve the content of the programme over the next three years.

In year one we are looking to recruit services in Dublin, Athlone and Tullamore who operate as full day-care and have an ECCE room. The programme will run between March-June 2016. If you are interested in being part of the roll out of the first phase of the Kids Active programme please fill out the form below and a member of staff from Early Childhood Ireland will be in touch about the next steps. Services will be randomly selected to participate in the programme should we receive more expressions than required.

Name of Service

(required)

Address of Service

(required)

Membership Number

(required)

Email

(valid email required)

Phone Number

(required)

Contact Name

(required)

Job Title of Contact Person

(required)

Type of Setting

- ☐ Full day-care
- ☐ Sessional

Do you run an ECCE room?

- ☐ Yes
- ☐ No

Why do you think your service would be a good fit for the Kids Active Programme?

(required)

By submitting this Expression of Interest form you agree the following:

- ☒ Complete any necessary consent forms
- ☒ Attend a short training session over 2 evenings (each session will last approximately two hours)
- ☒ Use any supplied resources and equipment in your practice
- ☒ Facilitate a visit to your service from one of the project team
- ☒ Participate in the evaluation element of the programme

Submit

Share  (<http://www.facebook.com/sharer.php?u=https://www.earlychildhoodireland.ie/kids-active/&t=Kids+Active+Expression+of+Interest?>>) 
<http://twitter.com/share?url=https://www.earlychildhoodireland.ie/kids-active/&text=Kids+Active+Expression+of+Interest> 
<http://www.linkedin.com/shareArticle?mini=true&url=https://www.earlychildhoodireland.ie/kids-active/&title=Kids+Active+Expression+of+Interest>



(<http://www.youtube.com/user/EarlyChildhoodIre>)



(<http://www.facebook.com/earlychildhoodireland>)



(<http://twitter.com/#/EarlyChildhdIRL>)



Appendix C

Informed Consent

(Parents/Guardians)

Informed Consent Form

Project Title: 'Kids Active: Evaluation of a Preschool Physical Activity Programme'

Investigators: Dr. Sarahjane Belton, Dr. Johann Issartel, Dr. Wesley O'Brien and Ms. Christina Duff

Introduction to the study:

Physical activity has been shown to be extremely beneficial to youth, however unfortunately in Ireland the majority of our young people do not participate in enough physical activity to keep themselves healthy. Kids Active is a programme aimed at increasing physical activity participation in early childhood settings. It is important that researchers from DCU carry out work to determine how well this programme works before we roll it out nationally.

This is what will happen during the research project:

1. My child will have their height and weight measured
2. My child will be recorded using a video camera to measure how well they can
 - Run
 - Vertical jump
 - Overhand throw
 - Catch
3. My child will be asked to wear a small device (accelerometer) around their waist on an elasticated belt to measure how much they move in a specific length of time (5 days). Their teacher will be responsible for putting this on in the mornings and removing it before they go home. My child will not be required to wear the accelerometer at home.

All information gathered will be treated in the strictest of confidence. To ensure this, my child's name will be removed from all data and replaced with an ID number. Only the researcher will know my child's ID number, and only the researchers will have access to the information.

Please read Option 1 and Option 2 below and complete as appropriate.

Option 1: Child to be included in the study

I have read and understood the information in this form. I have read and explained the information in the form to my child. The researchers have answered my questions and concerns and I have a copy of this consent form. I agree for my child to be included in this study. My child's teacher may advise researchers of any medical condition which might affect my child's participation in the research described above.

ACTION: To advise the research team of your decision please sign and return this form to your child's teacher for attention of Dr. Sarahjane Belton. Please use the DCU envelope provided.

Parent/Guardian Signature

Name (Block Capitals): _____

Child's Name (Block Capitals):

Witness: _____ Date: _____

Option 2: Child to be removed from the study

I have read and understood the information in this form. I have read and explained the information in the form to my child. The researchers have answered my questions and concerns, and I have a copy of this consent form. I request that my child is **not** included in the study. I understand that my child will not be penalised in any way for doing this.

ACTION: To advise the research team of your decision please sign and return this form to your child's teacher for attention of Dr. Sarahjane Belton. Please use the DCU envelope provided.

Parent/Guardian Signature:

Name in Block Capitals:

Child's Name in Block Capitals:

Witness: _____ Date: _____

Appendix D

Manager Consent

Dear _____

You are being invited to participate in research for Kids Active, a new physical activity programme for early childhood care and education settings. This programme is being developed by Early Childhood Ireland in collaboration with the Irish Heart Foundation and Dublin City University and is designed to support educators to promote physical activity in their settings.

In order to evaluate the effectiveness of the Kids Active programme, researchers from Dublin City University will collect data before and after the implementation of the programme in your pre-school. This will involve members of the project team from DCU and Early Childhood Ireland coming to your facility for one day to measure levels of physical activity and fundamental movement skills of the children. This research will be non-invasive and the researchers will aim to ensure it is enjoyable for all children involved. The research will be carried out as follows:

Physical Measurements

Children's height and weight will be measured using a standard portable weighing scale and a collapsible stadiometer. Children will be required to have shoes removed for height and weight measurement.

Fundamental Movement Skills

4 movement skills (run, vertical jump, overhand throw and catch) have been chosen to be tested. This will require a space of 15-20 meters to facilitate the run. The teachers for each class being tested will be required to be present to facilitate the testing of their group.

For each skill, the researchers will demonstrate how to do the movement first, then ask each child individually to do it by themselves 3 times. A video camera will be set up to record how the movement is performed. This is so that each movement can be replayed several times during analysis to be assessed by the researchers. When all children have completed the movement 3 times the researchers will then repeat the same process for the next skill until each child has had all 4 movements recorded for each child. The time required for this will vary depending on the size of the class.

Physical Activity

Each child will be asked to wear a small movement sensor (accelerometer) that will show how much they move around each day in a week at pre-school. The accelerometer is worn around the waist on an adjustable elasticated belt and children will only be required to wear it while at preschool. The research team will show teachers how to fit the belts to each child and how to remove them. Once fitted each accelerometer will be labelled with each child's name to ensure that the same children wear the same accelerometers every day. Teachers will be required to put the accelerometers on the children each morning when they arrive and remove them before they go home throughout the week.

All information gathered is confidential and will be kept safely stored in DCU. This information will not be shown individually to anyone - it will be combined with information from lots of other children and as such no-one will have access to an individual child's information. Information gathered on the group of children involved in the study will be made available via Early Childhood Ireland to managers, teachers and parents upon commencement of the intervention programme (note: this will be one to two years after data collection commences).

All members of the research team are experienced in working with young children and all necessary precautions will be taken to ensure that children are comfortable and safe at all times. The research team will endeavour to ensure that this is an enjoyable and fun experience for all children involved!

All parents of children who meet the age criteria for this research will receive a letter with a plain language statement (explaining the study and what will be involved) and an informed consent form. The informed consent form will require a signature from parents/guardians to confirm that they do or do not wish their child to be part of this research.

Children can stop being part of the study at any time at their own or their parent/guardian's request by informing the pre-school manager any of the research team. As such, if parents or teachers inform you that a child is no longer taking part in the research please pass this information to a member of the research team. All contact details can be found below and parents will also receive this information as part of the plain language statement.

| Name | Institution | Phone | EMAIL |
|----------------------|-------------------------|--------------|--|
| Dr. Sarahjane Belton | DCU | 01- 7007393 | sarahjane.belton@dcu.ie |
| Dr. Johann Issartel | DCU | 01-7007461 | johann.issartel@dcu.ie |
| Dr. Wesley O'Brien | UCC | 021-490 2319 | wesley.obrien@ucc.ie |
| Ms. Christina Duff | DCU | 085 1353354 | Christina.duff4@mail.dcu.ie |
| Dr Mareesa O'Dwyer | Early Childhood Ireland | 01-404 0645 | Modwyer@earlychildhoodireland.ie |

If you have any queries regarding the conduct of this project you can contact:
The Secretary, Research Ethics Committee, Office of the Vice-President for Research, Dublin City University,
Tel: 01-7008000, Fax: 01-7008002
DCUREC/2016/013

In order for your pre-school to participate in the research element of this study as described above, please sign the attached consent form.

Thank you for your time.

Yours sincerely,

Dr. Sarahjane Belton

Manager Consent Form

I have read (or have been read) the above information regarding this research for the Kids Active programme, and consent for my pre-school to participate in this study. If I have any questions about the study at any time I will contact one of the research team.

(Printed Name)
(Signature)
(Date)

Appendix E

Plain Language Statement (Educators)

Plain Language Statement for Preschool Teachers

Title: Kids Active: Evaluation of a Preschool Physical Activity Programme

Principal Investigator: Dr. Sarahjane Belton.

University Department: School of Health and Human Performance, Dublin City University

Involvement in the Research Study

- ✓ Your preschool is involved in a Physical Activity study called 'Kids Active'
- ✓ The research project will be carried out by Dublin City University, in collaboration with The Irish Heart Foundation and Early Childhood Ireland, and is funded by Medtronic and the Community Foundation for Ireland. Funding was secured for this study through an open call and the funders will have no access to the data.
- ✓ Findings of the project will be shared with you through Early Childhood Ireland once the study is completed. Preschool managers will receive information on the findings of the project which will be shared with you through the manager. Information on the overall findings of the study will also be published on the Early Childhood Ireland website (this will be 1-2 years after the data collection)
- ✓ Dr. Sarahjane Belton, Dr. Johann Issartel, Dr. Wesley O'Brien and Ms Christina Duff will be carrying out the study in the preschool.
- ✓ Teachers are requested to talk to their class about being part of the research study and explained what it will involve.
- ✓ The research will be non-invasive and the researchers will aim to ensure it is fun and enjoyable for all children involved.
- ✓ This is what will happen during the study:
 - 2) You will be asked to complete a questionnaire online via SurveyMonkey regarding how you feel about delivering physical activity to preschool children.
 - 2) Researchers will come into the pre-school on one day and ask each child in your class to do certain movements. These will be:
 - i. Run
 - ii. Vertical Jump
 - iii. Overhand Throw
 - iv. Catch
 - Researchers will demonstrate how to do the movement first, then ask each child to do it by themselves 3 times. A video camera will be set up to record how the movement is performed.
 - Researchers will measure the height and weight of each child
 - You, or another teacher, will be required to be present for this to facilitate the movement testing and assist with the children.
 - 3) The children in your class will also be asked to wear a small movement sensor (accelerometer) that will show how much they move around each day in a week at pre-school.
 - The accelerometer is worn around the waist on a belt and you will be required to fit the belt on each child in the morning and remove it before they go home. The accelerometers will be labelled with the children's names to ensure that each child wears the same accelerometer every day during the study.
- ✓ Children can stop being part of this study at any time at their or their parent/guardian's request. Just inform the manager or one of the researchers from DCU know and they will not have to take part.

- ✓ All of the information obtained for the study will be completely confidential* - no one will get to look at it except Dr. Sarahjane Belton, Dr. Johann Issartel, Dr. Wesley O'Brien, Ms. Christina Duff and Dr. Mareesa O'Dwyer.

If you have any questions about the study at any time you can contact one of the researchers from DCU or Early Childhood Ireland.

| TITLE | SURNAME | FIRST NAME | PHONE | INSTITUTION | EMAIL |
|-------|----------|------------|--------------|-------------|--|
| Dr. | Belton | Sarahjane | 01- 7007393 | DCU | sarahjane.belton@dcu.ie |
| Dr. | Issartel | Johann | 01-7007461 | DCU | johann.issartel@dcu.ie |
| Dr. | O'Brien | Wesley | 021 490 2319 | UCC | wesley.obrien@ucc.ie |
| Ms. | Duff | Christina | 0851353354 | DCU | Christina.duff4@mail.dcu.ie |
| Dr. | O'Dwyer | Mareesa | 01-404 0645 | ECI | Modwyer@earlychildhoodireland.ie |

*If you have any queries regarding the conduct of this project you can contact:
The Secretary, Research Ethics Committee, Office of the Vice-President for Research, Dublin City University,
Tel: 01-7008000, Fax: 01-7008002
DCUREC/2016/013*

*Confidentiality of information provided can only be protected within the limitations of the law. It is possible for data to be subject to subpoena, freedom of information claim or mandated reporting by some professions.

Appendix F

Plain Language Statement (Parents/Guardians)

Plain Language Statement for Parents

Title: Kids Active: Evaluation of a Pre-school Physical Activity Programme

Principal Investigator: Dr. Sarahjane Belton.

University Department: School of Health and Human Performance, Dublin City University

Involvement in the Research Study

- ✓ Your child's preschool is involved in a Physical Activity study called 'Kids Active'
- ✓ The research project will be carried out by Dublin City University in collaboration with The Irish Heart Foundation and Early Childhood Ireland and is funded by Medtronic and the Community Foundation for Ireland. Funding was secured for this study through an open call and the funders will have no access to the data.
- ✓ Findings of the project will be shared with you through Early Childhood Ireland once the study is completed. Preschool managers will receive information on the findings of the project which will be shared with you through the manager. Information on the overall findings of the study will also be published on the Early Childhood Ireland website (this will be 1-2 years after the data collection)
- ✓ Dr. Sarahjane Belton, Dr. Johann Issartel, Dr. Wesley O'Brien and Ms Christina Duff will be carrying out the study in your child's preschool.
- ✓ The research will be non-invasive and the researchers will aim to ensure it is enjoyable for all children involved.
- ✓ Parents/guardians are requested to talk to their child about being part of the research study and explain what it will involve.
- ✓ This is what will happen during the study:
 - Researchers will come into the preschool on one day and ask each child to do certain movements. These will be:
 - Run
 - Vertical Jump
 - Overhand Throw
 - Catch
 - Researchers will demonstrate how to do the movement first, then ask each child to do it by themselves 3 times. A video camera will be set up to record how the movement is performed.
 - Researchers will measure the height and weight of each child.
 - Children will also be asked to wear a small movement sensor (accelerometer) that will show how much they move around each day in a week at pre-school. The accelerometer is worn around the waist on a belt and their teacher will put it on in the morning when they arrive and take it off before they go home.
- ✓ Children can stop being part of this study at any time if they or their parent/guardian request. Just inform the teacher or one of the researchers from DCU know and they will not have to take part.
- ✓ All of the information obtained for the study will be completely confidential* - no one will get to look at it except Dr. Sarahjane Belton, Dr. Johann Issartel, Dr. Wesley O'Brien and Ms. Christina Duff

- ✓ If you have any questions about the study at any time you can contact one of the researchers from DCU or Early Childhood Ireland.

| TITLE | SURNAME | FIRST NAME | PHONE | INSTITUTION | EMAIL |
|-------|----------|------------|--------------|-------------|--|
| Dr. | Belton | Sarahjane | 01- 7007393 | DCU | sarahjane.belton@dcu.ie |
| Dr. | Issartel | Johann | 01-7007461 | DCU | johann.issartel@dcu.ie |
| Dr. | O'Brien | Wesley | 021 490 2319 | UCC | wesley.obrien@ucc.ie |
| Ms. | Duff | Christina | 0851353354 | DCU | Christina.duff4@mail.dcu.ie |
| Dr. | O'Dwyer | Mareesa | 01-404 0645 | ECI | Modwyer@earlychildhoodireland.ie |

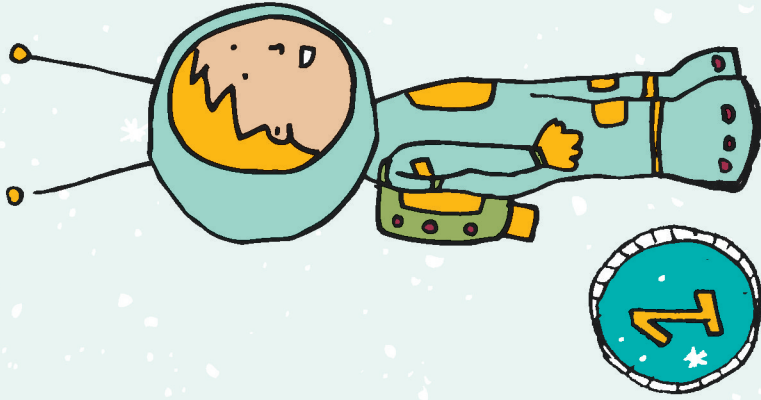
*If you have any queries regarding the conduct of this project you can contact:
The Secretary, Research Ethics Committee, Office of the Vice-President for Research, Dublin City University,
Tel: 01-7008000, Fax: 01-7008002
DCUREC/2016/013*

*Confidentiality of information provided can only be protected within the limitations of the law. It is possible for data to be subject to subpoena, freedom of information claim or mandated reporting by some professions.

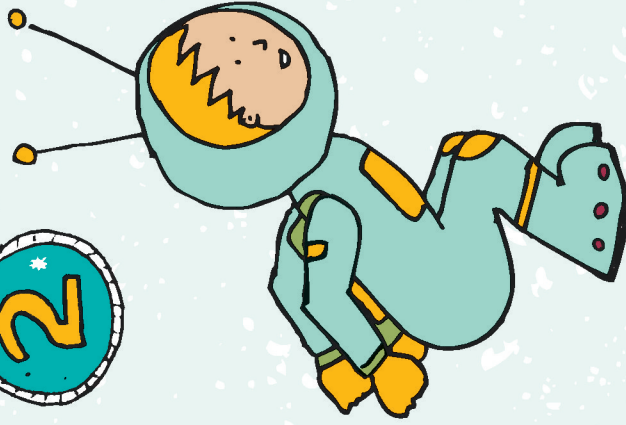
Appendix G

Kids Active FMS cards x 4
(Double-sided)

VERTICAL JUMP



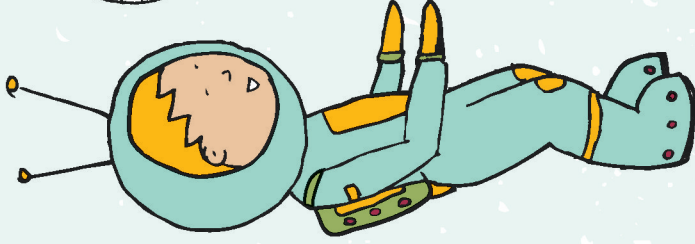
Bend knees to strap up your moonboots and look in front of you.



Keep knees bent, reach under your jet pack to press the buttons on the side.



Look up and get ready to push upwards with legs and reach arms up into the sky at the same time.



Brace for landing (bend knees).



Countdown for lift-off.

3-2-1-BLASTOFF!



VERTICAL JUMP

**KIDS
ACTIVE**

MOVE AND PLAY
EVERY DAY

PRACTICE ACTIVITIES

- Practice technique first before jumping for height, emphasising actions of arms, legs and head.
- Experiment with trying to jump without arms, without bending knees for takeoff or while looking at floor.
- Try different surfaces for jumping (indoor, playground, trampoline) to see how body movements adjust.

EQUIPMENT NOTES

- Mark height by putting chalk on fingers and jumping near wall.
- Suspend something from ceiling or a beam (ribbon, streamers, anything on string) to practice jumping while maintaining eye contact with object.

AT THIS AGE, EXPECT TO SEE:

LIMITED CROUCH.

LOOK FORWARD OR UP TO THE SKY.

HEAD FACING DOWNWARDS.

BODY SCRUNCHED UP (NOT EXTENDING).

TRY TO KEEP YOUR FEET TOGETHER.

FEET LEAVING THE GROUND/LANDING AT DIFFERENT TIMES.



**BEND DOWN TO
TOUCH YOUR MOONBOOTS.**



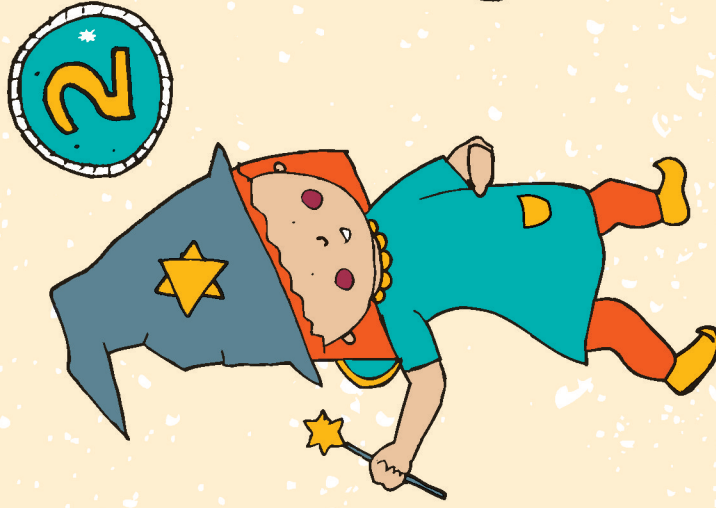
REACH UP REALLY HIGH.



OVERHAND THROW



Turn to the side to grab your wand behind you. Point with other hand to where you're going to cast the spell.



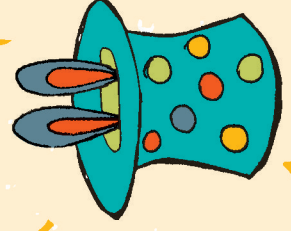
But oh! Your back is itchy, scratch it with your wand.



You're going to need to take a strong step forward with your front leg for the spell to work.



Put wand back in your opposite front pocket.



READY? Everyone say
"ALAKAZAM!"
to cast your spell.

ALAKAZAM! (Al/a-ka/zam)
AL (step) **A-KA** (arm moving forward across body) **ZAM!** (let go)



OVERHAND THROW

**KIDS
ACTIVE**

MOVE AND PLAY
EVERY DAY

PRACTICE ACTIVITIES

- Prioritise distance over accuracy.
- Throw against or toward wall.
- Perform action as group with teacher leading and modelling movement step by step.

EQUIPMENT NOTES

- Select items for throwing that are soft, light and small enough to be held in hand.
- Use items that do not roll (beanbags, balls of paper, shuttlecocks, balls of wool).

AT THIS AGE, YOU MIGHT SEE:



NO ROTATION OF HIPS OR UPPER BODY.

**TURN TO REACH BEHIND
FOR YOUR WAND.**

SCRATCH YOUR BACK.



ELBOW BENDING IN FRONT OF BODY INSTEAD OF ROTATING BEHIND.

LETTING GO OF OBJECT TOO EARLY OR LATE.

**PUT YOUR WAND BACK IN
YOUR OPPOSITE POCKET.**



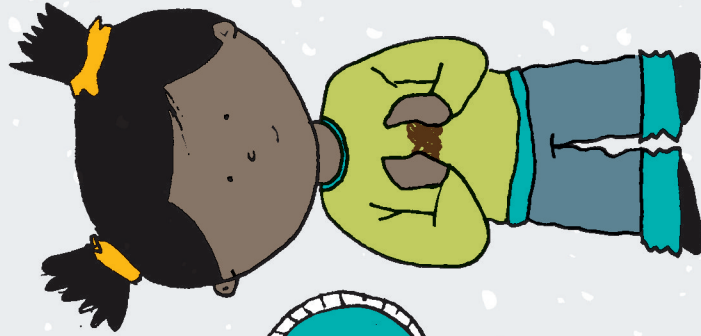
NO FOLLOW THROUGH.

LET GO ON 'ZAM' OF "ALAKAZAM!"

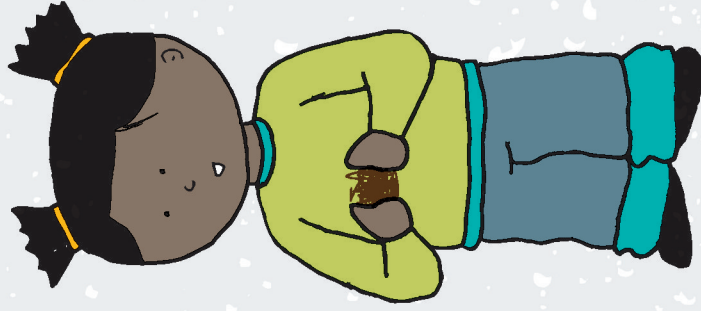




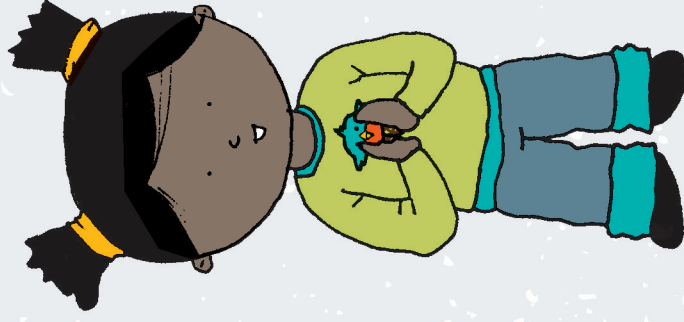
CATCH



Spread hands out wide with pinkies touching to make a nest. Hold your nest in front of your body; keep it nice and big so the bird can get in.



Keep looking at the bird so your eyes can tell your hands where to move.



When the bird flies toward you, move the nest towards it and guide the bird in.





CATCH



PRACTICE ACTIVITIES

- Start by throwing directly in front guiding object into hands, progress to larger distances.

Solo practice:

- With one hand high and other low, drop from one hand into other.
- Toss gently into air and catch (starting from sitting with object that doesn't roll).
- Put beanbag on head, get hands ready and nod head forward so beanbag slides off into hands.

Partners: One partner sits or kneels and other stands. Standing partner drops into waiting sitting partner's hands from different distances.

During throwing games, move around the room and throw at least once to each child to give feedback individually.

EQUIPMENT NOTES

- Start with larger object that are easier to catch, move to smaller as skill improves.
- Bean bags are light, don't roll and are easier to grip than balls.
- (Also try: soft toys, rolled up blankets, rolled up socks).
- Scarves and balloons move slowly to give time to think about position.



AT THIS AGE, EXPECT TO SEE



REMEMBER TO KEEP
LOOKING AT THE BIRD.

KEEPING HANDS BY SIDES UNTIL OBJECT ALMOST AT BODY.

NOT LOOKING AT OBJECT OR TURNING FACE AWAY.

CATCHING AGAINST THE BODY OR IN THE FOREARMS.



GET YOUR NEST READY,
KEEP IT NICE AND BIG.



TRY TO GET THE BIRD
RIGHT INTO ITS NEST.

RUN



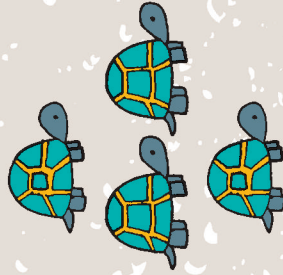
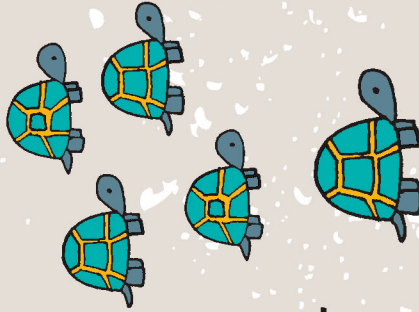
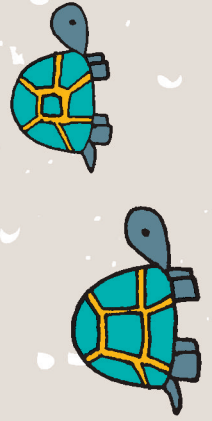
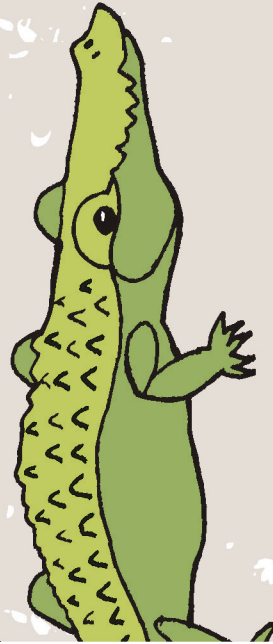
You're a zookeeper and someone has left a door open in the Reptile House.



You need to move as fast as you can to the door to close it before all the turtles escape!



Lift your knees up high to step over the turtles so you can get to the door.





RUN

**KIDS
Active**

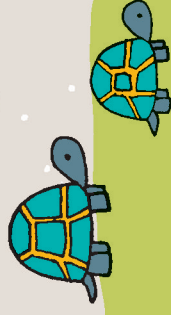
MOVE AND PLAY
EVERY DAY

PRACTICE ACTIVITIES

- Create plenty of opportunities to practice in open spaces with free play running or simple relays.
- Practice on the spot marching with high knees or pretending to run in place (practicing movement of opposite leg with opposite arm).

SAFETY

- Emphasise watching out for others and obstacles nearby.
- Make sure there is sufficient space for slowing down/stopping if running fast.



AT THIS AGE, EXPECT TO SEE:

FEET SHUFFLING.

ARMS HELD OUT FOR BALANCE OR RESTRICTED TO SIDES.

LOOKING AT GROUND.



LOOK TO WHERE YOU
NEED TO GO.



LIFT UP KNEES TO STEP
OVER THE TURTLES.



SWING YOUR ARMS BACK
AND FORWARD TO HELP YOU
GET TO THE DOOR FASTER.



Appendix H

**Kids Active activity cards x 6
(Double-sided)**

— BODY SHAPES —

Individuals and groups use their bodies to make shapes.



— COLOUR SORT —

Run to retrieve items and bring them back to the correct colour zone.

FMS THROW

— JAVELIN STRAWS —

Throw straws to see how far they can go.



FMS IN THIS THEME;
RUN & THROW

COLOURS AND SHAPES

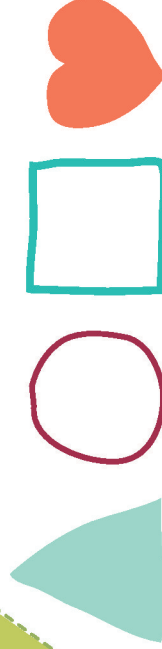
Coordination
of body movements.
—AND—
Working cooperatively.

Matching and sorting.

Demonstrate
self belief
in abilities;
welcome
and seek
challenges.

Recognising
symbols, listening
and watching
for verbal and
non-verbal
commands.

Discovering, exploring
and refining motor skills.
—AND—
Becoming familiar with symbols
representing actions.



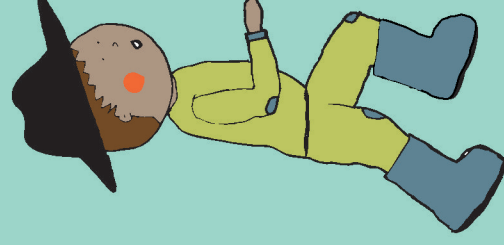
Shapes on the floor make
lots of different games.

— FLOOR SHAPES —

FMS RUN

— RED LIGHT, GREEN LIGHT —

Run when the light
turns green, stop on red.



GO

STOP

COLOURS AND SHAPES

- JAVELIN STRAWS -

Mark a space to stand and mark several targets at different distances.

Use coloured drinking straws as "javelins".

Each child gets one of each colour to throw.

Use coloured bowls, buckets, sheets of paper with numbers or pictures or lines of masking tape to mark distance.

RED LIGHT, GREEN LIGHT

Mark two points to move between.

Educator can shout out "Green light" or hold up something green to signal 'Go'.

Children run from one point to the other.

Children run until teacher shouts "Red light" or holds up something red to signal 'Stop'.

Leave lots of gaps between lights to give opportunity for more running.

More Active: Keep marching on spot when "stopped".

- FLOOR SHAPES -

Small Shapes: Can only step on certain shapes (e.g. find a path around room stepping on only rectangles).

Large Shapes: Jump from shape to shape.

Shape Toss

Standing near, throw bean bag or soft toy to closer shapes. Progress to standing further away (throw for distance).

Variations:

- Vary motor skills (jump with two feet together, hop, side step, crawl etc).
- drive toy cars along line of large shapes.
- Stand in shape and jump in and out or side to side.

BODY SHAPES

Individual: Make shapes with whole body (triangle, rectangle, star, circle) or different body parts.

Groups: Challenge teams of 2 or more to make shapes by working together.

- COLOUR SORT -

Equipment:

- * Several objects in different colours (lego, blocks, balls, beanbags)
- * Hula hoops, buckets, bowls or coloured paper.

Run to pile, pick up one of the objects (emphasise that they can only take one at a time).

Run back and put it on/in the corresponding colour.



FMS JUMP

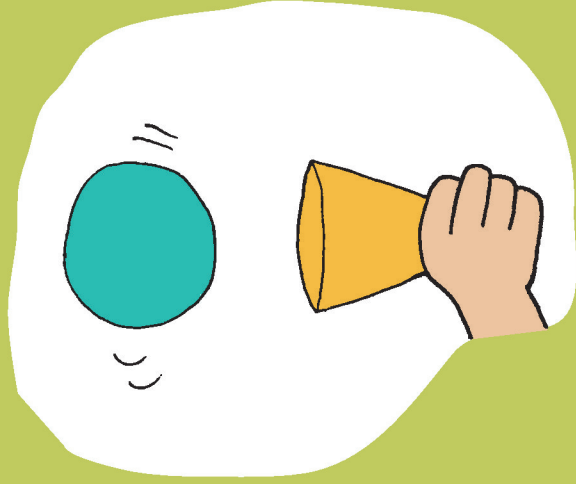
— ANIMAL JUMPS —

Jump like 3 different animals.

FMS CATCH

— CATCH THE EGG —

Catch the egg using a paper cone.



FMS IN THIS THEME;
CATCH & JUMP

RIBBIT



Discovering how
different things affect
movement and figuring
out how to jump higher.

ANIMALS

Role playing and
expressing self
through active storytelling.
Understanding roles of
people in the community.

Experimenting with
environment and
new physical skills.

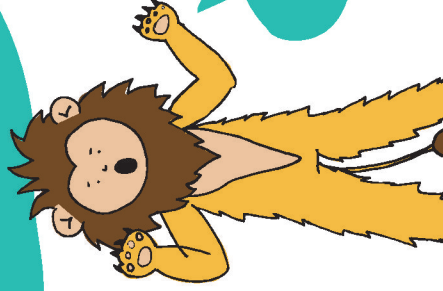
AND —

Listening to
instructions and
understanding
prepositions.

Taking turns and letting the
next person know when to go.

— AND —

Using existing knowledge of animals
to understand movements.



ROAR

Take it in turns to move
like different animals.

— ANIMAL RELAY —

— ACTIVE IMAGINATION —

Take a trip to the zoo,
be a farmer or act like
different jungle animals.



— ANIMAL OBSTACLE COURSE —

Move like or around the animals.



ANIMALS

-ANIMAL JUMPS -

Talk about different jumping animals and jump like them.

- 1) **Frog:** Touch the ground with hands.
- 2) **Kangaroo:** hands out in front close to body.
- 3) **Rabbit:** Lots of little jumps.

Discuss: Which jumps higher/how do they jump? Are people jumps different than the animal ones?

Call out different animals and change to that jump.

Finish by practising jumping high using arms and legs.

CATCH THE EGG

Encourage children to:

- pick up balloons that touch the ground and throw them back into air.
- use their cone to throw the balloon back up when caught.
- Try to keep all balloons moving.

Variations:

- Work in pairs passing balloon between cones.
- Pass balloon around circle by transferring from cone to cone, rotating upper body.
- (add more balloons for extra challenge).

ACTIVE IMAGINATION

Zoo: "Cycle" to zoo, march to the different areas, wave to the animals and move like them. Jump up high to see the far away animals...

Farm: Pretend to be a farmer. Wake up in morning, drive tractor around farm, feed the different animals, milk the cows, pick up the chicken eggs...

Jungle:

Climb trees like a monkey, prowl like a lion, swing elephant trunk...

Or try an active telling of Going on a Lion/Bear Hunt storybook.

ANIMAL OBSTACLE

COURSE

Set out obstacle course to move through like different animals:

- Slither under blanket like a snake.
- Jump over rope like a frog.
- Gallop from one obstacle to another like a horse.
- Crawl (with hands and feet on two parallel lines) like a cat.

Variation

Scatter stuffed or toy animals along course to jump or step over. Children make that animal sound as they move over it.

- ANIMAL RELAY -

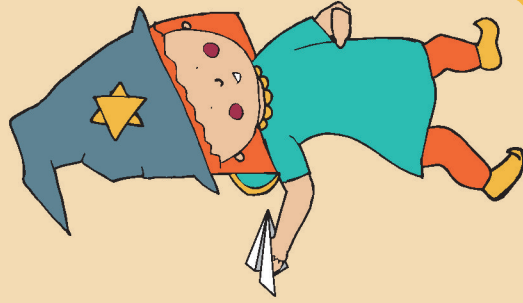
- 1) Take turns moving like chosen animal from one side of the room to the other and back until all children have had a go.
- 2) Change animal each round or choose 'an animal on way up and another on way back.
- 3) Give children option of choosing their own animal and everyone can guess what it is.



FMS THROW

— PAPER PLANES —

Practice overhand throwing using paper planes.



— CAR TRIP —

Drive car around in circle (can use small hoop, plastic or paper plate for steering wheel).

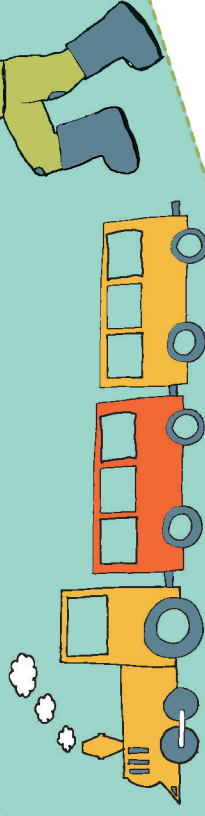


FMS IN THIS THEME;
THROW & RUN

FMS RUN

— HOW LONG IS THE TRAIN? —

Run to the train and add a new carriage.



— MOVE LIKE A... —

Moving like different modes of transport, Stay in place or move around.



MODES OF TRANSPORT

Working cooperatively.

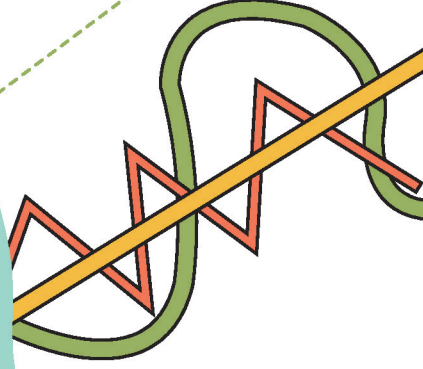
Predicting and analysing where plane will go & how to throw it.
Discovering and exploring motor skills.

Role playing and expressing self through active storytelling.
Understanding descriptive words for ways of moving.

Developing sense of shape and space.

Recognising commands & using knowledge of different transport types to move in certain ways.
AND
Recognise own methods of transport.

Masking tape lines in different arrangements make lots of different games.



— TAPE LINE GAMES —

MODES OF TRANSPORT

- PAPER PLANES -

Preparation:

Print a basic paper plane template. Children can colour and personalise before educator folds them.

Practice throwing for distance, emphasising points on the FMS card.

Set targets or mark where planes land and see if everyone can beat their own distance.

HOW LONG IS THE TRAIN?

Using a train set or photocopies of train carriages, take turns to pick up a carriage and run to the other end of the room to add it to the train.

Train can be wooden set or a picture of train stuck to the floor or wall (affix double sided tape on sheet for wall train).

- CAR TRIP -

Drive car around in circle:

- Alternate fast and slow.
- Beep horn.
- Stop (red light/stuck in traffic) and go (green light/traffic moving).
- Steering wheel held up high (driving over hill) or crouch down low (going under bridge).
- Jump over potholes.
- Reverse (for older groups). Make sure to keep saying "look over shoulder, move nice and slow" etc.
- Flat tyre (wobble or lean to one side): pretend to get out of car, bend down and pump up tyre (pumping action up and down).

MOVE LIKE A...

Moving around room

Car: Steering wheel.

Train: Bend elbows and make circles along sides of body.

Plane: arms out and moving side to side.

Skating: drag feet along ground, opposite arms to opposite leg.

Staying in same place

Bike (sit on floor leaning back with hands on ground and pedal feet in air).

Boat (sit on floor and row).

More Active: Teacher calls out different vehicles to signify specific movements, changing between sitting and standing.

- TAPE LINES -

Train tracks:

- Jump over lines with feet together.
- Take big steps over.
- Hop on one foot.
- Jump sideways over lines.
- Use lines as targets for overhand throw airplanes.

"Path" lines

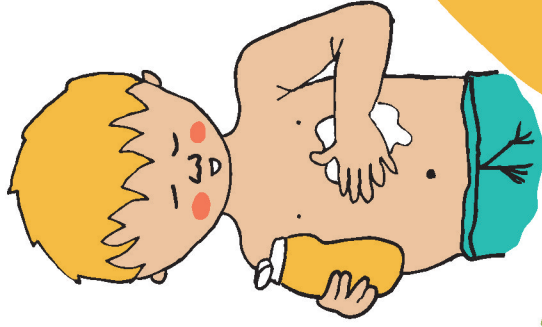
- Walk along different shaped lines keeping balance.
- Move on hands and feet along parallel vertical lines.
- Walk wide or narrow on 2 lines making 'V' shape.



— SUNSCREEN —

(Active Imagination)

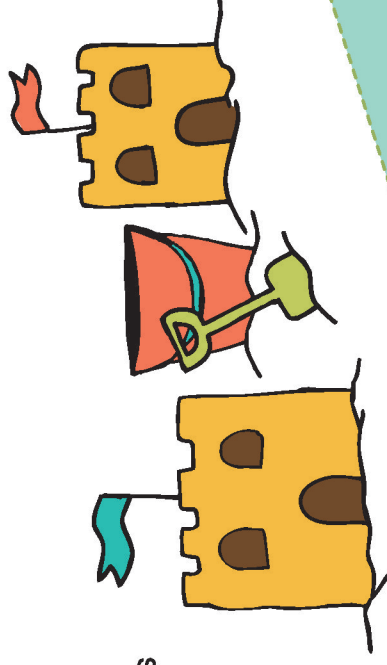
Pretend to apply sun cream to different parts of body before going out in the sun.



— SANDCASTLES —

(Active Imagination)

Make lots of sandcastles at the beach.



— BEACHBALL RELAY RACES —

Keep the ball between partners using different parts of the body or holding the ball.



FMS IN THIS THEME;
CATCH & JUMP

SUMMER

Expressing own ideas, preferences and needs.

Making healthy choices and being aware of bodies.

Cooperating.
— AND
Using cognitive & physical skills.
— AND
Communicating with partner.

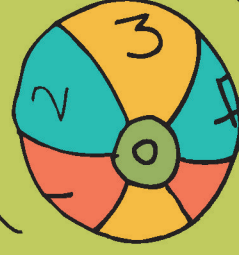
Practising jumps and refining motor skills.

Recognising symbols.
— AND —
Giving commands to the group.

FMS CATCH

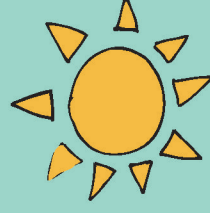
— BEACHBALL SHOUT —

Catch the ball and call out the first number/symbol/animal you see.



— WAVE JUMPING —

Splash in the sea until a big wave comes to jump over.



FMS JUMP

SUMMER

-SUNCREAM -

Active Imagination

- With one arm reaching up, apply sunscreen up and down from shoulder to fingertips.
- Change arms, apply to chest and tummy, reach around to back.
- Apply to the front and sides of legs (bending knees), one at a time or together.
- Move from standing to sitting, lift up one leg to reach the back of leg, rub along back of leg top and bottom.

Advanced:

- Try reaching and twisting in different ways to reach different parts of the back.
- Experiment with keeping leg up and letting go with hands. Lift leg up and down.

- Make movements easier or harder depending on age and ability.
- Vary speed.

BEACHBALL

Relay Races

Take turns to run with the ball to the finish line and back to pass to the next person, or:

- facing each other both keeping hands on ball, walking sideways.
- using other parts of body to trap the ball between partners (arm, hip, shoulder, chest, back).
- walking forward side by side and gently handing the ball to each other sideways.

BEACHBALL

Catching Game

Preparation: Stick pictures around the ball or use a permanent marker to write numbers or letters on it.

On catching the ball, a child calls out the picture they see and all perform the associated command.

Ideas for pictures to add to ball:

Animals: Move like that animal.

Numbers: Jump that number of times (or touch the ground, shake head, touch knees).

Letters: say the letter and the educator will name something beginning with that letter to pretend to be;

Symbols: (swirl=twirl around, arrow=jump).

Body Parts: Move that body part.

-SANDCASTLES -

Active Imagination

Sample:

- Legs hip width apart and squat down low like trying to sit in a chair, use both arms with hands together for digging.
- Squat down and pretend to turn bucket upside down to make a sandcastle.
- Pretend to build your castle really tall so you have to jump up high to put more sand on top.

Run around 'the room to find a new area to dig each time.

- Pretend to dig with hands.
- Alternate fast and slow digging.

If children choose to, they can knock the castle down and start again by;

- jumping onto castle.
- kicking it down.
- pretending to throw buckets of water over it.

SEASIDE

Wave Jumping

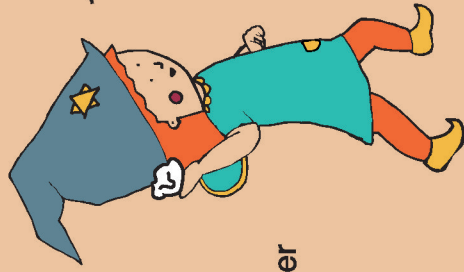
- 1) Educator stands in front of the group holding a piece of blue cloth or paper and gently shakes it.
- 2) Children run on the spot slowly and pretend to be splashing in the sea.
- 3) Educator says "Here comes the big wave!" and children get in position ready to jump until teacher shakes the cloth up and down to signify a wave.
- 4) Children jump high when they see/hear the wave then go back to "splashing".



FMS THROW

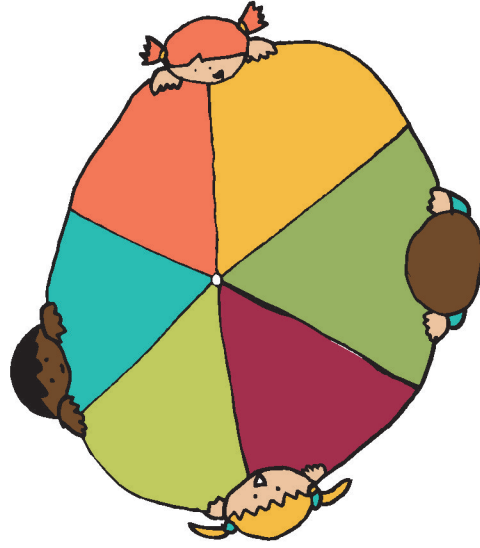
— SNOWBALLS —

Practice throwing with scrunched up newspaper “snowballs”.



— PARACHUTE GAMES —

Shake the parachute to make it snow or shake to the weather forecast.

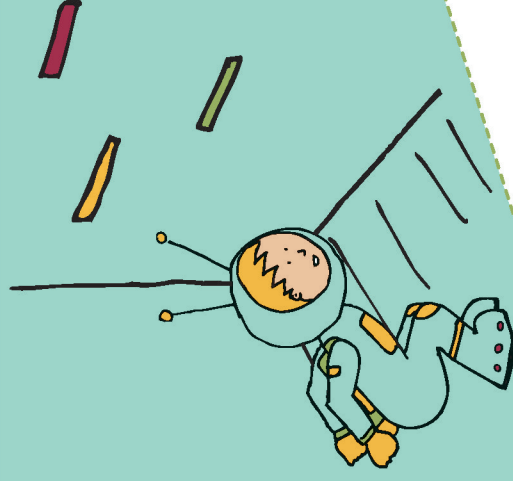


FMS IN THIS THEME;
THROW & JUMP

FMS JUMP

— RAINBOW JUMP —

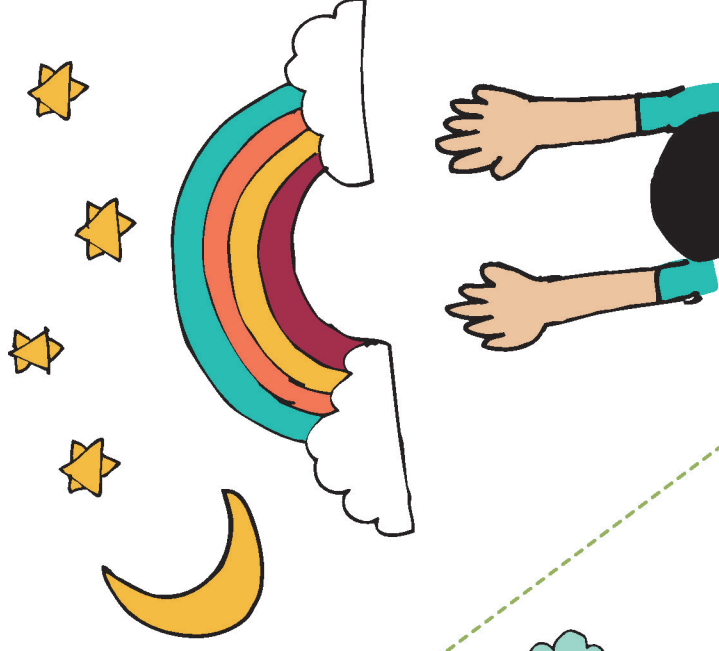
Make a “Jumping Rainbow” poster with strips of coloured paper.



— TOUCH THE SKY —

Active Imagination

Jump up to reach as far as you can. Starting low, going higher, naming things to touch.



Recognising progress and achievements. Contributing to a piece of collaborative artwork.

Practising overhand throw; refining motor skills.

WEATHER

Practising jumps and refining motor skills.

Working as part of a group.

Recognising commands and using knowledge of types of weather to move in certain ways.

— AND —

Using the body and voice to share information.



— WEATHER FORECAST —

Active Imagination

Act out the changing weather.

WEATHER

- SNOWBALLS -

- 1) Fill a large box or basket with scrunched up balls of newspaper.
- 2) Ensure that all children are on the same side of the room and emphasise that the aim is not to throw snowballs at each other but to see how far we can make them go.
- 3) Teacher counts in each throw and everyone throws at the same time.

RAINBOW JUMP

- 1) Each child selects a coloured strip of paper.
- 2) A large piece of paper is affixed to the wall and children take turns jumping as high as they can.
- 3) Teacher sticks their piece of paper to the height they reached with their name or initials marked on it.
- 4) The piece of paper can be displayed as a "jumping rainbow" and can be repeated another time to compare the difference.

- PARACHUTE GAMES -

Shake fast and slow for weather forecast.
 "In the morning it's nice and calm and sunny, with a gentle breeze and no rain (gently shaking parachute). Then out of nowhere, a **THUNDER STORM!**" (shake vigorously).

- Shake cotton wool balls up and down for snow.

- Use newspaper balls from the snowball throwing. Try to work as a team to roll the snowballs around in the parachute by bringing high or low to stop it falling off.

WEATHER FORECAST

Active Imagination:

Rain: Wiggling fingers from high over head, bending knees and bringing down to floor.

Wind: Arms in air waving side to side, stepping to side with feet as weight shifts.

Sun: Lie down on the ground and stretch out in the sun.

Snow: Pretend to pick up snow and throw snowballs.

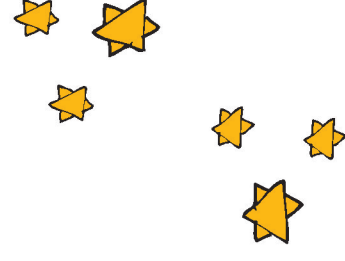
- TOUCH THE SKY -

Start by standing and reaching up high, then jump gently to try and reach the branches of a tree.

Progress to jumping higher, bending knees and getting lower to jump higher.

Try to reach a rainbow, then the sky, the clouds (touch the clouds, "Oh they're soggy!") Touch the rainbow.

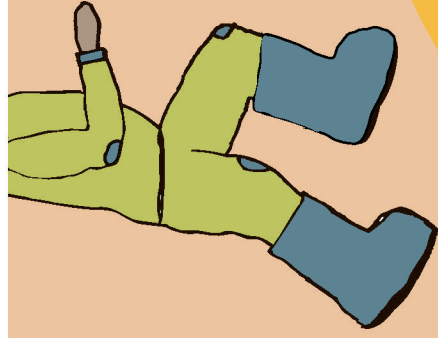
GRAB SOME STARS



FMS RUN

— FUNNY RUN —

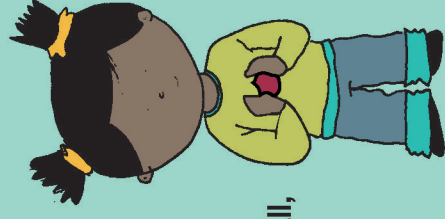
Discover how different parts of the body make up the run by experimenting with running in different ways.



FMS CATCH

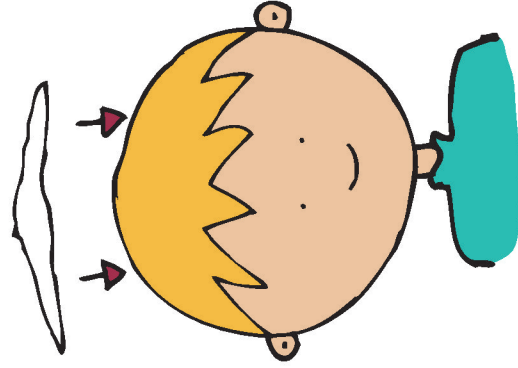
— CATCHING PRACTICE —

Partner practice using soft objects Eg: Large ball, rolled up blankets, socks, bean bags, soft toys.



— BALANCE GAMES —

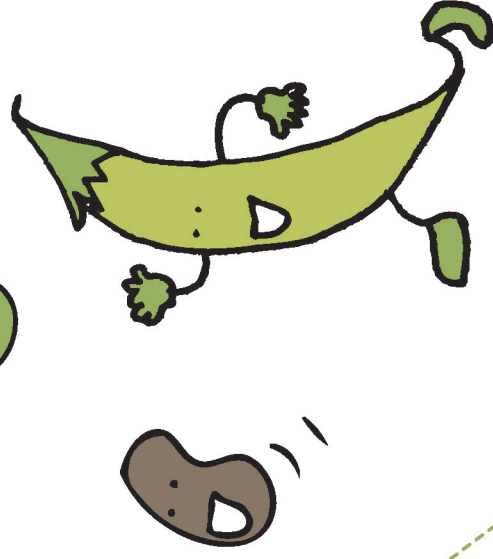
Educator calls out body parts to balance a tissue or beanbag on.



FMS IN THIS THEME;
RUN & CATCH

— BEAN GAME —

Educator leads group around room naming different beans to move like.



BODY PARTS

Communicating with partner verbally and non-verbally.

Exploring different ways of moving and using new physical skills.

Gaining control and coordination of body movements.

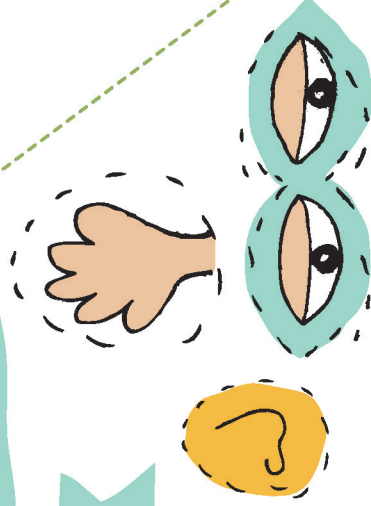
Matching and problem solving.

Listening and responding to verbal commands.

Recognising which actions correspond to which words (symbols)

— BODY PART RELAY —

Match the body part to the stickman or the clothes to the body part.



BODY PARTS

- FUNNY RUN -

- 1) Discuss how to run properly.
- 2) Get children to take turns trying to "run" (slowly) while:
 - reaching up high in air and on tiptoes.
 - with legs wide.
 - with legs straight.

(When all have had a turn, discuss how it felt/looked).

- 3) Practice correct running on the spot (slowly, exaggerating movements, lifting knees high and swinging arms, looking forward).

- 4) Finish with a simple relay or free play running to practice correct running form.

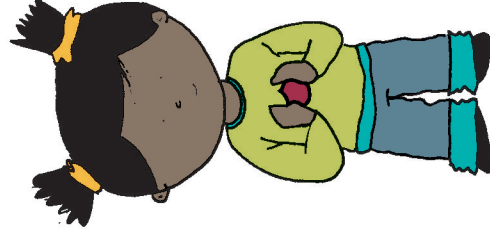
CATCHING PRACTICE

Individual: Start with dropping and catching from one hand to other.

Pairs: Throw and catch to each other. Vary distance.

Emphasise not throwing unless partner is ready to catch.

Move around to throw to each child and give feedback (see FMS Card).



BALANCE GAMES

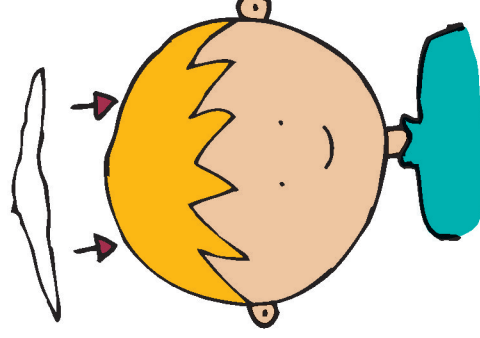
Start by sitting down and putting tissue on a body part and progress to;

- standing.
- walking.
- dancing.

Turn into game of "Freeze!"

Harder: Use heavier objects (beanbag, small soft toys etc).

Variation: Throw tissue in air and try to catch it with area named.



BODY PART RELAY

Preparation: Cut out outlines of different body parts and lay out in designated area on one side of the room.

Hang a large page (blank or with stick figures) on the other side of the room.

Children take turns (one line or in teams) to run up and retrieve a body part, then stick it to the poster in the position it should go in.

Variation: Use pictures of different items of clothing and match them to the right body part on a picture of a person.

- BEAN GAME -

Lead the group around walking, marching or running if there is space.

Call out the names of different types of beans (below) and keep moving ahead like that bean.

- Jumping bean (jump).
- Runner bean (run).
- Broad bean (walk arms and legs wide).
- String bean (reaching up tall with arms high in air).
- Frozen bean (shaking and rubbing arms saying "brrr").
- Baked bean (jump on tiptoes like floor is hot).
- Jelly bean (wobble and shake).

