UNIVERSITY OF DERBY

Increasing physical activity and fundamental movement skills in early childhood by using school-based interventions

Alexandra Patricia Dobell

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF UNIVERSITY OF DERBY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

College of Science and Engineering

September 2022

Copyright Statement

Acknowledgements

Firstly, I would like to thank my Director of Studies Dr Clare Roscoe, and supervisors Dr Mark Faghy and Professor Andy Pringle for their constant unwavering support, kind words, and encouragement throughout my PhD. You have all inspired me with your knowledge and expertise, guiding and pushing me to produce my best work possible, despite the difficult times we have faced over the past three years. You have helped me to grow as both a researcher, lecturer and as a person, helping me to secure a post-doctoral position I could have only dreamed of at the start of my PhD.

Professionally, I would also like to thank the Sport and Exercise Technicians, Kyle, Anya, and Pete at the University of Derby for ensuring I have always had the means to collect the precious data during the past three years. Additionally, fellow staff in the department (too many to mention), who have all offered support and guidance throughout the PhD process and developing as an academic. Many of you have become friends to lean on throughout my three years at Derby, so thank you.

Many thanks to all the wonderful participants across the country, from London to Teesside who gave up their precious time to contribute to this body of work.

Personally, I would like to thank my parents for continuing to support my studying, their unconditional love, and for being ‘home’ twice during COVID! Some of those days were very hard, so thank you for putting up with the stress and tears. Dad, thank you for the re-tweets and shares on Twitter and LinkedIn which led to many a participant. Mum, thank you for those local school connections and plenty of proof reading.

Publications from PhD

Dobell, A., Pringle, A., Faghy, M. A., & Roscoe, C. M. P. (2020). Fundamental Movement Skills and Accelerometer-Measured Physical Activity Levels during Early Childhood: A Systematic Review. *Children*, *7*(11), 224.

Dobell, A., Pringle, A., Faghy, M. A., & Roscoe, C. M. P. (2021). Educators Perspectives on the Value of Physical Education, Physical Activity and Fundamental Movement Skills for Early Years Foundation Stage Children in England. *Children*, 8(5), 338

Publications throughout PhD

Duncan, M. J., **Dobell, A**., Noon, M., Clark, C. C. T., Roscoe, C. M. P., Faghy, M. A., Stodden, D., Sacko, R., & Eyre, E. L. J. (2020). Calibration and Cross-Validation of Accelerometery for Estimating Movement Skills in Children Aged 8–12 Years. *Sensors*, *20*(10), 2776.

Duncan, M. J., Eyre, E. L. J., Cox, V., Roscoe, C. M. P., Faghy, M. A., Tallis, J., **Dobell, A.** (2020). Cross-validation of Actigraph derived accelerometer cut-points for assessment of sedentary behaviour and physical activity in children aged 8-11 years. *Acta Paediatrica*. 109, 1825– 1830

Altenburg, T. M., de Vries, L., op den Buijsch, R., Eyre, E., **Dobell, A.,** Duncan, M., & Chinapaw, M. J. M. (2022). Cross-validation of cut-points in preschool children using different accelerometer placements and data axes. *Journal of Sports Sciences*, 0(0), 1–7.

Oral communications

3 Minute Thesis 2020 and 2021 'Increasing physical activity and fundamental movement skills in early childhood by using school-based interventions'

University of Derby My Research My Reach - Postgraduate Research Student Online Showcase 2020: 'Measuring motor competence, physical activity and balance in children aged 4-5 years olds'

University of Derby PGR Research Café (March 2021) Extended Presentation- 'What do we know about the Fundamental Movement Skills and Physical Activity Levels of Children during Early Childhood?'

University of Derby PGR Research Café (September 2021)- 'Educators Perspectives on the Value of Physical Education, Physical Activity and Fundamental Movement Skills for Early Years Foundation Stage Children in England'

University of Derby My Research My Reach - Virtual PGR Conference 2021 (November 2021): 'Improving fundamental movement skills during early childhood: an intervention mapping approach'.

BASES 2021 (virtual) (November 2021)- 'Educators perspectives on the value of physical education, physical activity and fundamental movement skills for early years foundation stage children in England'

University of Derby Human Sciences Research Centre Seminar Series (January 2022)- 'Increasing physical activity and fundamental movement skills in early childhood by using school-based interventions'

3 Minute Thesis 2022 University finalist 'Increasing physical activity and fundamental movement skills in early childhood by using school-based interventions'

BASES 2022 (November 2022)- Fundamental movement skill competence and physical activity of 4-5-year-old school children in central England, what next?

Poster communications

Fifth Assembly of the International Motor Development Research Consortium 2021 (September 2021) (Virtual- poster with video)- 'Fundamental Movement Skills and Accelerometer Measured Physical Activity Levels during Early Childhood: A Systematic Review'.

Photo communications

University of Derby Images of Research 2022- Physically Active 4-year-olds- Judges Choice winner

Abbreviations

FMS Fundamental Movement Skills

PA Physical Activity

MVPA Moderate to Vigorous Physical Activity

PE Physical Education

MC Motor Competence

EYFS Early Years Foundation Stage

IM Intervention Mapping

SLT Senior Leadership Team

Abstract

Physical activity (PA) recommendations in the United Kingdom (UK) state that children aged 5 and under should be active for at least 180 minutes each day, with at least 60 from moderate to vigorous PA (MVPA). Good motor development aids children in participating in adequate levels of PA, and during the early years of childhood (3-5 years) children should begin to learn, practice, and develop fundamental movement skills (FMS). With declining childhood PA levels in the UK and a growing gap in PA performance due to deprivation, more must be understood about which key factors affect children's FMS development and PA participation. Crucially, the appropriate support and intervention to improve these factors must be informed and underpinned by a theoretical and evidence base from this population and their environment.

The aims of this thesis were to a) systematically review the literature available about 4-5 year old's FMS, and accelerometer measured PA levels, including the variation in measurement methods employed, b) investigate educators perspectives of PA, FMS and physical education (PE) for early years foundation stage (EYFS) children, c) assess a sample of English EYFS children's FMS competency and PA, finally, d) be the first to use intervention mapping (IM) to develop appropriate interventions to aid FMS development and PA participation in early childhood in school settings informed by the data sets collected through this programme of research.

The initial study of this PhD systematically reviewed the literature available for children aged 4-5 years of age's FMS levels and accelerometer-based PA levels. Following PRISMA guidelines 3 data bases were searched for appropriate articles before being screened for inclusion. Results showed that children's FMS competency levels were lower than expected for their age, PA was generally underperformed at MVPA levels, and that stability measurements were wide and varied for this age group. The review also focussed on the measurement methods and issues within the research area, with suggestion on how some of these issues should be overcome or improved.

The second study of the programme collected the perceptions that EYFS educators in England held about PA, FMS, and PE for children. Twelve educators (two headteachers, three external coaches, and seven EYFS teachers) took part in semi-structured individual interviews. Educators were from locations across England and taught in a range of SES schools and were predominantly female

(n=9). Thematic analysis was employed to identify key themes formed from codes within verbatim transcription of the interviews. The five emergent themes were: PA and PE in the EYFS; the benefits of PA and PE for young children; the barriers and challenges to achieving sufficient PA/PE for children faced by educators, and children; educator knowledge of FMS and key opportunities for development; intervention experience, needs, and training delivery.

The third study assessed the FMS competency, including balance (n=92), and accelerometer measured PA levels (n=54) of a sample of children from the central region of England attending the EYFS of school. This study aimed to understand the current achievement of English children and establish if a relationship between FMS and PA exists, and what variables may affect this. The key analysis showed that age tertiles of a school year (autumn, spring, and summer term births) had an effect on the children's FMS competency level, with the oldest children achieving the best level of FMS competency. The participants with sufficient PA data showed that they were meeting PA guidelines of both total PA (180 minutes) and MVPA (60 minutes) according to British population cut points for wrist worn accelerometers.

This study also was adapted for an online data collection during the coronavirus pandemic, this resulted in a very small sample of data collection, although this was not used in the synthesis of results. The important outcomes from this study included the challenges that are faced during remote data collection and recommendations of how to best collect data in these circumstances. This adds key knowledge to this area of research, particularly from a methodological perspective.

The final study was the most novel in nature, employing IM, a six-stage process used to design and develop programmes of theory and evidence-based health promotion interventions. To our knowledge this study was the first to begin to use IM to plan FMS promotion interventions and particularly focuses on early childhood in English school settings. By using the data sets collected throughout this programme of research, in addition to a planning group of key stakeholders, each task of the six steps of IM were detailed, including the planning, and drafting of selected programme materials. This begins to guide the development of an EYFS school-based intervention to implement both at the school setting, local authority, and community setting, with consideration to the developments needed at policy level intervention.

The studies in this thesis extend the knowledge within the area of PA and FMS in early childhood populations and specifically of those children at the start of school within English populations. The thesis has found that globally the literature reports FMS competency to be low in children aged 4-5 years and there is varying evidence surrounding performance PA levels, with a lack of consensus on how to best measure FMS and accelerometer measured PA in early childhood. This low global FMS competency is supported by the primary observations of 4–5-year-olds in central England, however these children did demonstrate sufficient PA levels, adding to the varying evidence available. Despite this, in England, educators reported that they value the use of PE and PA opportunities to help children develop physically, mentally, socially, and academically. Nonetheless, a lack of confidence in knowledge of FMS and application of how to teach and create opportunity leaves some teachers unable to promote and teach better FMS competency. Importantly, this thesis has developed a programme of FMS promotion interventions to be used in school settings and provided at teacher (implementer) and child (individual/participant) level. By considering the different levels of the socioecological model, the adaptability to meet different school's needs across England can be achieved, which meets the aims of the IM process.

Table of contents

Chapters

List of Appendices

List of Tables

List of Figures

Chapter 1

Introduction

1.1 General Introduction

1.1.1 Physical Activity during Early Childhood

Physical activity (PA) is defined as physical movement produced by the skeletal muscles of the body that expends energy (Caspersen et al., 1985). Rates of mortality and the development of chronic health conditions are reduced by engaging with regular PA and structured exercise programmes (Mora et al., 2008). It is established that PA is a lifestyle behaviour that promotes positive health benefits, with academic literature consistently demonstrating the benefits of PA on health are wide and varying (Department for Health and Social Care, 2019a; Warburton & Bredin, 2017), including in child and youth populations (Carson et al., 2017; Poitras et al., 2016). Timmons et al., (2012) found that PA in the early childhood years can improve adiposity, psychosocial wellbeing, cardiometabolic health indicators and motor development. While Janssen & LeBlanc, (2010) reported that during childhood, PA can reduce the incidence of chronic disease, improve health-related fitness, maintain a healthy weight, and increase bone density and strength. PA and physical fitness can also improve children's academic achievement and cognitive outcomes (Fedewa & Ahn, 2011), while preventing mental health disorders in adolescence including depression, anxiety, and mood disorder (Wu et al., 2017). These reasons alone, demonstrate the need to promote PA during the early years. Despite this knowledge, PA levels in for children and young people in England continue to decline (Sport England, 2021), along with concerning rates of obesity in child populations, with almost a quarter of UK children overweight or obese by the age of five years (NHS Digital, 2020). Decreasing sedentary behaviour (SB) in children while aiming to increase overall PA and sufficient moderate-vigorous physical activity (MVPA) is becoming increasingly important, even during early childhood.

Early childhood refers to the first stages of a child's life. In a Logan et al., (2015) review, early childhood was categorised as 3-5 years of age, and is widely reported as the 'Preschool' years in the literature. The UK government also provide PA guidelines specifically for children under five years of age, known as the 'early years' (Department for Health and Social Care, 2019a). From this age, PA and movement competency begin to develop more independently and possibly at a rapid rate, as demonstrated in the fundamental motor skills progression in Seefeldt's 1980 model (Seefeldt, 1980), with recommendation for monitoring of these variables every two to three months (Malina, 2004). It is important to stress the importance of establishing positive health self-regulation behaviours, such as daily PA, at young ages (Steinbeck, 2001), as tracking of these behaviours from childhood into adulthood is well reported in the literature (Barnett et al., 2009; Telama et al., 2013), showing mirrored patterns at both stages of life.

Each day of a child's life is made up of movement behaviours, which can be summed into a 24-hour period. Sleep, PA, and SB constitute these daily movement behaviours. Sedentary behaviour can be defined as activity performed at less than 2 metabolic equivalents of energy (METS) (Roscoe et al., 2017a), and includes activities that usually involve sitting or standing with little to no bodily movement (Pate et al., 2011). For young children, this could include reading activities, arts and crafts, and screen-based activities. Consequently, there is an argument that these activities form constructs of important learning processes for children, including the development of fine motor skills (Duncan et al., 2021). These elements of physical, social, and psychological development are key to overall child development, and for progression throughout life (Lazar & Darlington, 1982), therefore, these opportunities should be adequately accounted for in PA guidelines for the age group. Light PA constitutes between 2 and 3 METS (Roscoe et al., 2017a) and can include activities such as walking and easy cycling and can provide health benefits (Kelly et al., 2014). However, literature has largley focussed it's attention on recommending MVPA due to the widely reported health benefits at all ages (Ekelund et al., 2012; Warburton & Bredin, 2016). This level of activity would constitute behaviours above 3 METS for moderate, and 6 METS for vigorous (Roscoe et al., 2017a), examples of activities would involve; dancing, climbing, moderate to fast cycling, and ball games. Importantly, Jones et al., (2013) found that SB tracks more strongly than PA levels from young to middle childhood, reinforcing the need to reduce the high levels of SB at a young age and encourage participation and enjoyment at all levels of PA.

International PA recommendations have been made by global bodies including the World Health Organisation (WHO), with the most recent iterations stating that 'every movement counts', a message that is emphasised at each stage of life (World Health Organisation, 2020), supporting the ‘move more, sit less’ approach that has been recommended in the literature (Warburton & Bredin, 2016). National governments, including the UK, also have their own guidelines for PA, differentiated for various population groups. The UK Chief Medical Officers 2019 guidelines for the early years, state that children of this age should be active for at least 180 minutes each day, with 60 minutes of this being MVPA (Department for Health and Social Care, 2019a). Like the UK, countries including Canada and Australia have their own guidelines, prescribing identical amounts of MVPA, but including the development of 24-hour movement guidelines (Canadian Society for Exercise Physiology, 2020; Okely et al., 2017). This demonstrates a global consensus and approach to childhood PA. Despite the guidance, global PA levels in children have been consistently reported to be lower than these recommendations (Rhodes et al., 2020; Tremblay et al., 2014; Tucker, 2008), suggesting appropriate intervention, including changes in the wider environment, knowledge, and policy is needed, not simply the dissemination of knowledge.

In England it is common for children to begin school at the age of four years, although, not compulsory until a child is five years of age. The early years foundation stage (EYFS) at school offers children a transition from preschool, into a more formal education setting. In the EYFS, children’s height and weight are measured as part of the national child measurement programme (NHS Digital, 2020). This informs public health authorities about levels of overweight and obesity in this population via body mass index (BMI) measurement. In England children are classed as overweight when their BMI is >90th centile, or obese when their BMI is >97th centile according to national data. These measurements are representative of groups across England, including the geographical distribution and differences across sociocultural areas including sex, ethnicity, and deprivation. Currently almost a quarter of UK children are overweight or obese by the age of five years, rising to 35% of children by the age of 11 years (NHS Digital, 2020). With a correlation between obesity and health issues such as metabolic syndrome, cardiovascular disease, diabetes, and poor mental health, even during childhood (Bhadoria et al., 2015), it is important that efforts are made to reduce these health issues and their onset in childhood. Some health conditions that overweight and obesity contribute to can be alleviated using PA and exercise, independent of weight or fat loss, by improving health markers such as blood cholesterol, blood pressure, insulin levels and hormonal control (Janssen & LeBlanc, 2010).

These benefits further strengthen the argument for encouraging children to become more physically competent and enjoy lifelong PA.

To support the weight status data, yearly measurements are collected concerning childhood PA levels in England, with the most recent figures suggesting that 45% of children meet the UK government's PA guidelines (Sport England, 2021). This information is key to informing national public health policy for children, and policy and guidance within schools. A large majority of PA data is collected by children's self-report or parent proxy report, especially for population based reports such as the Active Lives Survey in England (Sport England, 2021). However, the considered gold standard for in-field PA measurement during childhood, is objective and device-based assessment such as accelerometery (Cliff, et al., 2009). Promisingly, some research studies using accelerometry in this younger age group has shown English children comfortably meeting PA guidelines (Foweather et al., 2015a; Hall et al., 2018; Hesketh et al., 2014, 2015). Despite this, others have shown young children to have very high levels of SB and low levels of activity (Roscoe et al., 2019a). Hesketh et al., (2015) employed the use of an Actiheart accelerometry device attached around the child's chest, while Roscoe et al., 2019 and Hall et al., (2018) used a GENEActiv accelerometer attached at the child's wrist. Additionally, Hesketh et al., (2015) collected data in a sample of children considered to be affluent, while Roscoe's sample was from an area of deprivation. With these small, but arguably significant results in mind, it is important PA promotion and opportunity for participation is increased for all young children in England. Therefore, research should continue to increase our knowledge surrounding the actual activity levels of children, and the determinants and influences that help them to achieve sufficient amounts.

Acknowledging PA participation and promotion of any population group from a socio-ecological perspective should be given due consideration to provide an understanding of the scope and relationship of determinants, the influential enablers and inhibitors. Social determinants of health must be recognised as influential and incredibly important in health provision (Dahlgren & Whitehead, 1991). Social environments are also closely linked to health, and thus must be thought about during efforts to increase and sustain PA participation, as it is more than accepting individual responsibility for an individual or their child in terms of being physically active (WHO, 2003). A key goal of any PA intervention or policy should be to help change or adjust the population group's knowledge, confidence, self-efficacy, and environment to achieve this outcome. This means effecting change, not only in children's behaviours, but their parent's and carers, as well as their environment, are key to seeing improvement in PA levels. During early childhood, social and parental support is crucial to creating opportunities for PA (Nguyen et al., 2016). Research has found that American parents who engaged in PA resulted in children being 5.8 times more likely to be active than children with inactive parents (Moore et al., 1991). However, British parents have stated that more information is needed in accessible modes to make promotion of PA at home a more convenient and accessible process, with busy working lifestyles commonly cited as a reason for lack of PA engagement with their children (Khanom et al., 2020). Against this lack of parental engagement, further research in England has shown that young children are more active in care and educational environments then they are at home (Hesketh et al., 2015; Roscoe et al., 2019b), and this finding has also been represented in international literature (Gordon et al., 2013). This evidence is important as young children have little autonomy over the structure of their day and the activities they participate in. Therefore, their environment, opportunities, influences, and role-models of behaviour around them, are vital to the development of motor skills. Consequently, the education and provision of resources at both out of home care and at home, should be considered key determinants for preventing SB and promoting PA behaviours.

Further to this, is the widely observed effect of deprivation and socio-economic status on PA levels and the health of children, which should be given due consideration during promotion, policy, and participation (Lakerveld et al., 2020). In England alone, there is a 15% difference in children from the most affluent families (53%) to least affluent families (38%) meeting the recommended PA levels for school aged children (Sport England, 2021). The national child measurement data from the UK government (NHS Digital, 2020) provides evidence to show that the gap in PA attainment due to affluence and deprivation, is a pattern that is also mirrored by obesity and overweight rates. Reports from 2019/20 show that 13.3% of children aged 4-5 years old from the most deprived areas are classed as obese, while this figure is as low as 6% in the least deprived areas of the country (NHS Digital, 2020). Most concerningly, this gap has continued to widen over the past 13 years in England (NHS

Digital, 2020). With such strong evidence to show that obesity is linked to poorer health of individuals, it is important that PA levels and obesity, but also the deprivation gap is addressed, with strategies, policy and environmental changes interventions implemented for children in the most deprived areas

1.1.2. Physical Activity and Motor Competence

It is clear from the prior information presented that PA participation is key during early childhood and beyond. Understanding the relationships that effect PA attainment and participation during this age are essential. Although there are a multitude of factors that have already been mentioned and will be discussed throughout this thesis, to be physically active, physical competency plays a pivotal role (Logan et al., 2015), even during the early years (Figueroa & An, 2017). Physical competency allows children to both develop movement skills and freely participate in activities, developing better movement self-efficacy (Peers et al., 2020), allowing the possibility of further enjoyment and engagement in PA by these children (Williams et al., 2008), especially into middle childhood (Barnett et al., 2009).

Physical competency will be viewed as motor competence (MC), which is defined as skill proficiency development, resulting in gross movements of humans that are goal-directed and a collection of PA performances (Bisi et al., 2017). Within MC there are several terms that can be used to class and define skills, FMS are one of the terms sitting within this collection and are essential during early childhood (Seefeldt, 1980). FMS are the basic building blocks to developing gross MC and participating in PA and more advanced sport activities for children. These FMS develop rapidly from 3 years of age and can be mastered by 6-7 years of age (Gallahue et al., 2011). Mastery is considered present when all key movement patterns within the skill are executed with the desired outcome. Three domains can be used to separate FMS: locomotion, manipulation or object control, and stability. Locomotion involves moving the body through space, and from point A to point B. Common skills associated with this domain include running, jumping, leaping, and galloping. Manipulation includes controlling and contacting objects such as throwing, catching, kicking, and striking. Finally, stability involves the control of the body both in static and dynamic environments, this can include important actions such as twisting and bending (Gallahue et al., 2011). Figure 1.1 demonstrates what is commonly considered and assessed as FMS, including further skill examples.

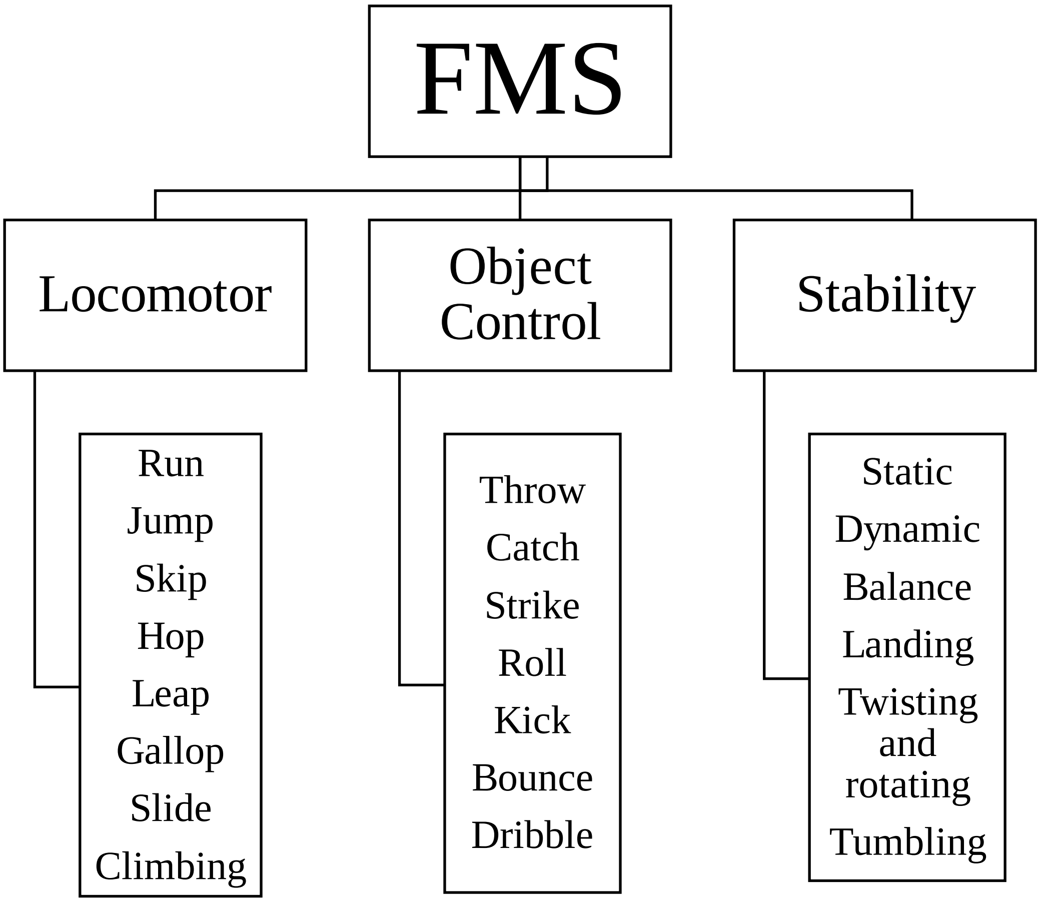


Figure 1.1. FMS domains and examples of subdomain skills

Whilst levels of PA should, and can be independently considered, they hold an important relationship with MC and FMS (Holfelder & Schott, 2014). A child with strong MC will have the ability to move well and fluently through space, as well as perform refined object control skills and have good overall body control. Jones et al., (2020) revealed in a meta-analysis that FMS competency level can predict level of PA in early childhood, with an association between 0.13-0.26. Although this relationship is low, it demonstrates the need to establish the relationship in the early years, as literature suggests that this relationship strengthens as children age (Stodden et al., 2008b).

The relationship between PA and MC is complex, and therefore, a number of models have proposed a relationship between MC and PA outcomes during childhood (Hulteen et al., 2018;

Seefeldt, 1980; Stodden et al., 2008b). Although each model proposes that FMS are important to PA attainment, the complexity from additional factors and determinants influencing the outcome, and the type of relationship created, differ from model to model. The three most cited and used models will now be discussed.

Seefeldt's (1980) model (Figure 1.2) proposed a four-level hierarchical approach to motor development. The base of this model is rudimentary movements and reflexes, fundamental motor skills (or FMS) which progresses onto transitional motor skills, and sport specific skills. Between FMS and transitional motor skills there is a proficiency barrier. If children are unable to overcome this barrier, it is proposed that they will not be able to use transitional skills which lead to sport specific skills. Sport specific skills allow children to participate more widely in PA opportunities as they enter middle childhood adolescence and adulthood (Haywood & Getchell, 2019). The overall message of this model communicates that children will be limited if they are not aided or guided with tuition and practice to overcome the proficiency barrier and partake in sport (Brian et al., 2020), which are usually common and important forms of PA in modern society (Waddington, 2000). The children who are skilled and considered FMS competent, will break through the proficiency barrier and enter the next stage of the model (Costa et al., 2021). This rather linear approach to motor development has been questioned by researchers (Brian et al., 2020) and the lack of inclusion of possible mediating factors to overcome a proficiency barrier do limit the inference and use of the model during modern research approaches.

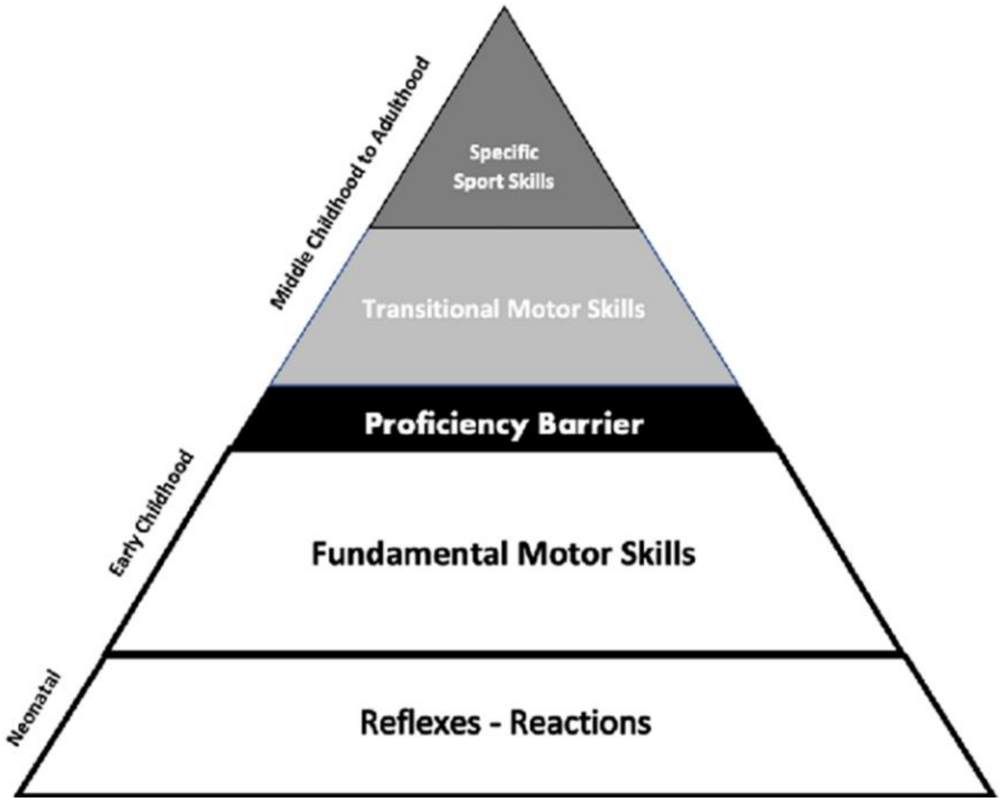


Figure 1.2. Seefeldt's Hierarchical Model (Seefeldt, 1980)

Therefore, in 2008, Stodden et al., (2008) proposed a dynamic association model (Figure 1.3). This model proposes that there is a positive spiral of engagement for FMS and PA, which can be mediated positively by health-related fitness and perceived MC. Simply put, as FMS/MC competency increases, this positively influences PA participation of the individual, which is hypothesised to lead to a lower risk of obesity in a child. This positive spiral of engagement in FMS improvement and PA participation, allow a child to continue to lead a life at a healthy weight status, which can be further positively mediated by higher perceived MC and health related fitness. This can also be argued in the reciprocal direction using this model, i.e., that engagement in higher levels of PA, helps to further increase FMS/motor competency for the individual, due to likely and possible regular practice of FMS during PA participation. The other mediating and important factors within this model include a child's own perceived MC; how a child views their own physical ability and individual FMS/MC, is also a key part of physical self-perception (Barnett et al., 2008; Crocker et al., 2000). In addition to health related fitness; which encompasses body composition, cardiovascular fitness, flexibility, muscular endurance, and muscle strength (Caspersen et al., 1985).

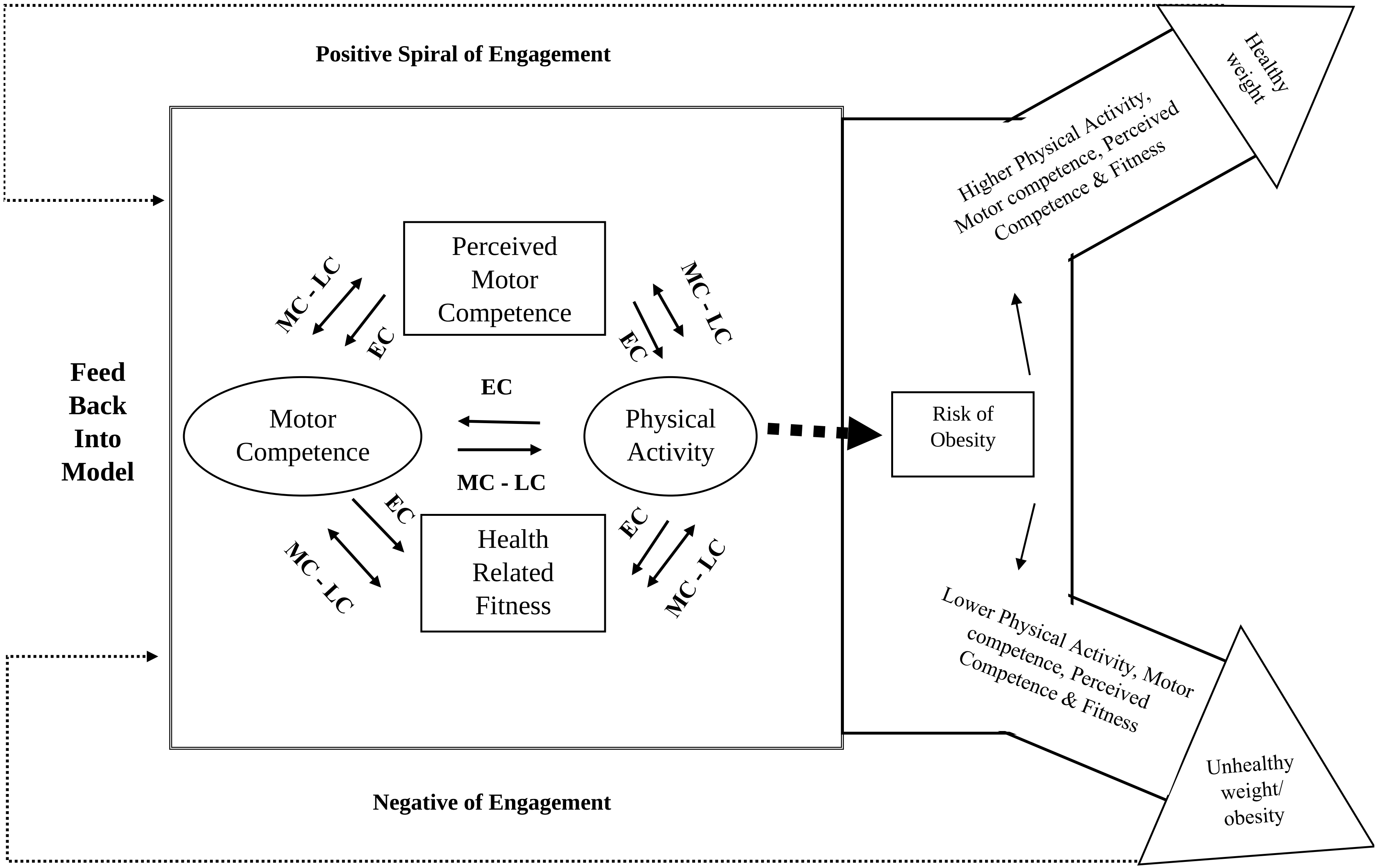


Figure 1.3. Stodden's dynamic association model (Stodden et al., 2008

Stodden's model further suggests that the relationship between FMS and PA in both directions may be low in early childhood, strengthening as a child enters middle childhood and adolescence (Stodden et al., 2008b). Despite a weaker relationship during early childhood there is a strong argument that aiding children to develop their FMS levels during early childhood, where development from the age of 3 years is rapid (Gallahue et al., 2011), will enhance PA levels during middle childhood and beyond (Barnett et al., 2009). Since its conception there has been evidence published to support Stodden's model during childhood. In particular, in 2015 Robinson et al., (2015) reviewed the evidence supporting or refuting the model, concluding that there certainly was a positive relationship between MC and PA across childhood and the strength of association between MC and various health related fitness variables did increase as the children aged. When specifically focussing on early childhood, Jones' et al., (2020) review reported that in the early years, FMS competency can drive PA performance, and that PA is associated with FMS competency, presenting evidence that the relationship is reciprocal, but weak during early childhood. Further emerging longitudinal studies have begun to suggest that earlier development of skills can predict future PA, in addition to BMI status (Duncan et al., 2021), however, many more longitudinal studies are needed to make firmer conclusions about all of the relationships and associations presented in the model, including key mediators (Barnett et al., 2021; Jones et al., 2020).

In 2015, Logan et al., (2015) conducted a systematic review, examining the relationship between FMS and PA during childhood and adolescence. Specifically within this review the authors summarised results for early childhood (defined as ages 3-5 years), relating the results to the models of both Seefeldt, (1980) and Stodden (2008). When interpreting the results of the study to Seefeldt's model, Logan and colleagues found that few studies were able to provide sufficient statistical methods to assess the accuracy of this model. However, Williams et al., (2008) provided evidence to show that children who were more proficient in MC performance spent significantly more time being physically active than their less proficient peers, perhaps supporting the theory of a proficiency barrier. The review also established that there were several studies to support a hypothesis that the relationship between FMS and PA is low during early childhood but does exist, supporting the theory of Stodden's model. This evidence helps to provide a basis for new and updated models to be proposed, with the latest scientific developments considered.

Recently, Hulteen and Colleagues (2018) proposed the Lifelong PA model (Figure 1.4.), a model that introduced a geographical and sociocultural filter, and considered further psychological elements beyond perceived competence, such as self-efficacy. This was the first model to introduce foundational motor skills, rather than fundamental. With the argument that the term 'fundamental' suggests that children must develop the skills to be successful, while 'foundational' suggest these skills are a base to progressing further in PA within their chosen environment (Hulteen et al., 2018). Examples of these foundational skills include squatting, swimming, and riding a bicycle, and can perhaps be considered movements and physical activities that can be engaged in throughout the lifespan (Foweather et al., 2021; Hulteen et al., 2018). The important and novel element of this model is the geographical and socio-cultural filter. This allows different socio-cultural experiences children may have at home, in school or in different countries around the globe to be considered, and how these factors may influence the differences in achieving proficiency in MC. For example, ethnicity, family size and strong sporting tradition are all key factors that could be considered within this model, and it could be argued that this model helps to view a child's physical development and PA in the most holistic way. This model has been able to summarise the developments in this broad area of research since the establishment of Seefeldt's model in 1980, and the collation of numerous factors and determinants affecting PA, MC and FMS are key strengths to this model.

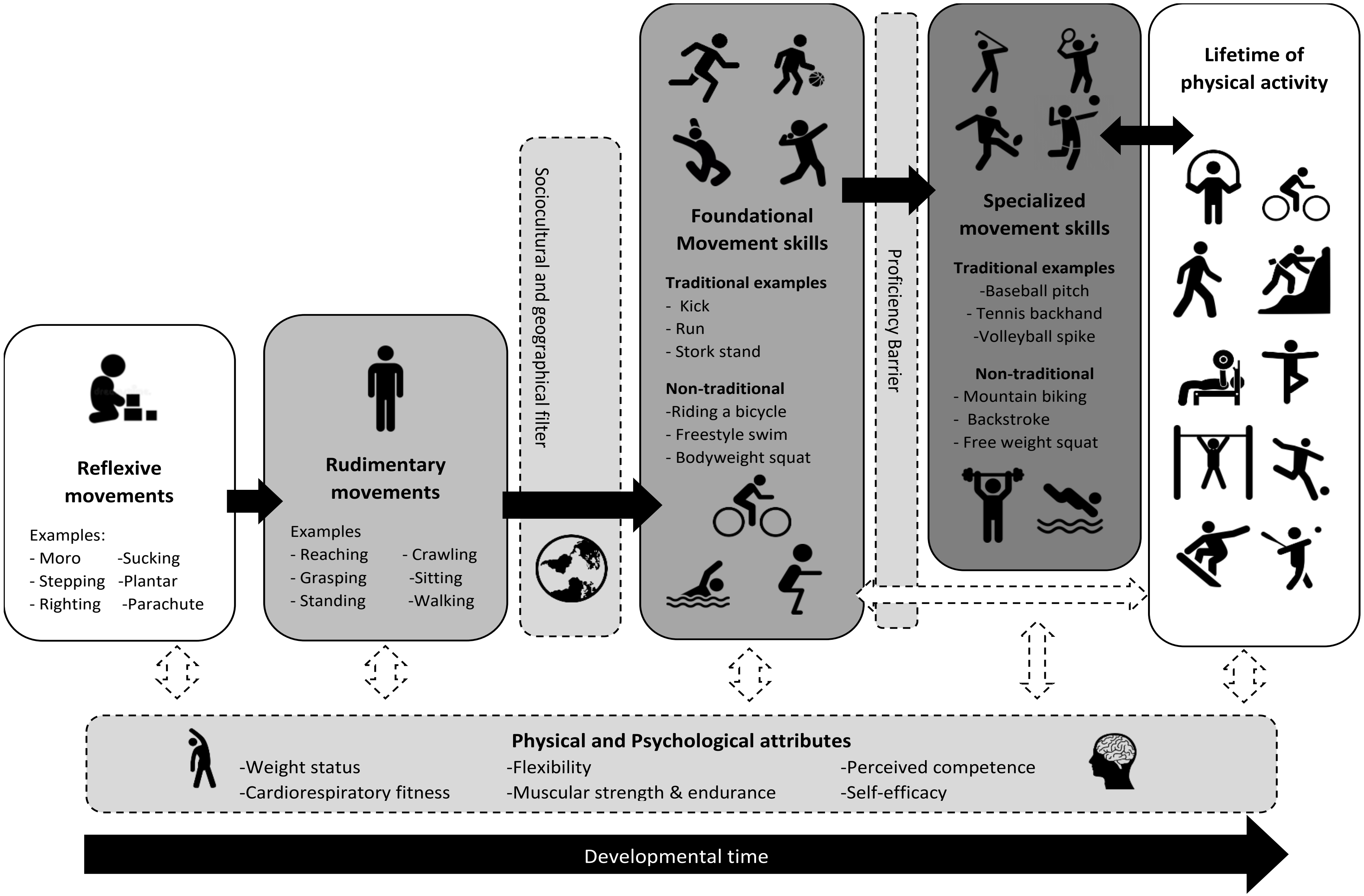


Figure 1.4. Hulteen et al's., (2017) Lifelong PA Model

The discussed models are currently the most cited in the literature and since their respective publications there has been a continued number of studies that have used these models to base their hypotheses around and the literature has continued to find different confounding and mediating factors; including sex, socioeconomic status, ethnicity, and weight status, that influence these models, supporting their hypotheses or rejecting them (Barnett et al., 2015, 2021; Costa et al., 2021; Logan et al., 2015; Pacheco et al., 2021). These models have been pivotal in continuing to build the research community's knowledge, influencing both the more modern and updated models such as Hulteen et al., (2018), but also the research design at all stages of childhood (Costa et al., 2021; Lima et al., 2017; Meester et al., 2016).

A recently published systematic review (Barnett et al., 2021) closely considered the relationships proposed in Stodden's model (Stodden et al., 2008), bringing into question many long held beliefs by academics and researchers. Although not all the dynamic relationships the model proposes were investigated, there was a large amount of mixed evidence for the relationships considered most important within the model. Surprising findings were made within this thorough review and importantly, all relationships to MC were examined. Whilst there was indeterminant evidence for the relationship from MC to PA, there was no evidence for the reciprocal relationship of PA to MC. This evidence could suggest that it is more likely that improving MC can positively influence PA levels, than exclusively encouraging PA alone, especially over the lifespan. The findings also further highlighted the importance of MC and movement skill tuition for children, as simply participating in PA does not appear to result in an increase in MC (Barnett et al., 2021).

An important consideration is that the relationships and associations between MC and PA are frequently assessed using the levels of MVPA that children perform. Although the promotion of MVPA has been continually highlighted in the literature and policy materials due to its strong relationship with improving health outcomes (Department for Health and Social Care, 2019a; Janssen & LeBlanc, 2010), it is important to note the importance of light PA (LPA) and total PA (TPA) in improving the health of young children, including the cardiometabolic markers associated with MC in youth (Poitras et al., 2016). Light PA is also important in developing and mastering object control skills for children (Foweather et al., 2015a), which are skills that are usually more difficult to develop in the early years (Morgan et al., 2013), while TPA has been associated with FMS in the early years (Jones et al., 2020). Research should continue to attempt to associate more than MVPA when examining these variables, creating evidence for further models and interventions to have a TPA focus.

What all three models, and evidence to either support or refute them highlight, is the need for practice, guidance, and tuition to help children become competent movers, develop positive lifelong behaviours, and lead healthier lifestyles that include sufficient PA performance. Helping children to establish improved FMS competency during early childhood will allow children to develop better overall MC and have improved gross motor skill performance, leading to higher PA participation (Williams et al., 2008), which will mediate the reported positive physical and mental health benefits. Not only this, but better MC has also been linked to, higher levels of self-efficacy (Suton et al., 2013) which supports the Lifelong PA model (Hulteen et al., 2018), an improvement in academic achievement (Jaakkola et al., 2016), while additionally helping children to avoid social isolation and increase psychosocial wellbeing when performing PA with peers (Piek et al., 2008). This demonstrates, that although PA is vital to overall health, the influence of MC ability should not be underestimated when aiming to positively influence children's movement behaviours. When considering the models introduced in this chapter, it is important to consider FMS competency as a key component to PA achievement, as much as PA independently.

1.1.2.1 Skill acquisition and pedagogical approaches

Skill acquisition and the development of motor skills is dependent on the constraints placed upon the individual, which create boundaries which the neuro-musculoskeletal system must operate (Button et al., 2008). According to Newell's dynamic constraints theory (Newell, 1986), learner, environment, and task constraints are present. These may, in turn, affect the level of FMS competency a child is able to attain by limiting, shaping, or containing the skill. This can consequently influence their level of PA achieved (Goodway et al., 2019). The factors related to individual constraints include the child's sex, age, and if a disability is present, these are known as structural and physical characteristics. There are also functional and behavioural characteristics at the individual level such as motivation, communication level, and coordination. The environmental constraints include factors such as peers, parents, teachers, cultural environment (whether physical skill development is considered important within a culture), and beliefs. It also includes the physical environment such as weather, surface of activity, and equipment. Finally, the task constraints comprise of the demands and intended outcomes of task, any rules, roles within a game or task and the setting of the task. For young children many of these factors or constraints are still developing, such as motivation to be active and communication with other children or their teachers. They are also still heavily guided in decisions and environments by their parents and carers. Using constraints led approaches have been found to be the most successful form of FMS intervention (Tompsett et al., 2017), which is important information to form the content of any newly designed FMS intervention.

By considering these constraints, different pedagogical approaches to teaching skills and activities to children have been developed. The approaches can affect the environment and task constraints of a given activity or skill, while also considering a child's structural and functional characteristics. Linear and nonlinear pedagogies can be used to manipulate the constraints of a task or skill. For example, within a linear environment a teacher/coach will make a task progressively more difficult by changing an element of environment or task constraint. Linear pedagogies follow information processing theory (Schmidt, 1975), by providing a set of movement experiences for children to progress through and develop their skills. This usually includes giving direct instructions and demonstrations to the children. Guiding them from the cognitive, to associative, and finally autonomous stages of learning. Learners use their previous experiences, and new sensory inputs and desired movement outcomes when completing an action. During the action, sensory feedback can be used to produce specific movement outcomes, leading to learning outcomes such as movement patterns or skills (Fitts & Posner, 1967).

During non-linear approaches, which can also be described as exploratory learning, children can individually explore a carefully designed learning environment (Chow & Atencio, 2014). There may be no direct progression of a task, skill, or activity, however, facilitators can still use the environment, task, and individual constraints to change the nature of the learning process, such as changing a piece of equipment (size, shape, weight etc.) or adding in or removing rules. This results in a more autonomous experience which encourages the children to use skills they have already developed, while exposing them to potentially new skills. An example of a non-linear approach used in teaching and coaching is the STEP model, this stands for space, task, equipment, and people (UK Coaching Learning, 2019).

1.1.3. Assessing Motor Competence and Physical Activity during Early Childhood

Whilst we know that it is important to improve MC and PA during early childhood, assessing the change including improvements in MC is vital. As such measuring children's current achievement and observing if appropriate levels of both variables are being reached, is key to practitioner and researcher knowledge, in addition to the design and evaluation of intervention programmes. There are a plethora of assessment tools to assess children's MC, and these have continually been reviewed against criteria including feasibility (Klingberg et al., 2019), popularity and validity, to name just a few variables (Eddy et al., 2020). Tools that measure FMS and MC through process and product orientated outcomes are popular within the literature and both present their own strengths and limitations to assessment which will be discussed through this thesis. Of clear interest to the current research project is the ability to examine FMS, which is classed as gross motor control. Some motor competency batteries are intended to cover more MC elements than purely those gross in nature, such as the Bruininks-Oseretsky Test of Motor Proficiency Second Edition (BOT-2) (Bruininks & Bruininks, 2005) and the Movement Assessment Battery for Children- Second Edition (MABC-2) (Henderson et al., 2007), both of which examine the fine motor control of children in addition to gross motor skills. Although these elements are important in overall and holistic child development, they can occasionally offer too much detail for MC assessment. Thus, researchers will discount parts of the assessment, potentially reducing its validity and reliability in the process.

However, some testing batteries exclusively assess gross motor development such as the Test of Gross Motor Development- version 2 and 3 (TGMD-2 and 3; (Ulrich, 2000, 2016), with the most recent iteration being updated to reflect the appropriate skills and scoring criteria for mastery (Ulrich, 2016). The TGMD protocols are known for measuring process-based competency in a number of popular FMS, yet the assessment fails to assess stability, one of the key FMS sub domains (Goodway et al., 2019). To this extent, an issue is arising with MC assessment, with a combination of tools being used in research settings and studies to gain a complete picture of children's locomotor, object control and stability skills, to form their FMS/motor competency. Consequently, it can be difficult to summarise the knowledge and literature as continually different methods of assessment are being employed, creating discrepancies and anomalies in measurement methods.

Most recently a review by Eddy and colleagues (2020) aimed to assess the psychometric properties of FMS observational tools, including content, construct and criterion validity, alongside reliability of these different tools and their use in school settings, with school aged children. The review initially returned 33 possible FMS tools from 90 different studies. However, nine tools had to be excluded due to failing to meet study specific criteria, important to testing the FMS of children, such as testing at least two domains of FMS and being an observational tool, rather than methods such as proxy reporting. The three most popular tools reported were the BOT, TGMD and MABC, with far higher numbers of reliability and validity studies than any of the other tools reported. A key finding of this study was, that although the majority of the tools assessed locomotor and object control skills, less than half of the 24 tools assessed stability FMS. Just nine tools assessed all three subdomains of FMS (Eddy et al., 2020), revealing an issue with not only the most popular FMS competency tests, but the field of assessment as a whole. Further to this, Klingberg reviewed the feasibility of FMS assessments for pre-schoolers (Klingberg et al., 2019). This study examined 65 studies which summarised 13 different tools in total. Important characteristics to feasibility included administration time, equipment, space, assessment type, item, training, and qualification. This study similarly found that the TGMD-2 was the most popular tool used, however, was one of the least feasible assessments within a pre-school setting. This disjointed nature of assessments and their practicalities for use in 'real-world' settings, limits our understanding in this area and means that results must be interpreted with caution. The complexity of the processes for use of the FMS assessments, can be a barrier to implementation in the appropriate settings, but also to research participation. Key stakeholders e.g. participants and practitioners, must have an appreciation for the reasoning of protocols, as well as an interest in the area (Gaupp-Berghausen et al., 2019), to allow for improvements to be made to promote consistency and participation within this area. There is a need for a greater consensus and agreement for MC measurement and assessment must be developed, however, key judgements and inferences can be made from the information that current assessments offer. Despite this, new assessments and programmes, should consider the usability and feasibility of the assessment by multiple stakeholders including childhood practitioners (teachers, coaches and medical), and not just researchers, to enable implementation in a wide range of settings.

Physical activity during childhood has been an area of research interest for over 40 years, and over this period of time a number of measurement tools have been developed (Loprinzi & Cardinal, 2011). Measuring PA is more complex than it may first appear, and research aims to consider as many measurement variables as possible, considering not only the quantity, but also the quality of PA. In large scale studies, for a long period of time and still at population level (NHS Digital, 2018), self-report measures of PA have been used, especially with adult populations (Kriska & Caspersen, 1997). Obvious methodological flaws with self-report PA can be the social pressure that PA examination brings, including increasing PA during the recall period (Dishman et al., 2001) and inaccurate participant recall due to lack of understanding and subjective interpretation. These factors lead participants to report false quantities of their regular PA habits (Sallis & Saelens, 2000), development and introduction of objective measures was able to overcome some of these issues, however, tools such as pedometers are only able to provide a quantity of PA output and are unable to report the intensity, further complicated by the lack of reliability of these tools, even within controlled environments (Gayle et al., 1977; Washburn et al., 1980). Further objective tools such as heart rate monitors have been explored for PA measurement due to their ability to report intensity, however, these can encounter issues with both wearability of the most accurate devices such as chest electrodes, to the accuracy of wrist worn devices (Dishman et al., 2001). Finally, accelerometery offers the novel solution of measuring both the quantity and intensity of movement by measuring acceleration of limbs in different planes of movement (Cliff, Reilly, et al., 2009). Initial accelerometer models observed PA in a singular plane, before the development of triaxial tools, providing further information on limb motions (Adolph et al., 2012). This is important to PA measurement in the early years due to the development of bodily motions and erratic PA (Cliff, Reilly, et al., 2009; Oliver et al., 2007).

When compared to adults, measuring children's PA comes with further challenges. A young child is unable to report their own PA due to not fully understanding the concepts needed for such measurements. This means research has commonly relied on proxy-report by parents or main care givers such as teachers. This encounters the same issues that self-report PA for an adult does, but can also offer further discrepancies, especially a parent reporting for a child attending a care or educational setting, where they are not aware of their daily PA schedule or habits (Cliff et al., 2009; Oliver et al., 2007). Accelerometery therefore seems like an obvious choice for children and young people, with research continuing to attempt to establish the most accurate ways to measure PA using these devices (de Almeida Mendes et al., 2018). The sporadic movements and lack of continuous PA behaviours have posed as challenges to using these tools (Pate et al., 2006), as well as the choice of several models to measure PA. Beyond this, the placement of the accelerometer on the body, to the frequency at which movements are recorded, and the varying epochs to produce different outputs which are then quantified by a range of cut-points available within the literature (Migueles et al., 2017, 2019), are methodological issues that have shown large variance in outcomes during measurement studies (Li et al., 2020). The picture quickly becomes clear that there are a number of considerations to make when using these tools.

Measurement challenges for MC assessment and PA levels in the early years are clear and continue to pose challenges for researchers. This is coupled with the difficulty of integrating and implementing assessment in the community, education, and care settings for children. The ability to do this would allow a greater understanding, awareness, appreciation, and perhaps self-efficacy to use these important measurements and interpret their key impacts on child health. This highlights the need to continue to work with key stakeholders to understand and deliver in collaboration, to gain the improvements that are needed in these areas.

1.1.4. Physical Activity and Motor Competence determinants and correlates during Early Childhood

Research continues to establish relationships, cause, and correlation between mediating factors and PA levels, and the determinants that may increase or decrease these levels (Bingham et al., 2016; O'Donoghue et al., 2018). As this introduction has established, FMS are important to PA performance, and many factors influencing PA levels also influence MC and FMS of children. Research has shown that even during the early years, sex of a child can have significant effects on the level of FMS and MC achieved. Across English studies, differences between girls and boys have been found. Eyre et al., (2018) found that girls had lower FMS competency scores than boys, while Roscoe et al., (2019) found that girls had better locomotor skills than boys, and that boys had better object control skills than their female peers. Health related fitness, perceived competence, self-efficacy, and weight status have been previously mentioned as possible individual determinants for PA and FMS performance, as shown in the proposed models by Stodden and Hulteen. BMI has been found to be correlated with both PA and FMS in young children, showing lower proficiency in those presenting overweight or obese BMI. Children who have higher adiposity levels may lead to restricted movement abilities at certain joints which in turn reduces their movement fluency and ability, such as run ability (Bryant et al., 2014). Perceived competence can be assessed just as motor skills and FMS can be, and a tool has been developed for use in child populations, the Pictorial Scale of Perceived Movement Skill Competence (PMSC-2) (Barnett, Vazou, et al., 2016). Previous work has examined the association between FMS and perceived FMS, and in younger populations and only weak associations have been established, and this has been attributed to limited cognitive skills to understand perception of their own performance (Morano et al., 2019). Health related fitness including cardiovascular fitness, muscular endurance and flexibility have all been found to have a relationship with MC in previous research, as reported in Barnett et al's., 2021 systematic review of the literature. In a 2012 study by Hardy et al., a relationship between inadequate cardio respiratory fitness and low FMS competency, where cardiorespiratory fitness was measured using a 20m shuttle run. Demonstrating that having higher levels of fitness can lead to better FMS, this may be because children with better fitness can practice their skills for a longer period of time without tiring.

However, research should also take a socioecological view of health behaviours, as this helps to reveal numerous factors that should be considered during intervention and promotion of MC and PA. An individual's environment is recognised as significant in the performance of health enhancing behaviours and reducing health inequalities, this includes the physical and built environment (Foster

& Hillsdon, 2004; Sallis et al., 2018), in addition to the social contributions (Gubbels et al., 2011). To this end, research has explored factors such as socio-economic status (SES) (Kelly et al., 2006), parental influences and family context (Cools et al., 2011), as well as access to outdoor spaces and equipment, with positive influences in early childhood being reviewed and summarised by Iivonen & Sääkslahti (2014). This section will briefly explore and introduce key determinants to PA and FMS performance, especially from a socioecological perspective.

Previous literature from both the UK (Adeyemi-Walker et al., 2018; Roscoe et al., 2019a) and internationally (Goodway et al., 2019) has found that children from lower socio-economic or disadvantaged backgrounds tend to perform less PA, but also exhibit lower FMS (Adeyemi-Walker et al., 2018). This finding was also reported for girls in Australia (Hardy et al., 2012). Children from low SES backgrounds or families may not be able to afford extra-curricular activity, which in turn will reduce the child's opportunity to practice FMS and increase their levels of PA. Jago et al., (2017) found that up take of school extra-curricular activity was associated with 7.58 more minutes of MVPA each day for children attending these opportunities, with similar results for community based activities. Employment opportunities would be recognised as key to reducing levels of lower SES, however, research reports that maternal employment status could also have a negative impact upon young children's health behaviours (Hawkins et al., 2009). Mothers in part and full-time employment as part of a single parent or dual parent (where both parents were employed) household, reported that they were less likely to engage in PA opportunities with their child, due to restrictions on time (Hawkins et al., 2009). This was further demonstrated by these children acquiring higher screen time, thus increasing SB and being driven to school, thus negating PA opportunities such as active transport. This meant these children had less PA experiences than the children whose mother's didn't work. Mothers who are unable to offer their children PA opportunities due to work commitments may be from lower SES backgrounds, and may be working jobs with unsociable hours which further increase difficulty to engage with their children in PA. Additionally, qualitative research provides information around beliefs and perceptions, with parents of a lower SES feeling that their communities offer a lack of space, both within and out of the home, that they have safety concerns around their local area, and little to no equipment and time to facilitate PA; all factors cited by parents leading to lower PA levels for their children (Khanom et al., 2020). Cools et al., (2011) explored the achievement of FMS levels by pre-schoolers (age 4-6 years) in relation to the family context. This context presents multiple constraints on performance and key findings showed that paternal PA, active transport opportunities and emphasis of sport-based PA by parents were key in the performance of FMS at these ages. Other external factors relating to family context include the social influence of parents, peers and family, including the promotion of active lifestyles through both role modelling and encouragement (Edwardson & Gorely, 2010; Rhodes et al., 2020). Parents of young children who are more self-motivated to exercise themselves, because of the understanding of the benefits of exercise, were found to perform over 6 minutes more MVPA per day (Solomon-Moore et al., 2017). This finding means they could positively influence their child's PA through role-modelling, with over 60% of the sample reporting an intention to participate in family-based PA. Further to this, ethnicity and family context (for example, language spoken at home) has previously been associated with FMS competency level that children can achieve. It has been shown that children, particularly boys from Non-English speaking families or without English as their first language in English speaking countries have lower levels of FMS than their peers with English as their first language (Hardy et al., 2012). Extending this finding further, researchers have found that children from Asian backgrounds have lower object control abilities than their English-European peers (Barnett et al., 2019). While Adeyemi-Walker et al., (2018) and Eyre et al., (2018) reported that Asian children had lower locomotor skill competency than their white and black peers in central England schools. Collectively these important pieces of research highlight the impact of creating clear opportunities for children, and that policy must work on increasing the accessibility of these opportunities to those from areas of deprivation, as well as for children of working parents and children without English as their first language, summarised in Figure 1.5. It should be recognised that cost may not necessarily be the largest barrier, but time, location, and parental knowledge around the activities and self-efficacy (Cooper et al., 2021) to engage with these opportunities is key to increasing the uptake.

When examining the level of FMS competence of a child, we must consider the amount of tuition opportunities that children are afforded. Many of these opportunities can be associated with the factors already discussed that are related to PA, such as time available, participation in extracurricular clubs, and social norms for young children. To this end, more needs to be known about the FMS tuition opportunities children are receiving both within school and the home environment. Although parents and family play a large role in influencing their children's behaviours, teachers also play a meaningful role in children's lives once they start school, and can positively influence children's PA habits (Smuka, 2012) and FMS competency within the correct environment. With most children beginning formal education at 4 years of age in England, the school environment can provide children with more structure and increased opportunity to learn new motor skills that are both gross and fine in nature (Department for Education, 2017), while also becoming more physically active. Research has shown that the school environment is a promoter of exercise and PA in youth, as children attending school or education tend to be more active on weekdays than weekends (Foweather et al., 2015a; Roscoe et al., 2019b). This also becomes a key time in a child's life to extend or begin to establish positive health behaviours in a structured environment with both their peers and under the guidance of teachers. These behaviours are not only key to movement development, but also reducing mental health issues (Wu et al., 2017) and cardio-vascular disease risk (Chung et al., 2020) at a young age. A school environment may be the first time a child has been exposed to a more structured level of PA or larger spaces for movement, such as playgrounds and school fields, with outdoor spaces being known to be one of the key influencing factors on children's PA (Cooper et al., 2010; Klesges et al., 1990; Sallis et al., 2000), with positive and consistent reporting for higher levels. Cooper et al., (2010) also reported that outdoor spaces consistently showed children being more active when in these environments, with higher accelerometer counts than when indoors ($p<0.05$). Therefore, the built environment of a school can also be considered important for PA and MC promotion and attainment.

Although not a mandatory requirement till key stage 1, many English schools provide children with PE opportunities from 4 years of age, with the aim of PE providing children with the opportunity to learn about different forms of PA, exercise and sports, with the goal of developing lifelong PA habits and gaining knowledge about healthy lifestyles (Department for Education, 2013). Consequently, this initial year of school provides important starting opportunities for children aged 4-5-years-old to further develop their physical skills in preparation for further PA and sport engagement in primary education (Department for Education, 2013; Duncan, Roscoe, Noon, et al., 2019a). This should include a large foundation of FMS, especially if competency is to be reached at 7 years old (Gallahue & Donnelly, 2003). Despite this, it has been reported within the literature, that reduced priority is given to PE delivery and planning due to the 'overcrowding' of curriculums (Hills et al., 2015) and curricular conflicts (Ma et al., 2021). This suggests that not only is PA reduced but time to practice and develop MC and FMS may also be compromised. Due to schools and educational settings being important environments for intervention, and the possibility of intervention to improve PA and FMS, the following section will explore this in more detail.

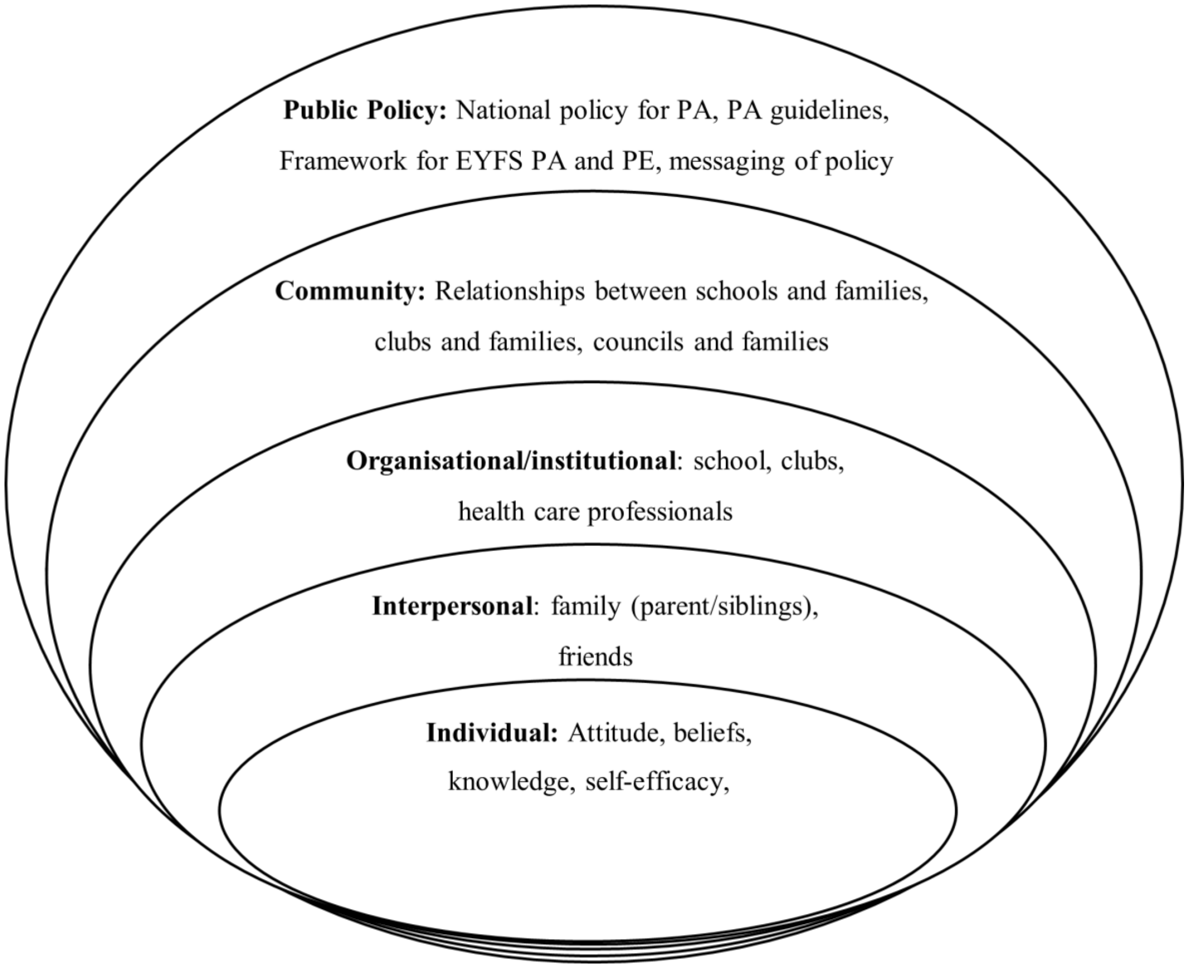


Figure 1.5 Socio-Ecological Model of the influences on early childhood PA

1.1.5. Intervention at Early Childhood

Physical activity interventions have been popular in child populations for a considerable period of time, and many have focussed on a reduction in weight and obesity levels (Nguyen et al., 2016). It is known that early interventions are key at such young ages to ensure mechanisms and behaviours are in place to promote lifelong activity and healthy lifestyles (Tucker et al., 2006). A contemporary focus on interventions to improve FMS, MC and PA in children have been established over the previous 15 years, including interventions specifically during early childhood, with reviews examining intervention design and effectiveness (Logan et al., 2012b; Morgan et al., 2013; Tompsett et al., 2017).

Despite PA interventions taking place there is little evidence surrounding the effectiveness of intervention on improvements in FMS competency for children in the early or preschool years, especially within the UK. A systematic review of the effectiveness of FMS intervention during childhood, which covered children from ages 5-18 years old, (Morgan et al., 2013) found interventions in Australia (Barnett et al., 2009; Cliff et al., 2007, 2011), Sweden (Ericsson, 2011), USA (Martin et al., 2009; Matvienko & Ahrabi-Fard, 2010) and Greece (Karabourniotis et al., 2002) to be effective. Just one English intervention in the review was reported within the review (Foweather et al., 2008), with only significant changes in static balance between intervention and control groups. Positively, these interventions show that short term positive change can be achieved through interventions, with many studies reporting significant increases in a range of skills compared to control groups (Morgan et al., 2013). However, not only is this review now compromised by its publication age, and also does not report on intervention for children in the early years of life, up until 5 years of age.

More recently, Strooband et al., (2020) reported positive outcomes in 25 studies within a systematic review of motor skill interventions for children from birth to 6 years of age. However, the authors warned that the results must be interpreted with caution, due to high level of bias within the studies. Other reviews have sought to examine how FMS intervention can influence PA levels attained by children. In 2021 Graham et al., reported in a meta-analysis that FMS intervention for 5–11-year-olds could increase MVPA by 4.3 minutes per day. However, this review failed to explore if the FMS interventions had positively influenced and increased children’s movement competency. While Stevenson et al., (2022) reported how interpersonal factors, including parental involvement within interventions targeting motor skills can be significant to observing intervention success.

Beyond these collective reviews, other individual interventions for early years populations have taken place in recent years (Stevenson et al., 2022). Trost & Brookes, (2021) presented positive improvements in FMS from a novel digital applications intervention to improve FMS in children aged 3 to 6 years old, based in Brisbane in Australia. In Ireland a two-year intervention that aimed to increase FMS in its second year for children aged 6 years old, saw improvements in the intervention group's locomotor, object control and overall competency in FMS (Bolger et al., 2019). Within a group of Turkish and Bulgarian children, digital physical exercise videos were used to improve pre-school children's locomotor skills (Bulca et al., 2020). The intervention group of 442 children showed a significant improvement in their motor skills in comparison to the control group. This intervention lasted 8 weeks but the authors do not state if a follow up period was included.

One of the major current limitations of FMS interventions for children include the lack of longitudinal change measurements, which was noted in an expert statement by Duncan et al., (2022). This can be noted within systematic reviews, with follow ups lasting up to just six months in many cases, or with no follow up at all, in a number of cases (Graham et al., 2021). This is likely due to the lack of sustainability of the interventions being used. Post-test and follow-up durations of interventions are therefore limiting the inference of whether interventions have been a success and could be successful outside of research setting delivery. Additionally, there is a wide range and variation in the length of time that interventions are delivered from six to 36 weeks. Within some timeframes there is a lack of consideration to the setting an intervention is delivered in, for example in schools in the UK, termly based interventions could be advantageous to planning the use of intervention into school timetables and curriculums. Using systems that already exist should be considered as important in intervention delivery and design to enhance implementation and sustainability.

What is also notable is the lack of early years intervention in the UK and specifically England. Some evidence has recently emerged, showing that a daily intervention or movement programme can improve young children's FMS, however, only to a level that is expected of children at this age, showing children are starting school with delays in their motor skills (Preedy et al., 2022). Although global evidence is of use, cultural differences must be considered when observing intervention effects.

It is not always suitable to accept that an intervention in one country will be effective within another. The differences in systems such as education and public policies, as well as cultural norms are clear determinants of children's PA, FMS, and overall health behaviours, which should be considered in the socioecological model (Bronfenbrenner, 1979).

Despite a number of interventions, it has been consistently reported that not enough is being done to effectively interpret the findings of these studies and implement meaningful FMS and MC development, tuition, and practice in educational settings. This is particularly true for English children, as Duncan and colleagues (2019) reported that children aged 6-9 years, were unable to master any key FMS mentioned in the English school key stage one and two PE curriculums (Department for Education, 2013). This prompts concern over the understanding of teachers to deliver FMS within education, and the tuition that children are receiving.

Recent research has focussed on more specific elements of intervention such as integrating learning opportunities into fun and guided play opportunities (Moghaddaszadeh & Belcastro, 2021), parent involvement using remote technology (Webster et al., 2020) and use of different teaching pedagogies (Crotti et al., 2020). While other research has begun to assess teacher's and student's feelings around FMS assessment in school (Goss et al., 2021; Lander et al., 2016), little is known about teacher's attitudes towards intervention and their effectiveness, in addition to what they believe would be beneficial in their environments. As one of children's main care givers, understanding teacher's knowledge, thoughts and opinions surrounding PA and FMS is important (Eyre et al., 2022). The ability to give key insight to school environments, the viability of intervention and opportunity to increase both teacher and child knowledge are key to creating sustainability of intervention. Research in this area tends to be broad and focus on whole school approaches, which can be important to the attitudes of the school overall (Daly-Smith et al., 2020). However, due to children growing, maturing, and learning at such quick rates, more attention should be paid to each stage, especially at the early years.

As established, educational environments have been shown to increase children's PA levels (Gordon et al., 2013; Hesketh et al., 2014), demonstrating the importance of this environment and the positive influence within them to facilitate PA participation. Importantly, schools can help to begin to close a deprivation gap for children, where all children have access to the same space, equipment, resources, teachers, and their knowledge. The time spent in school can be key for children to achieve their daily PA recommendation (schools should provide 30 minutes of MVPA per day in England), but also help to create healthier habits, and instil confidence and competence to complete more PA at home and outside of the school environment. Educational programmes have been reported to positively improve children's MC, FMS and PA at young ages (Iivonen & Sääkslahti, 2014). The review by Iivonen and Sääkslahti (2014) reported on eight programmes that were delivered in educational settings, all of which had different constructs and outcomes, but with a general aim to improve PA and FMS competency, and all programmes were successful in improving various elements related to FMS and PA. Intervention dose and frequency are critical elements to intervention delivery, Duncan and colleagues (2022) state that typically intervention is delivered once a week for 20-24 weeks in school settings in the UK and Ireland. This guideline can be used to plan and deliver future interventions as it is seen as acceptable and successful in many intervention cases. In summary, PA and FMS activities at school should take advantage of the resources available, but also use time to encourage the practice of skills using minimal equipment and space so that this can be replicated in a child's home environment to allow continued practice.

Interventions must also move beyond research study participation, as previous research has found that children from lower SES backgrounds are less likely to participate in interventions and research studies (Heinrichs et al., 2005; National Institute for Heath and Care Research, 2022), which is concerning when children of this group tend to exhibit lower levels of PA and MC. A key outcome of an intervention should be to increase individual self-efficacy and knowledge (Cooper et al., 2021), and should also target increasing the facilitators confidence, in addition to the children's behaviours and outcomes. Therefore, intervention must reach further than the schools opting to use resources and opportunities provided by researchers, and implication within policy must be achieved to see real change, especially for children from low SES (Craike et al., 2018). Although knowledge surrounding interventions during early childhood exists, it still lacks clarity and conclusive evidence and most importantly, effective, and sustainable interventions are yet to be established to aid children at this age.

1.1.6. Identified gaps in the evidence base

Although there is consensus that PA and FMS are directly related, there is still a gap in the knowledge and understanding of how these variables can be improved, especially during early childhood. This time period provides a key opportunity to develop skills in a rapid manner, and research shows early development of movement skills, influences longitudinal outcomes for children (Duncan et al., 2021). Using mixed methods during research helps to provide a deeper and wider understanding of the topic being studied (Almalki, 2016), by providing numerical and measurable outcomes, as well as creating key discussions with research participants and possible key stakeholders of intervention. Given that intervention is complex and complicated, effective intervention requires in-depth planning (Bartholomew-Eldredge et al., 2016), a research programme that employs mixed methods to explore and combine quantitative and qualitative methodologies, as well as narrative discussion around summaries of existing knowledge seems more appropriate than a purely quantitative or qualitative programme of research.

Intervention design should be considered carefully and based on several factors. Existing data is one key element, while the manner in the way this data has been collected can also be key in furthering our understanding in the future, including intervention and the measurement of intervention studies and their success. Although research has been conducted broadly in this age group there is less of a consensus and summary of the typical achievement and measurement for FMS and PA for 4–5-year-olds, which can help form key intervention suggestions, especially for English populations.

Health promotion and intervention should follow a research and theory informed approach (Bartholomew-Eldredge et al., 2016) and systematic reviews can provide important initial literature by summarising, synthesising, and reviewing key areas of knowledge and research, that are important in understanding and identifying the key determinants of achievement and performance. This helps to expand the evidence needed to support the design and implementation of a health improvement programme but also can be used to model the proposed change during these programmes. As researchers it is important that we understand if children are achieving what they are theoretically able to. Establishing the levels of PA and FMS competency that children possess at this key age is important for not only informing these interventions, but to ascertain if there are key patterns in development, sex differences or ability in domains of FMS. While reviews must be specific in their criteria and the studies that they examine, they can provide a balanced overview of the literature available. Discussion of the difference in study designs, outcomes, analysis and strength and limitations are all presented coherently in the literature (Gough et al., 2017).

As there is currently not a review summarising the FMS competency and objectively measured PA for the 4-5 years old age group, the first study of this research programme was to systematically review the published knowledge and literature on this topic, focussing on summarising literature concerning the current FMS competency and PA performance of 4–5-year-olds. This overview will provide an initial and important description for the basis of future intervention design and focus for this age group. Following this, the environments and behaviours that influence these outcomes can be considered.

Secondly, intervention design and implementation should be informed by key stakeholder's opinions and perspectives. While initial intervention research is important to establish the effectiveness of the intervention mechanisms, the implementation and sustainability will be best understood by those working and living within these settings (Morley et al., 2019). Qualitative enquiry can provide rich and needs led accounts of key experiences (Williams & Smith, 2020), perspectives from within these settings, but also ideas to enhance the design and implementation of new intervention programmes. Qualitative data can also help establish current problems within the environment and how these may affect the performance of health behaviours, while supporting established quantitative research findings.

Therefore, the second study of this research programme aimed to understand key educators' perspectives of PE, PA, and FMS at the EYFS. This study also created a dialogue with key stakeholders around how intervention should be best delivered in school settings, and what would help achieve longevity and sustainability of these programmes.

Intervention should most importantly be specific to a target population group and their needs. Detail related to this population group can be pivotal in achieving good intervention design, but crucially establishes what will result in an effective intervention programme. Quantitative research provides measurable outcomes, which can be used to design intervention goals, objectives, and outcomes. Reliable and valid methods of data collection ensure that this data best describes the target population (Frey, 2018).

In the case of this research programme, data for 4-5-year old's FMS competency and PA levels is limited for an English population, in particular in central England where this research was conducted. Consequently, to best describe and set intervention programme outcomes and objectives based on the most recent achievement of these children, the third study of this programme of research aimed to investigate and observe the FMS competency and overall PA levels of children in Central England. Additional important information relating to wider socio-ecological influences discussed in this introduction were collected to aid in the design and implementation of effective interventions, where the relationships between these influences and variables could be observed.

The three preceding studies of this programme of research lend themselves to inform the fourth study of IM (Bartholomew-Eldredge et al., 2016). IM is formed of six key steps which are briefly summarised in Table 1.1. These six steps are made up of tasks to complete the mapping process and result in the creation of effective, sustainable interventions. Existing evidence is crucial to understanding the problem that an intervention aims to solve and address. The three initial studies of this PhD help to establish the problem within the population, informing the logic model of the problem (refer to Figure 5.3). These studies also help to establish what needs to be changed, through individual behaviours in addition to changes within the environment, which ultimately inform a logic model of change, composed of programme outcomes and objectives. Programme design, production, and implementation form steps three to five of the mapping process. As previously stated within this section, these components should be informed by key stakeholder opinion and experience, with the second study of this programme of research being richly informed by qualitative opinion and experience. Finally, step six of the mapping process allows an evaluation plan to be established. This plan should consider practical and meaningful ways to evaluate the success and the need for improvement in a programme. The design of this plan should be informed by pre-existing reliable and valid measurements, with these being explored and discussed within the systematic review and subsequently employed within study three to measure the population. The RE-AIM framework (Glasgow et al., 1999) has been used to evaluate the impact of public health interventions for over 20 years with a range of groups and topics. It uses five dimensions of reach, efficacy, adoption, implementation, and maintenance to assess the success of an intervention. These themes match well to the aims and structure of IM, by reflecting key delivery partners, that is the identification of adopters, implementers, and maintainers in step five. The RE-AIM framework aims to support the development of multi-level intervention at individual, environmental and policy level. This once again, reflects a strong link to the socioecological model (Figure 1.5; Bronfenbrenner, 1979) and the basis of the IM process.

An initial development of the IM process, by using the knowledge gained and curated within this PhD to inform an IM iteration is detailed in Chapter five. The depth of detail, time and resources required for a traditional and full IM process could not be realistically achieved during this programme of study, and this non-traditional format allowed the development of a novel proposal.

Table 1.1 Intervention mapping six steps

	Step 1	Logic Model of the Problem
	Step 2	Programme Outcomes and Objectives – Logic Model of Change
Evaluation	Step 3	Programme Design
	Step 4	Programme Production
	Step 5	Programme Implementation Plan
Implementation	Step 6	Evaluation Plan

1.2 Research philosophy

In this section the research philosophy and methodological position adopted by the researcher in this programme of research will be discussed, with justification for the individual study approaches and the underpinning of the overall research project paradigm. Combining the research's ontology- what is true or real and the nature of reality, epistemology- the nature of knowledge and different methods used to gain knowledge, methodology- how this knowledge of reality is found, and finally, axiology- the philosophy of value, resulted in the knowledge built within this thesis (Scotland, 2012).

Table 1.2. Key research philosophy terms and examples

Term	Examples
Ontology	Objectivism or constructivism
Epistemology	Positivism or interpretivism
Methodological	Quantitative or qualitative, mixed
Axiology	Philosophy of value- consider what you value and how this may impact study design

A researcher should be able to acknowledge that there are values and biases in individual's and group's realities of the world, thus use the appropriate methodology to represent these (Creswell, 2012). Although methodology should be repeatable and able to gain reliable results, where important measurements to guide decisions are made, how reality is constructed for each individual should also be considered in proposing effective health intervention and research outcomes (Labonté et al., 1999). The mixed methods design, known as the 'third-paradigm' (Anguera et al., 2018), of this research project means that the ontology acquired was not either completely objectivist or constructionist in definition, nor the epistemology acquired being either exclusively positivist or interpretivist in definition. This results in the research project sitting between either ends of this research philosophy spectrum, creating a realist approach to discovering reality and how it is created. Thus the knowledge established sits within what may be known as the 'third paradigm' of research (Denscombe, 2008).

The methodological considerations within this PhD have been chosen to best fit the question of each individual study which give an overall mixed methods approach (Sale et al., 2002). Methodological decisions were made based upon the researcher's current knowledge, values, and methods believed to best help answer the key questions of the individual studies and the overall research project. These will be discussed in the following sections of this thesis.

Chapter 2 followed a systematic research design, which is positivist in nature, but a narrative discussion allowed for a realist approach to presenting the findings (Gough et al., 2017). The systematic review of the published literature focussed on reporting data from quantitative methodologies and positivist research paradigms. However, the narrative review of the collected data allowed the researcher to appreciate the realities in differences of data collection methodologies and choices made within the reported studies. This resulted in a cross-cultural review of the data available, giving rise to several suggestions and interpretation from the established research, important to informing theory-based health intervention.

Chapter 3 employed a qualitative research methodology and study design of a constructivist philosophy. Constructivism has no single reality and thus reality is interpreted in multiple ways by the participants and researcher, establishing an interpretivism epistemology. Using this lens allowed exploration of key stakeholder needs, experiences, perceptions, values, knowledge, and opinions to be explored. A phenomenological approach to the questions used in this chapter aimed to examine the individual's own reality, while a focus on the empirical world was important in deriving the real-world experience, such as the 'how' and 'what', not just the 'why' to answer the research question (Holloway, 1997).

Chapter 4 was strongly based in a positivist research paradigm, with an objectivist approach to the research. A hypothesis to the research question was proposed, meaning this study exclusively examined the world through quantitative methods and outcomes, so that the world is seen in a measurable and singular reality, creating 'scientific fact' (Guba & Lincoln, 1989; Nagel, 1986). This study used reliable and valid tools for measurement which resulted in experimental research design and used an element of statistical analysis, creating good internal validity (Kaboub, 2008). The measurements made were not subjective or influenced by the researcher's view, as objective measurements were employed, significantly reducing researcher bias or interpretation (Reiss & Sprenger, 2020). This study was important in forming a strong foundation for the need for interventional research and planning, additionally it explored methods to measure change in key environments considered in this research project.

Chapter 5 combined both qualitative and quantitative evidence from the preceding research in this programme, demonstrating a mixed methods approach. Mixed methods suggests mixing should take place and chapter 5 is a clear example of where the data sets collected in this programme of research came together and were used, reported, and interpreted, meaning it was of a pragmatic approach (Morgan, 2007), but also realist in its design. It focussed on the application of using established research to resolve problems in 'real life' and how the available data, including both scientific fact and lived experiences can be used to solve problems and answer questions, especially in specific population groups and communities (Mertens, 2010). An iterative process undertaken with key stakeholders was a key methodological element to this study, meaning that the data created was revisited on multiple occasions to address questions and issues established. Also known as ‘action research’ this studied aimed to establish interventions that were informed by Chapters two to four, combining knowledge of both a positivist and interpretive approach.

Overall, this research project follows a pragmatist research paradigm. This means that reality has been constantly renegotiated, debated, and interpreted in many ways, as demonstrated by the mixed methods design in this project. As previously stated, mixed methods research is the combination of both qualitative and quantitative methods of data collection within a study or programme of research. Importantly, analysis from these data collection techniques should happen in parallel or sequentially to inform the subsequent phase of research (Tashakkori & Teddlie, 2010), or research programme in this case. Mixed methods is a useful tool to help understand and solve complex social research questions, and thus seems appropriate to help inform complex intervention design and implementation. Engaging with key stakeholders forms a critical part of this programme of research and Greene (2015) stated that mixed methods allows research to ‘meaningfully engage with difference’, which summarises the impact of this PhD. This research aimed to both report what happens in reality, but also why and how it happens (Labonté et al., 1999), the resulting approach used the methods that best solved the problem and research questions proposed, resulting in methods of both qualitative and quantitative designs throughout. Table 1.3. presents the methodology, with the dominant and sequential methods highlighted by the font (capitals or lowercase respectively) of each study/chapter and how these are related and linked to one another.

Table 1.3. Study chronology, methodologies, and relationships

	Study 1	Study 2	Study 3	Study 4
Title	Fundamental Movement Skills and Accelerometer-Measured Physical Activity Levels during Early Childhood: A Systematic Review	Educators Perspectives on the Value of Physical Education, Physical Activity and Fundamental Movement Skills for Early Years Foundation Stage Children in England	Fundamental movement skill competence and physical activity of 4-5-year-old school children in central England	Improving Fundamental Movement Skills during Early Childhood: An Intervention Mapping Approach
Methodology	QUANT and qual	QUAL	QUANT	QUAL and quant
Relationship between studies	Data and results from this study informed the questions proposed for study 2, the methodological needs for study 3, and the logic model of the problem and evaluation methods for study 4	Outcomes from this study were used to inform the logic model of the problem, logic model of change, programme design and implementation in study 4	Methodological decisions were informed by study 1. Results of this study inform the logic model of the problem, logic model of change, programme materials and evaluation in study 4	Informed by all previous studies Attempts to solves problems highlighted in studies 1-3

Chapter 2

Fundamental Movement Skills and Accelerometer-Measured Physical Activity Levels during Early Childhood: A Systematic Review

Publication:
Dobell, A., Pringle, A., Faghy, M. A., & Roscoe, C. M. P. (2020). Fundamental Movement Skills and Accelerometer-Measured Physical Activity Levels during Early Childhood: A Systematic Review. *Children*, 7(11), 224. https://www.mdpi.com/2227-9067/7/11/224

Citations (15):
Aldania, T., Sumaryanti, & Suhartini, B. (2022). IMPLEMENTASI KETERAMPILAN GERAK DASAR DALAM PERKEMBANGAN MOTORIK ANAK DI TK AL-AZHAR BANDAR LAMPUNG. *Jurnal Pelita Ilmu Keolahragaan*, *2*(1), Article 1. https://jurnal.primagraha.ac.id/index.php/pjkr/article/view/228

Akbar, Z., Awalludin, & Tohar, K. (2021). Fundamental movement skills and sensory movement strategies to support online learning in early childhood. *Journal of Physical Education and Sport*, *21*(4). https://doi.org/10.7752/jpes.2021.s4317

Carvalho, A. D. S., Silva, L. S. L. da, Abdalla, P. P., Ramos, N. C., Mota, J., & Machado, D. R. L. (2022). Autonomous fundamental motor skills in the school environment: A cross-sectional study. *Motricidade*, *18*(1), Article 1. https://doi.org/10.6063/motricidade.24245

Cline, A. (2022). *Improving physical activity and movement skill competency in Gloucestershire's key stage two children* (Doctoral dissertation, University of the West of England, Bristol). https://uwe-repository.worktribe.com/OutputFile/9236987

Dobell, A., Pringle, A., Faghy, M. A., & Roscoe, C. M. P. (2021). Educators Perspectives on the Value of Physical Education, Physical Activity and Fundamental Movement Skills for Early Years Foundation Stage Children in England. *Children*, *8*(5), 338. https://doi.org/10.3390/children8050338

Foulkes, J. D., Knowles, Z., Fairclough, S. J., Stratton, G., O'Dwyer, M. V., & Foweather, L. (2022). Is Foundational Movement Skill Competency Important for Keeping Children Physically Active and at a Healthy Weight? *International Journal of Environmental Research and Public Health*, *19*(1), 105. https://doi.org/10.3390/ijerph19010105

Foweather, L., Crotti, M., Foulkes, J. D., O'Dwyer, M. V., Utesch, T., Knowles, Z. R., Fairclough, S. J., Ridgers, N. D., & Stratton, G. (2021). Foundational Movement Skills and Play Behaviors during Recess among Preschool Children: A Compositional Analysis. *Children*, *8*(7), 543. https://doi.org/10.3390/children8070543

Fernández-Valero, P., Soto, J., Páez, J., Leyton, B., Kain, J., Hurtado, J., & Reyes-Amigo, T. (2021). Fundamental movement skills and physical activity recommendations for preschool children. *Journal of Physical Education and Sport*, *21*, 3286–3293. https://doi.org/10.7752/jpes.2021.s6436

Honrubia-Montesinos, C., Gil-Madrona, P., & Losada-Puente, L. (2021). Motor Development among Spanish Preschool Children. *Children*, *8*(1), 41. https://doi.org/10.3390/children8010041

Howells, K., & Coppinger, T. (2021). Children's Perceived and Actual Physical Activity Levels within the Elementary School Setting. *International Journal of Environmental Research and Public Health*, *18*(7), 3485. https://doi.org/10.3390/ijerph18073485

Juliantine, T., Setiawan, E., Jumareng, H., Gani, R., & Asnaldi, A. (2022). Do fundamental movement skills, physical activity and enjoyment among inactive student during the COVID-19 Era improve after exergame? *Journal of Physical Education*, *33*, 2022. https://doi.org/10.4025/jphyseduc.v33i1.3327

Paez, J., Hurtado, J., Reyes, T., Abusleme, R., Arroyo, P., & Oñate, C. (2022). Relationship between Parents' Physical Activity Level and the Motor Development Level and BMI of Their Children. *International Journal of Environmental Research and Public Health*, *19*(15), 9145. https://doi.org/10.3390/ijerph19159145

Pamungkas, R., Angga, P. D., & Wahyudi, U. (2022). COMPARISON OF LOCOMOTOR AND MANIPULATIVE MOVEMENT ABILITY BASED ON HEIGHT IN ELEMENTARY SCHOOL CHILDREN. *PROGRES PENDIDIKAN*, *3*(2), 77–83. https://doi.org/10.29303/prospek.v3i2.244

Pranoto, N. W., Ma'mun, A., Mulyana, M., & Kusmaedi, N. (2021). The Effect of Fundamental Motor Skills Intervention Program on Kindergarten Students. *International Journal of Human Movement and Sports Sciences*, *9*(3), 583–589. https://doi.org/10.13189/saj.2021.090326

Viegas, Â. A., Mendonça, V. A., Pontes Nobre, J. N., Souza Morais, R. L. D., Fernandes, A. C., Oliveira Ferreira, F. D., Scheidt Figueiredo, P. H., Leite, H. R., Resende Camargos, A. C., & Rodrigues Lacerda, A. C. (2021). Associations of physical activity and cognitive function with gross motor skills in preschoolers: Cross-sectional study. *Journal of Motor Behavior*, *0*(0), 1–16. https://doi.org/10.1080/00222895.2021.1897508

Further dissemination:
Dobell A, Pringle A, Faghy MA, Roscoe CMP. 'Fundamental Movement Skills and Accelerometer Measured Physical Activity Levels during Early Childhood: A Systematic Review'. Fifth Assembly of the International Motor Development Research Consortium 2021 (September 2021), Virtual-poster with video.

Dobell A, Pringle A, Faghy MA, Roscoe CMP 'What do we know about the Fundamental Movement Skills and Physical Activity Levels of Children during Early Childhood?' University of Derby PGR Research Café (March 2021), Extended Presentation

2.1 Abstract

This study reviews the current evidence for the levels of achievement in FMS and PA measured using accelerometers among 4–5-year-old children and examines differences by gender. This review was conducted using the PRISMA framework. Keyword searches were conducted in Pubmed, Medline, Google Scholar and SPORTDiscus. Inclusion criteria included age: 4–5 years old; FMS measurement: Test of Gross Motor Development 2 and 3; PA measurement: objective methods; balance measurement: static single limb; study design: cross-sectional observational/descriptive, randomised control trials, intervention studies; language: English. Twenty-eight articles from twenty-one countries met the inclusion criteria and were split into either FMS and PA articles (n = 10) or balance articles (n = 18). Three articles showed children achieving 60 min of MVPA per day, two articles demonstrated significant differences between girls' and boys' performance of locomotor skills, and five reported locomotor skills to be more proficient than object control skills at this age for both genders. Balance was measured in time (n = 12), points score (n = 3) or biomechanical variables (n = 3), displaying heterogeneity of not only measurement but also outcomes within these data, with static single limb balance held between 6.67 to 87.6 s within the articles. Four articles reported girls to have better balance than boys. To our knowledge, this is the first study to review FMS, objectively measured PA and balance during early childhood (4–5 years old), and thus adds key summary knowledge to the research area. There is little conclusive evidence of the current levels for FMS, PA, and balance achievement in young children 4–5 years of age. The academic literature consistently reports low levels of FMS competence and mixed evidence for PA levels. Inconsistencies lie in balance measurement methodology, with broad-ranging outcomes of both low and high achievement at 4–5 years old. Further research is required to focus on increasing practice opportunities for children to improve their FMS, increase PA levels, and establish sufficient balance ability. Consistent and comparable outcomes during early childhood through more homogenous methodologies are warranted.

2.2. Introduction

Early childhood (3–5 years) is a critical time to develop health behaviours that are subsequently used throughout the lifespan and are important in reducing the likelihood of disease and illness during both childhood and beyond (Carson et al., 2017; Ebbeling et al., 2002). Among these behaviours are recommended levels of PA, and ensuring children are sufficiently active is key to positive physical, cognitive and psychosocial health in children (Carson et al., 2017).

UK government guidelines recommend that young children under five years of age and specifically pre-schoolers (3-4 years of age) should aim to achieve 180 min of PA per day, with at least 60 min of this being moderate to vigorous PA (MVPA) (Department for Health and Social Care, 2019a). This guideline is mirrored by multiple international governments, including Canada (Canadian Society for Exercise Physiology, 2020) (60 min of energetic play) and Australia (The Department of Health, 2012). Although the World Health Organization (WHO) does not provide guidelines for under 5 years of age, it recommends that children aged 5 years and above should achieve at least 60 min of MVPA each day, with additional PA at this level providing additional benefits (World Health Organisation, 2011). Measurement of PA during early childhood is challenging, but essential to understanding how we can improve health in young children. Objective assessment such as accelerometry and pedometry offer the collection of continuous PA, without researcher or parental burden to report activity for young children (Konstabel et al., 2019; Loprinzi & Cardinal, 2011; Pate et al., 2010). These measures have been identified as more reliable and accurate compared to subjective measures over extended periods of assessment (Bingham et al., 2016; Penpraze et al., 2006) and are now recognised as a preferred method. Accelerometer type, placement on the body, and the cut points and epochs employed by researchers have seen great variation in the literature, and can affect overall PA outcomes, questioning the validity and objectivity of accelerometry (Migueles et al., 2019). Identifying these variations, or if there are more commonly made choices by researchers to create an overall picture of how PA is objectively examined in young children is important. Further to this, there is currently not a consensus if PA guidelines are being achieved during early childhood when measured using accelerometry.

Over the last 20 years there have been multiple studies examining PA behaviours and more recently more studies examining FMS and their relationship with PA. With FMS being the building blocks to more complex movement patterns (Goodway et al., 2019; Logan et al., 2018). Each element is equally important to increasing overall MC, including gross and fine motor skills, in addition to performing day to day activities and postural control (D'Hondt et al., 2009; Donath et al., 2015; Gabbard, 2018; Verbecque et al., 2016). Creating an environment for developing FMS and MC, including adequate skill practice opportunities, is vitally important to sustained involvement in, and achievement of, PA for children of this age and onwards (Barnett et al., 2009; Jaakkola et al., 2016). During early childhood, children should be encouraged to perform MVPA to help develop these FMS and higher levels of MC (Fisher et al., 2005). Understanding the current prevalence of FMS competency during early childhood is important to identifying areas of development for both research and intervention.

The Test of Gross Motor Skills 2 and 3 (TMGD-2 and -3) (Ulrich, 2000, 2016) are frequently adopted methods for the assessment of MC for young children across the globe. In 2018, Logan et al., (2015) reported that it was the most widely used tool (51% of studies) in a review of 124 studies examining FMS measurement and terminology. This is further supported by Klingberg et al., (2019) noting the popularity of the TGMD tools for measuring FMS in preschool children. The strengths of the TGMD protocols and assessment include the reliability of the process-based scoring system, where two attempts of each skill are scored with between three and five performance criteria for the 12 or 13 skills in the TGMD-2 and TGMD-3, respectively, while also providing good reliability and validity as a measurement tool (Eddy et al., 2020). These batteries also employ measurement of skills commonly seen in play and sport performance (Griffiths et al., 2018), which are vital for PA participation throughout childhood and the lifespan (Robinson et al., 2015).

Balance and stability are a critical domain of FMS (Gallahue & Donnelly, 2003) yet are rarely examined in large-scale studies alongside locomotor and object control FMS (Xin et al., 2020b). Interestingly, the MC assessment tools, TGMD-2 and TGMD-3, are both without elements of static or dynamic balance assessment (Ulrich, 2000, 2016). Although other assessment batteries have been developed, such as the Movement Assessment Battery for Children (Henderson & Sudgden, 1992) and Bruininks–Oseretsky Test of Motor Proficiency (Bruininks & Bruininks, 2005), that both examine balance in addition to fine motor skills, the TGMD batteries remain as one of the most popular forms of assessment, especially for gross motor development (Logan et al., 2018).

Given its importance, various studies have examined the balance ability during early childhood in separate studies, using tools such as the paediatric balance scale (PBS) (Franjoine et al., 2003). Hardy et al., (2010) previously stated that stability and balance ability has ceiling effects during early childhood and, by the age of four years, children have sufficient mastery of dual stance balance (Guffey et al., 2016; Richardson et al., 1992). Therefore, the inspection of single limb balance can be employed to explore the development of more complex balance ability at these early years. Some studies have stated that during the ages of four to five years, there is a large natural development of balance ability (Jiang et al., 2018; Venetsanou & Kambas, 2011), and therefore, discount the need for measurement. This matches findings by both Chow & Chan (2011) and Krombholz (2006), who reported continually increasing balance ability as children aged. Nonetheless, static balance is known to be an important precursor to locomotor activities (Roncesvalles et al., 2001), and inspection of balance ability in young children will help inform both future research and interventions. This will allow young children to achieve better overall FMS, and explore the association between locomotor, object control and balance skills. PA and FMS are clearly interrelated and stand to give researchers and practitioners an important overview of key behaviours and skill development in early childhood. Currently, locomotor, object control and balance competency and PA behaviours have not been summarised for children of 4–5 years, a key age for both balance development (Hardy et al., 2010) and the start of formal education in the UK (GOV.UK, 2020), where children are asked and expected to use such skills on a regular basis. Although there are a wide range of assessment methodologies employed to test and measure levels of MC, FMS, PA and balance in children (Eddy et al., 2020), this review will focus on the TGMD-2 and -3 protocols for locomotor and object control skills, due to their consistent popularity and dedicated focus of measuring gross motor development, designed for typically developing children 3–10.9 years of age (Ulrich, 2000, 2016). Balance ability will be observed through dedicated balance studies of this age group. Therefore, the aim of the current systematic review is to summarise the methods used and outcomes achieved during assessment of the current levels of achievement of locomotor and object control FMS, PA and balance competency in 4–5-year-old children.

Three main objectives have been identified for the purpose of this review with young children 4–5 years of age: (1) observe the locomotor and object control skill competency of young children measured via the TGMD batteries, (2) observe current PA achievement in young children and how these are measured using objective methods, (3) identify common static balance measurement methods and achievement in early childhood.

2.3. Materials and Methods

2.3.1. Protocol and Registration

This review was registered with PROPSERO (registration number CRD42020181666) in June 2020. The review protocol can be found by searching this number on the PROSPERO website or using the address: https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=181666.

2.3.2. Study Selection Criteria

A systematic review of the literature was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (Moher et al., 2009) (please see Appendix 2.1, Table A2.1 for checklist) to identify all English language, peer-reviewed articles published between January 2000 and April 2020. Although articles must have been published in the English language, they could originate from across the globe, as this allowed for a broader picture of achievement in children aged 4–5 years. For both searches, observation studies, prospective cohort studies, baseline studies, intervention studies (if pre-intervention data were available) and validity studies were included, however, review articles were excluded from analysis.

The literature met the following criteria for the series of articles examining FMS and PA: participants of age 4–5 years; examined FMS measured by the TGMD-2 or -3; examined PA measured via objective methods; reported levels of MVPA over an hourly or daily period; data were collected at baseline or as part of an observational study, data were collected from typically developing and typical weight children without disability or developmental delay.

If articles included data for other age groups, then data must have been explicitly reported for 4–5-year-olds for the article to be eligible for inclusion. Articles must have explicitly reported data for typically developing and typical weight children if a comparison between another group with a disability, developmental delay or obesity was being examined. This was applicable for both the FMS and PA searches and balance searches.

2.3.3. Search Strategy

PubMed/Medline, Google Scholar and SPORTDiscus were searched up to 30 April 2020 using the following key words within the titles: fundamental movement skills, physical activity, and children for the FMS/PA articles. For example, Google scholar was searched using the terms "allintitle: 'physical activity' 'children' 'fundamental movement skills'". The balance literature was searched for using a combination of the keywords: balance, childhood, early childhood, children, and young children. For example, Pubmed and Medline were searched using the term "(balance [Title]) AND childhood [Title]". A screening of titles according to the criteria was completed. Subsequently, any duplicates from separate search engines were removed. A further screening of the abstract was undertaken according to the inclusion criteria and, if it was not clear if an article met the inclusion criteria at this stage, it was included in the full text screen. Full text articles were then assessed for eligibility, a visual representation of the search strategy can be observed in Figures 2.1, 2.2, and 2.3. Ten percent of the original search sample was randomly allocated and examined by a second researcher (CR), confirming or disagreeing with the first researcher's (AD) decision. Initially, disagreement was recorded among 7% (n = 1) of the articles. A discussion was held between the researchers to reach a consensus on inclusion of specific articles, which matched the first author's decision.

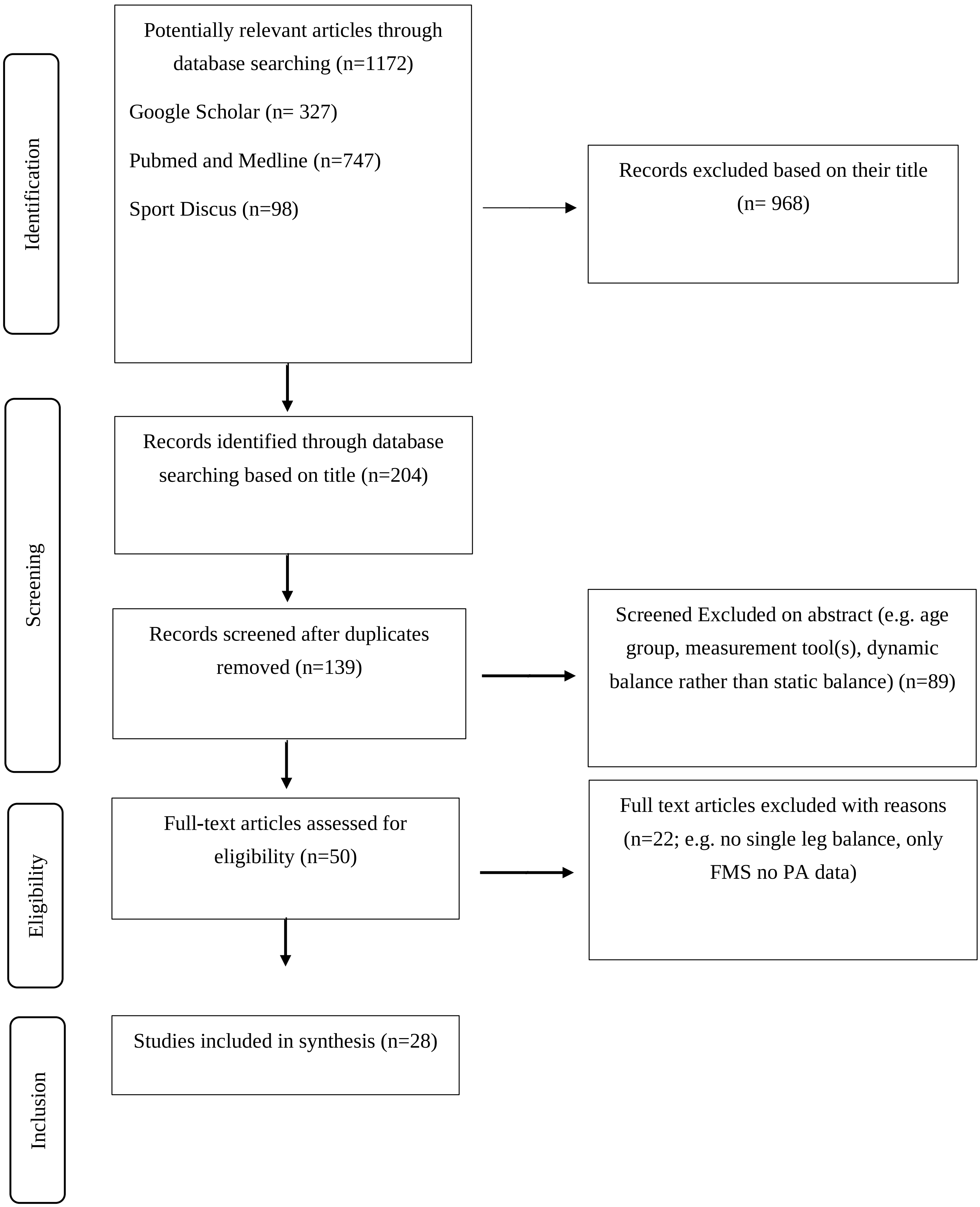


Figure 2.1. Combined searches Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart. PA=physical activity; FMS=fundamental movement skills

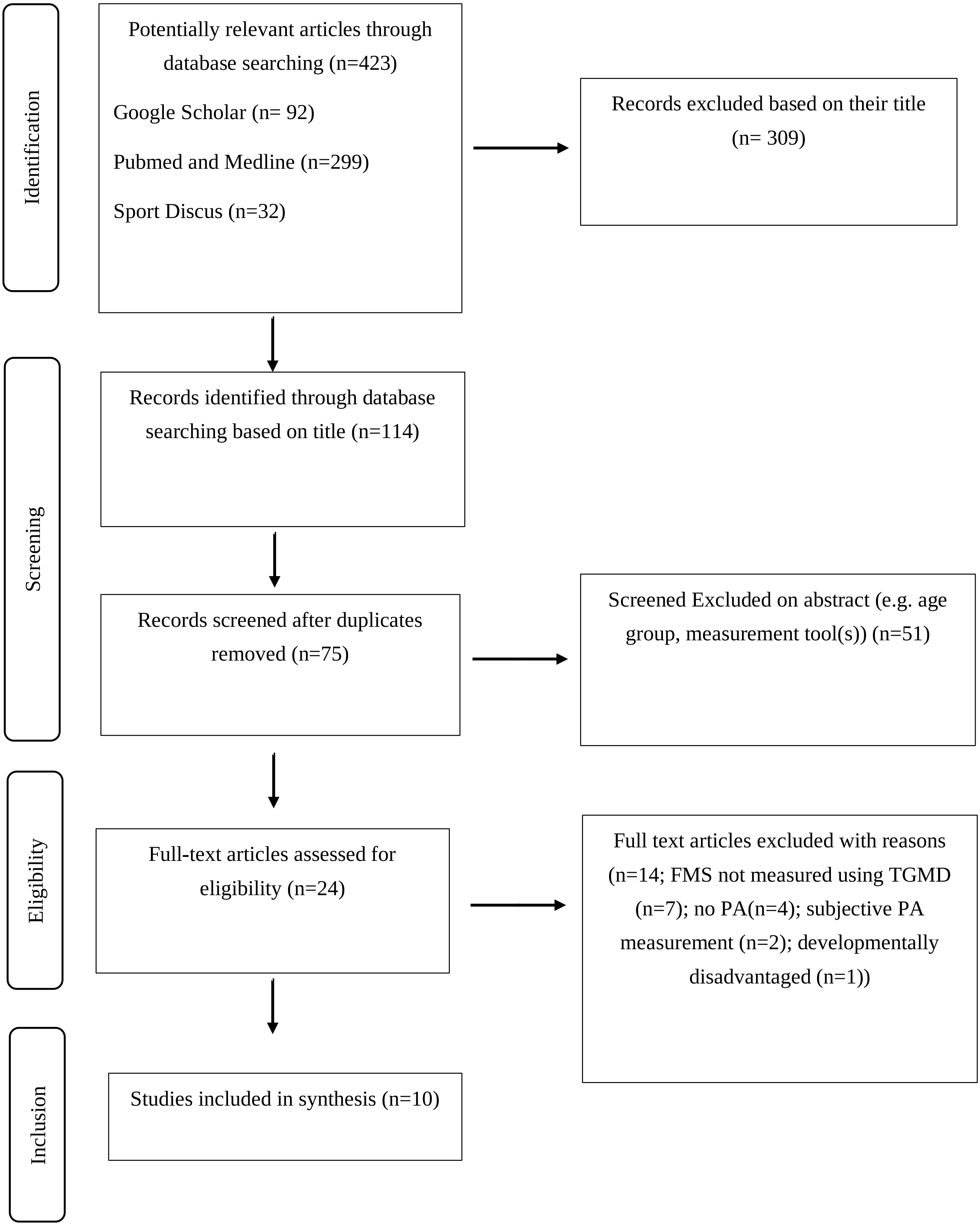


Figure 2.2. Locomotor, object control and physical activity (PA) searches PRISMA flow chart. TGMD=Test of Gross Motor Development.

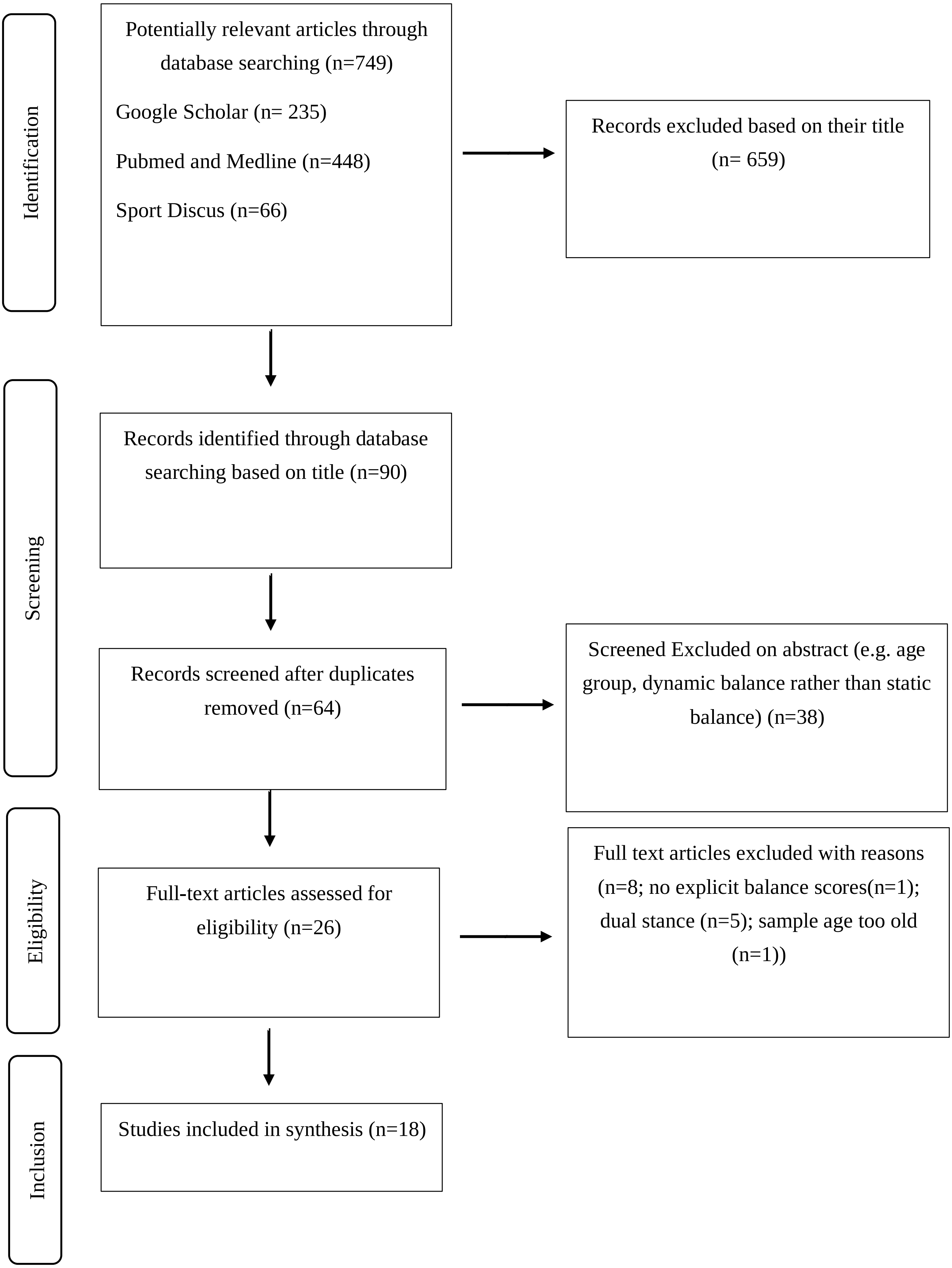


Figure 2.3. Balance searches PRISMA flow chart.

2.3.4. Data Extraction and Synthesis

For the articles that met the criteria, the following data were extracted for all paper types: author(s), year of publication, country of origin, setting, sample size for age 4–5 years, mean age of participants, study design (observational, randomised controlled trial, non-randomised trial), outcome measure(s) and overall findings related to FMS and PA achievement or balance ability.

2.3.4.1 Locomotor, Object Control and PA Articles

For FMS and PA articles, outcome measure(s) included: FMS assessment battery, accelerometer type and body location. FMS competency was reported as per individual article, for example, as a gross motor quotient or as a raw score. Some studies included in the current review used the full form of 12 or 13 items to assess MC and reported the raw scores out of 96 or 100 points, respectively. However, other studies use shortened protocols, and these studies were still included in the review, resulting in not all studies having full scoring. Sex differences were also reported for these variables.

As MVPA has been recognised as being particularly beneficial for health during childhood and throughout the lifespan (Lonsdale et al., 2013; Reily et al., 2018) this variable was considered the key measurement during this review. Daily and hourly MVPA levels were reported, and sex differences were reported where available. Information on the type of accelerometer, placement on the body, the cut points and epochs employed was also deemed important to report.

2.3.4.2. Balance Articles

For balance articles, outcome measure(s) included: balance assessment conditions and measurement tool(s). Where reported, biomechanical aspects of balance, including centre of pressure (COP) area and length, and time spent (measured in seconds) in a single-leg stance, were recorded as balance outcomes. Further to this, single-leg balance tests from test batteries, including the Bruininks–Oseretsky Test of Motor Proficiency Second Edition (Bruininks & Bruininks, 2005) and Movement Assessment Battery for Children (Henderson & Sudgden, 1992) that use a numerical score to reflect balance ability, were reported for this element of the review.

2.3.5. Study Quality Assessment

The mixed methods appraisal tool (MMAT) (Hong et al., 2018) was used to assess the quality and risk of bias within the studies included in the review. The studies were screened using two initial questions before being appraised according to five criteria according to their study design category. The categories included in this study included quantitative randomised controlled trials, quantitative non-randomised studies and quantitative descriptive studies. Questions/criteria were answered using; yes, no or cannot tell. For any "yes" answers a paper received one mark, any "no" or "cannot tell" would receive no marks, thus the maximum score for an article was 7. Quality score was used to indicate the strength of the evidence from the individual studies but was not used to determine their inclusion or exclusion within the review.

2.3.6. Analysis

Analysis for both the FMS and PA articles and balance articles was of a narrative approach due to the lack of heterogeneity of the data collected and multiple methods used.

2.4. Results

2.4.1. Study Selection

Overall, 1172 articles (including possible duplicates) were identified using the key word search across three search engines. Following this, 986 articles were excluded based on their title. Following removal of duplicate articles, a further 89 articles were excluded following examination of the abstract. Fifty articles were assessed for full text eligibility and 28 articles were included in the final analysis (Table 2.1 and 2.2). The most common reasons for exclusion included age group, i.e., being too old, subjective PA measures, alternative FMS assessment batteries to TGMD, dynamic balance measurement and static dual stance balance. These are reported in Figures 2.1–2.3., which shows how the study selection was completed for the study, FMS and PA articles and balance articles, respectively.

2.4.2. Origin and Participants

Of the 28 articles analysed, there were multiple countries of origin for both the FMS and PA articles and balance articles. For FMS and PA, of the 10 articles used in the analysis, there was a total of six different countries the articles originated from. This included: three articles from Australia, two from the UK and USA and one from Ireland, Norway, and Canada. For the balance literature, the 18 articles originated from 15 different countries including: two articles from Serbia, Korea and the USA and one from Spain, Indonesia, Belgium, Australia, Iran, Japan, China, Brazil, Romania, Greece, Ireland and Singapore.

The total number of participants for the FMS and PA articles combined was 1514. The average number of participants was 151 and ranged from 46 to 376. The total number of participants for the balance-related articles combined was 5036, the average number of participants was 280 and this ranged from 15 to 3575 participants. Therefore, the overall participation number for this review is 6550 participants with an average age of 4.7 years.

Of the FMS and PA articles, 90% reported the sex of the participants. The sample consisted of 1485 participants, 54% were boys and 46% girls. Of the balance articles, 78% reported the sex of the participants, (n = 4876), with 51% of them boys and 49% girls.

2.4.3. Study Quality Assessment

Most of the articles included were of high quality according to the MMAT. Using the MMAT, 58.6% (17 articles) of the studies were highly rated, meeting all seven criteria set out by the tool. A further 24.1% (seven articles) met six criteria, 13.8% (four articles) met five criteria and just 3.5% (one article) met four of the criteria. Four articles were assessed under the quantitative randomised controlled trial criteria, one article under the quantitative non-randomised criteria and the remaining 24 under quantitative descriptive criteria. Individual study scores can be found in Appendix 2.2 (Table A2.2).

2.4.4. Locomotor and Object Control Proficiency

Of the 10 articles collated for analysis (Table 2.1), all had employed the use of the full or partial TGMD-2 or TGMD-3 protocols as stipulated by the criteria. As these protocols had different total scores, due to allowing the inclusion of research that had not employed the full protocols or used a different scoring system, such as the Children's Activity and Movement in Preschool Study Motor Skills Protocol (CMSP), as such a meta-analysis could not be conducted.

Of the ten articles reviewed, three articles used the full TGMD-2 protocol and scored this against the TGMD-2 criteria (Barnett, Salmon, et al., 2016; Cliff, Okely, et al., 2009; Wasenius et al., 2018). A further three articles used a version of the TGMD-2 protocol adapted for use within individual studies (Duff et al., 2019; Jones et al., 2011; Roscoe et al., 2019a). This included using specific skills, removal of unwanted or unwarranted skills, and addition of more relevant skills related to the study outcomes or cultural differences. Foweather et al., (2015) used the full TGMD-2 protocol and scored this using the CMSP. Three articles employed the use of the TGMD-3 protocol, which is an updated version of the TGMD-2 protocol (Ulrich, 2000). Two of these articles used the full protocol, which scores 13 skills (six locomotor and seven object control skills) (Palmer et al., 2019; Webster et al., 2019), while Nilsen et al., (2020) used a partial protocol.

A common theme found between the MC performance of the children was the majority of authors reported locomotor skills being performed with more competency than object control skills at this age (Duff et al., 2019; Foweather et al., 2015a; Nilsen et al., 2020; Wasenius et al., 2018), similarly, both Duff et al., (2019) and Jones et al., (2011) found running to be the most proficient individual skill at this age, over any other individual locomotor or object control skill tested. On the other hand, only Palmer et al., (2019) found the opposite in their baseline assessments, with object control skills being performed with more proficiency.

Where sex differences were reported, it was found that girls performed locomotor skills with more proficiency than boys (Cliff, Okely, et al., 2009; Roscoe et al., 2019a), however, both authors reporting this found that there was no significant difference between the object control or total raw scores between sexes. On the contrary, Webster et al., (2019) found boys performed object control skills with higher proficiency than girls. When relationships with PA were assessed, Nilsen et al., (2020) found a significant and positive relationship between MVPA levels and locomotor and object control skills, while Roscoe et al., (2019) reported FMS mastery did not influence the PA level achieved.

2.4.5. PA Levels

Of the FMS and PA articles reviewed (n = 10) (Table 1), accelerometry was used to assess PA, with no other objective measure used to measure PA. Eight articles assessed PA using hip-based accelerometry and ActiGraph models including the ActiGraph 7164, GT1M and GT3X (ActiGraph LLC, Pensacola, FL, USA) to assess PA (Barnett et al., 2016; Cliff, Okely, et al., 2009; Duff et al., 2019; Foweather et al., 2015a; Jones et al., 2011; Nilsen et al., 2020; Palmer et al., 2019; Webster et al., 2019). Wasenius et al., (2018) used an Actical accelerometer (mini Mitter Co., Inc., Bend, Oregon), the position of the accelerometer was not stated. Roscoe et al., (2019) was the only article to use wrist-based accelerometry and a Geneactiv accelerometer (ActivInsights Ltd., Kimbolton, Cambridge, UK). Roscoe et al., (2019) also used Roscoe et al., (2017a) Geneactiv, wrist-based cut points to classify activity of the children. Further to this, three articles used Evenson et al., (2008) cut points (Barnett, Salmon, et al., 2016; Palmer et al., 2019), one used Pate et al., (2008) cut points (Webster et al., 2019), one used Adolph et al., (2012) cut points (Wasenius et al., 2018), one used Sirard et al., (2005) cut points (Jones et al., 2011), one used Janssen et al., (2013) cut points (Foweather et al., 2015a), one used Pate et al., (2006) cut points (Duff et al., 2019) and one article used both Reilly et al., (2003) and Sirard et al., (2005) cut points to classify activity. For the measurement of epoch length, one article used 1 s epochs (Nilsen et al., 2020), one article used 5 s epochs (Foweather et al., 2015a), two articles used 10 s epochs (Duff et al., 2019; Roscoe et al., 2019), five articles used 15 s epochs (Barnett et al., 2016; Jones et al., 2011; Palmer et al., 2019; Wasenius et al., 2018; Webster et al., 2019) and finally, one article used 1 min epochs (Cliff, Okely, et al., 2009). Therefore, a wide breadth of different cut points and epoch lengths was used in identifying PA behaviours of the participants in the studies.

Wear time varied between two days (Jones et al., 2011) and 14 days (Nilsen et al., 2020), with the most commonly reported length being seven days (Cliff, Okely, et al., 2009; Foweather et al., 2015a; Palmer et al., 2019; Wasenius et al., 2018; Webster et al., 2019). Barnett et al., (2016) reported eight days' wear, while Roscoe et al., (2019) reported four, and Duff et al., (2019) five days of wear. However, out of the eight articles that stipulated an acceptable wear time for analysis, six articles required three days of wear (Cliff, Okely, et al., 2009; Duff et al., 2019; Foweather et al., 2015a; Roscoe et al., 2019a;

Wasenius et al., 2018; Webster et al., 2019) and the remaining two articles required four days of wear time (Barnett, Salmon, et al., 2016; Nilsen et al., 2020).

Webster et al., (2019) reported the highest levels of MVPA with 102 min per day, while Cliff et al., (2009) only reported 23 min of MVPA per day. Of the articles reporting hourly MVPA, this varied between 13.6 min to 22.42 min per hour. Jones et al., (2011) reported that 7% of the children's day at preschool was spent in MVPA level.

2.4.6. Balance Proficiency

Balance articles (Table 2.2) were limited due to the inclusion of static balance, however, there was still sufficient evidence for analysis of this literature. Of the balance articles, 18 were used for data extraction and synthesis. There was not a common assessment method, therefore, a meta-analysis could not be undertaken.

All articles included static balance tests that required the children to balance on one leg. Some articles (n = 11) reported this on a firm surface with eyes open (Adamović et al., 2015; Amelia et al., 2019; De Oliveira et al., 2019; Fujinaga, 2008; Guffey et al., 2016; Jiang et al., 2018; Jung et al., 2017; Latorre Román et al., 2017; Marin, 2012; Moran et al., 2005; Zumbrunn et al., 2011). Stankovic & Radenkovic (2012) also asked children to stand on a single leg on a firm surface, repeating this with their eyes closed. Venetsanou & Kambas (2011) and Eshaghi et al., (2015) used balance beams in their methods. Meanwhile, other articles reported static balance on unstable surfaces such as foam (An et al., 2009; Cambier et al., 2001; Condon & Cremin, 2014) with or without visual aid (eyes closed). The articles that employed the use of foam surfaces, balance beams and closing of the eyes all reported a reduction in performance in a single-leg stance during these conditions. Barefoot and shod conditions were employed by Tan (2019) and found no significant (p=0.572) difference in the two conditions.

Twelve articles used time, in seconds, as the outcome measure for the single-leg tests (Amelia et al., 2019; An et al., 2009; De Oliveira et al., 2019; Eshaghi et al., 2015; Fujinaga, 2008; Jung et al., 2017; Latorre Román et al., 2017; Marin, 2012; Moran et al., 2005; Stankovic & Radenkovic, 2012; Tan, 2019). The range of time the single-leg stance was maintained for on a hard surface with eyes open ranged from 6.67 s (Amelia et al., 2019) to 87.6 s (Fujinaga, 2008), with eyes closed, 6.9 s was the lowest outcome (Stankovic & Radenkovic, 2012), with 33.62 s being the highest (An et al., 2009). Three articles used point scores to measure the outcome of the balance, including Adamović et al., (2015), Guffey et al., (2016) and Venetsanou & Kambas (2011). Meanwhile, the remaining three articles used biomechanical characteristics to measure balance (Cambier et al., 2001; Jiang et al., 2018; Zumbrunn et al., 2011), which are reported in Table 2.

Five articles reported sex differences between the children, as four articles reported girls having better balance than boys (Jiang et al., 2018; Latorre Román et al., 2017; Stankovic & Radenkovic, 2012; Venetsanou & Kambas, 2011) and, conversely, Marin (2012) reported boys to have better balance ability than girls. Four articles reported the effect of age on the children's balance ability, with clear increases in time held (Latorre Román et al., 2017), points scored (Venetsanou & Kambas, 2011) or reduction in sway velocity or centre of pressure movement recorded (Cambier et al., 2001; Jiang et al., 2018) as the children aged.

Table 2.1. Locomotor, object control and PA article descriptive results

Author	Country	Setting	Sample Size	Mean Age (years)	Study Design	Outcome Measure(s)	Overall Findings—Relating to Baseline FMS and PA
Barnett et al. (2016)	Australia	Home setting	127 (59 boys, 68 girls)	5 ± 0.1	Observational cohort study	TGMD-2 (full), Accelerometry MVPA levels @ hip, ActiGraph GT1M	(1) Most children were average or below their age recommended standard score for TGMD-2. (2) Children performed 52.8 min/day of MVPA.
Cliff et al. (2009)	Australia	Preschool	46 (25 boys, 21 girls)	4.3 ± 0.7	Cross-sectional	TGMD-2 (full), Accelerometry MVPA levels @ hip, ActiGraph 7164 uniaxial	(1) Girls had a higher LOCO level and gross motor quotient than boys, but no gender difference OC with raw scores. (2) The sample overall spent 23 min/day in MVPA levels.
Duff et al. (2019)	Ireland	Preschool	141 (71 boys, 70 girls)	3.9 ± 0.5	Cross-sectional baseline	TGMD-2 and Victorian FMS manual- run, vertical jump, throw and catch Accelerometry ActiGraph GT3x and GT1m @ Hip (only preschool time)	(1) Children were proficient in run (88.4%), but low across other skills assessed (4.9–18.5%). (2) 7.7 min/h MVPA on average over 3 h school day.
Foweather et al. (2015)	England	Preschool	99 (52 boys, 47 girls)	4.6 ± 0.5	Cross-sectional observational	TGMD-2 scored with CMPS (total 138), Accelerometer ActiGraph GT3X@ waist	(1) Children completed more VPA at weekends vs. on weekdays. (2) On average children completed 89.4min MVPA/day. (3) Children had higher proficiency of LOCO than OC skills.
Jones et al. (2011)	Australia	Preschool	97 (no gender data)	4.13	Cluster randomised controlled trial	TGMD-2 (5 skills; Run, Jump, Hop Catch, Kick), MTI 7164 ActiGraph accelerometer @ right hip	(1) 7% of time was spend in MVPA. (2) Children were most proficient in the run and least proficient in the hop.
Nilsen et al. (2020)	Norway	Preschool	376 (196 boys, 180 girls)	4.7 ± 0.9	Cross-sectional observational	TGMD-3 (partial), Accelerometer ActiGraph GT3X @ right hip	(1) Children had higher competence in LOCO than OC skills. Total FMS 25.5/44. (2) 70min/day of MVPA. (3) Significant and positive relationship between MVPA levels and LOCO and OC skills.
Palmer et al. (2018)	USA	Preschool	102 (63 boys, 39 girls)	4.4 ± 0.43	Randomised control trial	TGMD-3 (Full), Accelerometer ActiGraph GT3X@ waist	(1) 22.42 min/h as MVPA, with boys presenting more MVPA than LPA compared to girls. (2) Children were more proficient in OC than LOCO skills at baseline. (3) 19/100 was achieved for total FMS at baseline.
Roscoe et al. (2019)	England	Preschool	185 (99 boys, 86 girls)	3.4 ± 0.5	Cross-sectional observational	TGMD-2 (no underhand roll, added skip), Accelerometer- Geneactiv @wrist	(1) None of the children achieved the PA recommendations and were inactive, average MVPA was 25 min/day. (2) Girls scored better in the LOCO skills, and boys scored better in the OC skills, no sig. diff. in total FMS. (3) FMS mastery level did not influence PA levels of the children. Children scored from 6–82 points for total FMS, an average 52/90.
Wasenius et al. (2018)	Canada	Preschool	215 (117 boys, 98 girls)	3.65 ± 0.5	Cluster randomised controlled trial	TGMD-2 (full), Accelerometer Actical, omnidirectional	(1) At baseline LOCO skills were more proficient than OC between groups. (2) Children's average GMQ was 37.7/96. (3) 25 min/h average PA performed by all children at baseline over 5 h wear.
Webster et al. (2019)	USA	Childcare centres	126 (58 boys, 68 girls)	3.4 ± 0.5	Observational cohort study	TGMD-3(full), Accelerometer ActiGraph GT3X @ right hip	(1) 1.7 ± 0.6 h of MVPA per day. (2) Boys had better total TGMD-3 and OC scores than girls. (3) The average percentile for children 45.2 for overall FMS, or 37.7 points out of 100.

Key: PA = physical activity, FMS = fundamental movement skill, MVPA = moderate to vigorous physical activity, TGMD = Test of Gross Motor Development, LOCO = locomotor, OC = object control, CMPS= Children's Activity and Movement in Preschool Study Motor Skills Protocol, LPA= Light Physical Activity, GMQ= Gross Motor Quotient.

Table 2.2. Balance article descriptive results

Author	Country	Setting	Sample Size	Mean Age (years)	Study Design	Outcome Measure(s) for Single-Leg Balance	Overall Findings—Relating to Static Balance
Adamovic et al. (2015)	Serbia	Testing at university	54 (29 boys, 25 girls)	5.24 ± 0.14	Longitudinal observational	Standing on one foot for 20 s: score from 0–2.	(1) Standing on one foot was the least developed balance skill of the children. (2) Average score was 1.5/2 with 34% (20 children) of the sample achieving the maximum of 2 points (10–12+ s).
Amelia et al. (2019)	Indonesia	N/A	30 (no gender data)	5.5	Non-equivalent control group	Standing on single leg (trial on each leg) for up to 30 s, measured in seconds.	(1) Children were able to hold single-leg balance for 6.67 s on average at baseline.
An et al. (2009)	Korea	Elementary school	18 (no gender data available)	5	Cross-sectional observational	Single-limb standing test; 4 conditions; firm surface: eyes opened and closed, foam surface: eyes open and closed. Measured in seconds.	(1) Children could hold a single-leg balance for 37.55 ± 21.11 s with a firm surface and eyes open. (2) When eyes were closed this decreased to 33.62 ± 21.60 s.
Cambier et al. (2001)	Belgium	Primary School	73 (no gender data available)	4.5	Cross-sectional observational	Unilateral stance test, 4 conditions; firm surface: eyes opened and closed, consecutively on the left then right foot, measured using centre of gravity sway velocity.	(1) There was a higher sway velocity when eyes were closed on both feet, suggesting more movement in this position. (2) Between 4 and 5 years of age, the velocity of movement reduced.
Condon and Cremin (2014)	Ireland	Mainstream primary schools	26 (11 boys, 15 girls)	4.5	Cross-sectional	Single-limb standing test; 3 conditions; firm surface: eyes opened and closed, foam surface: eyes open, measured in seconds.	(1) Standing with eyes open allowed children to achieve a higher time. (2) Eyes closed and foam surfaces disrupted children’s balance, foam being the greatest disrupter for young children.
De Oliveira et al. (2019)	Australia	Primary School	511 (257 boys, 254 girls)	5.4	Cluster randomised control trial	One-leg balance: MABC-2, measured in seconds.	(1) At baseline children could hold a one-leg balance for an average of 16.75 s. (2) The intervention was found to have a positive effect.
Eshaghi et al. (2015)	Iran	N/A	20 (9 boys, 11 girls)	6	Cross-sectional observational	One-leg balance eyes open and closed on ground and repeated on balance beam from BOTMP-2, measured in seconds.	(1) Term children could remain balanced on one leg on the ground for an average of 9.70 s. This decreased by 1 s with eyes closed. (2) On a balance beam, balance was further reduced.
Fujinaga (2008)	Japan	Kindergarten	105 (51 boys, 54 girls)	5	Cross-sectional observational	One-leg standing test, measured by time, up to 120 s (seconds).	(1) Children on average achieved 87.6 ± 37.06 s in the single-leg stance.
Guffey et al. (2016)	USA	Hospital paediatric clinic and day care	28 (no gender data)	3.54 ± 0.84	Cross-sectional observational	Paediatric Balance Scale component 9 (standing on one foot), scored 0–4.	(1) Standing on one foot was recognised as a harder task for children to perform from the PBS, however, it was generally mastered by the age of 4 years for 10 s.
Jiang et al. (2018)	China	Public kindergarten	60 (30 boys, 30 girls)	4.5	Cross-sectional observational	Tekscan foot pressure measurement system, one foot eyes open, held for 10 s. Measured by envelope area (area), path length (length), maximum displacement in anteroposterior (forward–back) and mediolateral direction (left–right) of the centre of pressure.	(1) Girls had lower postural sway than boys. (2) There were no significant differences between balance measurements on one foot at ages 4 and 5 years. However, 5 year olds’ movements were consistently lower than 4 year olds, showing the increase in balance at this age.
Jung et al. (2017)	Korea	N/A	11 (4 boys, 5 girls)	5.8 ± 1.2	Cross-sectional observational	One-leg standing test (OLST) non-dominant leg, measured in seconds.	(1) On average children stood in the single-leg position for 38.1 ± 20.8 s.

Author	Country	Setting	Sample Size	Mean Age (years)	Study Design	Outcome Measure(s) for Single-Leg Balance	Overall Findings—Relating to Static Balance
Marin (2012)	Romania	Kindergarten	20 (9 boys, 11 girls)	4.5	Observational cohort study	The flamingo test for up to one minute, measured in seconds.	(1) 33.16 s was the average length of time children held the flamingo test for. (2) Boys (42.22 s) were much more proficient in holding the flamingo test than girls (24.09 s).
Moran et al. (2005)	Brazil	Public school	136 (62 boys, 74 girls)	5	Cross-sectional	Single-leg stance test for 10 s.	(1) 60 (44%) of the children in the control group failed to hold the single-leg balance for 10+ s.
Latorre-Roman et al. (2017)	Spain	Preschool	3575 (1816 boys, 1759 girls)	4.7 ± 0.93	Cross-sectional observational	Stork balance stand test, up to one minute, measured in seconds.	(1) At 4 years of age girls were more proficient than boys at balancing on their right leg. (2) On average children held the stork stance for 8.13 ± 7.81 s. (3) Between ages 4 and 5 years children's balance improved from 7.40 ± 6.99 to 10.51 ± 8.84 s, showing the improvements at this age.
Stankovic and Radenkovic (2012)	Serbia	Preschool	39 (26 boys, 13 girls)	5.5	Observational cohort study	Standing on one leg eyes open and standing on one leg eyes closed, measured in seconds.	(1) Children held their balance with eyes open for an average of 25.85 s, girls holding for longer than boys (28.8 vs. 22.9 s). (2) With eyes closed, 6.9 s was the mean score for all participants. Again, girls were able to hold this position for longer (7.3 vs. 6.5 s).
Tan et al. (2019)	Sinagpore	N/A	23 (9 boys, 14 girls)	6.32 ± 0.27	Cross-sectional observational	One-leg balanc:- MABC-2, measured in seconds. Barefoot and shod conditions, up to 30 s tested.	(1) Children were able to hold the one-legged balance for 25.74 ± 5.778 s while barefoot and 25.04 ± 6.698 s when shod. These were not significantly different.
Venetsanou and Kambas (2011)	Greece	Public preschools	283 (145 boys, 138 girls)	5.15 ± 0.45	Cross-sectional observational	BOTMP; standing on the preferred leg on the floor, standing on the preferred leg on a balance beam, standing on the preferred leg on a balance beam—eyes closed. Numerical point score.	(1) Girls scored consistently higher on all single-leg balance elements than boys. (2) The 54–59 month age group was significantly worse at balancing than the 60–65 month and 66–71 month age groups, showing clear progression at these ages.
Zumbrunn et al. (2012)	USA	Test in laboratory	15 (9 boys, 6 girls)	6.17 ± 1.1	Evaluation study	Stand on one foot for 5 s, COPsd A/P, COPsd M/L, COPsd Res, COPmax A/P, COPmax M/L, COParea, ARD, path velocity, COPvel A/P, COPvel M/L, ARF	(1) COP elements correlated well with the BOT balance subtests.

BOTMP-2 = Bruininks–Oseretsky Test of Motor Proficiency-2, PBS = Paediatric Balance Scale, MABC-2 = Movement Assessment Battery for Children 2, COP = centre of pressure, ARD= Average radial displacement, ARF= average radial frequency

2.5. Discussion

The aim of this study was to review the current evidence and literature surrounding 4–5-year-old children's FMS proficiency, PA levels and single-limb balance ability, whilst identifying the important variation in methodologies employed by researchers to reach these research outcomes. Low levels of locomotor and object control proficiency were found across the literature reviewed, in addition to a varied but still worrying picture around children achieving PA recommendations, further complicated by differences in factors such as accelerometer wear time and cut points. Balance measurement was found to be common in early childhood, but not regularly combined with locomotor and object control assessments. Methodological differences were a key issue, leading to no conclusive evidence for balance ability. A total of 28 articles were identified through keyword database searches. Ten of these related to locomotor and object control FMS and PA, and a further 18 related to balance ability and measurement. Literature in the English language was available from around the globe and provided data on locomotor and object control, PA and balance during early childhood. Sex, skill type (locomotor vs. object control) and physical development from 4–5 years old appear to affect these variables.

2.5.1. Achievement

Where explicitly reported, total TGMD scores and specific locomotor and object control FMS skills were of low competence, or below those expected for the children's ages (Barnett, Salmon, et al., 2016; Duff et al., 2019; Palmer et al., 2019; Wasenius et al., 2018; Webster et al., 2019). Authors reported standardised TGMD-2 scores (Ulrich, 2000), raw total scores and percentile scores across the literature. It should be noted that standardised, percentile and age equivalent scores are based on data from American samples only, and these data do not currently exist for other countries. Additionally, Roscoe et al., (2019) reported that raw scores varied from 6 points to 82 points out of a possible 90 for total FMS, illustrating that even at young ages, a wide range of achievement is present, and also shows a wide variation in a English cohort. Although children aged 4–5 years are not expected to achieve mastery in FMS proficiency, it has been noted in the literature that this is a possibility by the age of six years and children should have begun to establish movements from three years of age (Gallahue & Donnelly, 2003; Goodway et al., 2019). Therefore, a greater emphasis should be placed on FMS tuition at these younger ages, such as interventions and programmes in care and educational settings, focussing on FMS performance and development in early childhood to increase practice opportunities and the quality of teaching for young children. Practices such as these will ensure a larger number of children reach full potential in their motor development. It has already been established and commonly reported that higher MC ability will ultimately lead to better levels of PA engagement, overall habitual activity levels and thus better health behaviours, especially during middle childhood and onwards (Barnett et al., 2009; Stodden et al., 2008). This finding is further supported by the Jones et al., (2020) review that found a positive association between FMS, MVPA and total PA across 19 studies in the early years. Therefore, the argument to ensure purposeful development and practice of these skills at a young age is strong. However, previous research has cited underprepared and under trained early years educators and care givers (Roscoe et al., 2017b), to be a key issue leading to this low competency in young children. As such, further work needs to be undertaken to enhance their preparedness to promote FMS, including an understanding of the barriers and facilitators impacting their work/engagement. This improvement should be achieved through clearer guidelines, recommendations, and training based on research outcomes for early years educators and care givers. Improvements in these criteria could be important drivers of change in early years policies provided by governments.

Fifty percent of the articles reported that children's locomotor ability was better at ages 4–5 years than their object control skill ability (Duff et al., 2019; Foweather et al., 2015a; Jones et al., 2011; Nilsen et al., 2020; Wasenius et al., 2018), and thus could contribute to the performance of more MVPA (Jones et al., 2020). Locomotor skills generally require children to perform large gross motor movements which involve the whole body (Gallahue & Donnelly, 2003). Object control skills tends to include elements of fine motor development, such as gripping, and more complex processes, including hand–eye coordination, possibly explaining their lower achievement at this age, due to slower maturation of these skills. There was some repeated evidence for girls performing locomotor skills with higher proficiency than boys (Barnett, Salmon, et al., 2016; Roscoe et al., 2019a), this is commonly attributed to cultural and social gender norms, even at these young ages, where girls are more likely to take part in activities requiring more repetition of locomotor skills such as dance and gymnastics (McKenzie et al., 2002). This conclusion is supported by Iivonen & Sääkslahti's research in 2014 which reviewed the determinants of FMS in preschool-age children. This previous research also supports the findings of Webster et al., (2019), who reported better object control skill performance by boys compared to girls, however, no other studies in this review observed better object control by boys. Object control skills will generally be performed at a lower level of exertion at younger ages, due to longer elements of standing; for example, when catching a ball, a younger child will likely stand still until they are proficient enough to perform the skill in a moving or game environment (Duncan, Roscoe, Faghy, et al., 2019). Therefore, attributing object control skills to increasing MVPA levels is a difficulty faced between the quantity and quality of PA those children are achieving. Despite this, object control forms an important subdomain of FMS, essential for lifelong PA participation, and thus should be promoted from the early years.

In the UK and across several other governments around the globe (Canadian Society for Exercise Physiology, 2020; Department for Health and Social Care, 2019a; Goldfield et al., 2012; The Department of Health, 2012), the recommended amount of MVPA per day for children aged five years and under is at least 60 min, and total PA to be 180 min. Three articles demonstrated children who were overachieving these guideline levels of MVPA (Foweather et al., 2015a; Nilsen et al., 2020; Webster et al., 2019), and Palmer et al., (2019), also reported children reaching 22 min of MVPA during 45 min of free play, representing a promising value of 50% MVPA. Despite this, there are conflicting results of sufficient PA being achieved, as reported by Cliff et al., (2009), Roscoe et al., (2019) and Wasenius et al., (2018), where children fell below the national guidelines for the individual studies. Barnett et al., (2016) also reported a shortfall in MVPA achievement, however, the children were approaching the recommended guidelines, and these findings are encouraging as they indicate that children have the ability to be sufficiently active, especially if promotion of PA is furthered, helping to highlight that "some is good, more is better" (Iacobucci, 2019). Duff et al., (2019) found children achieving 7.7 min of MVPA/hour during a 3 h school day, representing just 23.1 min of MVPA being achieved in this environment. Similarly, Jones et al., (2011) reported just 7% of time at preschool spent in MVPA, resulting in 21 min for a 5 h day of preschool. Educational settings and childcare facilities are seen as facilitators for PA (Gordon et al., 2013; Hesketh et al., 2014) and where young children are most active (Foweather et al., 2015b; Roscoe et al., 2019b). Therefore, it is unlikely the children in both the Duff et al., (2019) and Jones et al., (2011) studies would be achieving the full 60 min of MVPA per day when combined with their activity outside these settings, which makes these finding more worrying. The limitations of the research of both Jones et al., (2011) and Duff et al., (2019) included the missed opportunities of PA data collection, such as active transport, due to the measurement of PA only during school or preschool hours. Active transport has been reported as an important factor contributing to both PA levels and FMS achievement (Cools et al., 2011). Collectively, the current review finds young children to be underachieving recommended levels of PA, especially MVPA, whether this be in an educational environment or inclusive of the home environment. Worryingly, children of older ages continue to struggle to attain PA at guideline levels, especially in developed countries such as the UK (Sport England, 2019) and America (SHAPE America, 2016). Therefore, promotion and encouragement of PA must be started at as early as possible, while continuing to understand the determinants that inhibit and facilitate engagement. Approaches must be centred around children, but include support of parents and care givers to achieve the best outcomes to increase the proportion of children performing enough PA (Nguyen et al., 2016).

Balance is recognised as a key element of FMS in combination with locomotor and object control skills. The Chief Medical Officer's PA guidelines for the UK highlight the need for good balance skills to perform activities such as skating, dancing and gymnastics, which children are encouraged to participate in (Department for Health and Social Care, 2019b). Good balance allows children to not only perform better PA, but also allows children to perform day to day activities important for physical health, socialisation and education (Donath et al., 2015; Gabbard, 2018; Verbecque et al., 2016). The synthesis of balance data in the current review was difficult as there was such a wide and varying array of methodologies, measures and outcomes, and a lack of a standardised approach should be considered as a limitation for this field of research. Fujinaga (2008) reported children holding a single-leg stance for an average of over 87 s, while Amelia et al., (2019) reported an average of children holding the stance for only 6.67 s. These large differences in time held by the children show why there is a lack of consensus on the expected balance achievement of children this age. Results based around achieving points tended to require children to hold the stance for only up to 10 s, with maximum points achieved for this time (Adamović et al., 2015; Guffey et al., 2016; Moran et al., 2005). This approach clearly represents how easily discrepancies between outcomes can occur. With an average of 87 s, it is likely all 105 children in Fujinaga's (2008) research would have achieved mastery in a points-based approach held for 10 s. Future research must focus on the development of a universal balance test or subtest that can be implemented into existing locomotor and object control FMS testing for young children. Considerations such as equipment and materials for measurement need to be considered to make it usable in as many settings as possible by both researchers and childhood practitioners.

Sex was also found to be an influential factor on balance ability, with girls out-performing boys in all the articles reporting sex differences (Jiang et al., 2018; Latorre Román et al., 2017; Stankovic & Radenkovic, 2012; Venetsanou & Kambas, 2011), with the exception of one article (Fujinaga, 2008). In previous literature, this is commonly attributed to societal gender norms, with girl’s preference and encouragement to take part in activities such as dance and ballet, where single-limb balance may be required frequently (Boyle et al., 2003; Schmalz & Kerstetter, 2006), and thus increase their static balance ability. This highlights the need to ensure that both boys and girls are encouraged to take part in a wide range of activities to increase their exposure to different movement patterns, environments, and opportunities. This said, four articles reported a clear increase in balance ability between children aged 4 and 5 years (Cambier et al., 2001; Jiang et al., 2018; Latorre Román et al., 2017; Venetsanou & Kambas, 2011), suggesting that balance ability is affected by maturation to a greater degree than other elements of FMS and MC at these ages.

2.5.2. Measurement

During searching for appropriate literature in the current review, it was apparent other FMS assessments had been used in the research for this age group, aside from the TGMD-2 and -3. Examples included the Movement Assessment Battery for Children, the Bruininks–Oseretsky Test of Motor Proficiency and the Motoriktest für Vier- bis Sechsjährige Kinder. The focus of these movement assessment batteries on identifying motor performance impairments in children (Brown & Lalor, 2009), or assessing both fine and gross motor development (Deitz et al., 2007), were reasons the authors felt they should not be included in the review with a key focus on gross motor development of normally developing children. Additionally, many of these articles did not measure PA in conjunction with FMS or MC measurement, therefore, were discounted even before FMS battery was accounted for. The overwhelming amount of literature returned within the searches used the TGMD-2 or -3, a finding that matches recent reports by both Logan et al., (2018) and Klingberg et al., (2019). Despite this, there was still discrepancies in how the assessment batteries were administered between the individual studies, possibly effecting validity and reliability (Hulteen et al., 2018). The difference in both choice and administration of assessment tool is one area leading to a lack of consensus within research to gain a full understanding of the FMS and MC levels achieved during early childhood, as there is not a universal tool available (Eddy et al., 2020). Although other FMS assessments are used and found in the literature, the TGMD-2 and -3 are popular due to their focus on locomotor and object control skills specific to sporting performance and common forms of PA. The use of these skills in Australia, the USA and the UK are especially common, as society and PE within schools is likely to focus on sports performance (Department for Education, 2013; SHAPE America, 2018; The Australian Curriculum, 2020). If children have mastery of these skills at an earlier age, then this would be advantageous to the individuals in these environments, because it will likely result in higher PA participation by these children and an opportunity to partake in sport with their peers (Stodden et al., 2008).

ActiGraph accelerometers were used in eighty percent of the articles examining PA, demonstrating a preference in accelerometer brand within childhood research. ActiGraph accelerometers have been consistently reported to be accurate and reliable for younger populations (Dobell et al., 2019; Evenson et al., 2008; Johansson et al., 2015), which makes them a strong choice for objective PA measurement. The popularity of this tool also highlighted the use of the processing programme ActiLife for analysis of accelerometer outputs (Barnett, Salmon, et al., 2016; Duff et al., 2019; Foweather et al., 2015a; Palmer et al., 2019; Webster et al., 2019), a programme which has been criticised in the literature for its frequency filtration method and the effect on the data collected (Peach et al., 2014). Barnett et al., (2016) further analysed their results using manual methods within Excel, while Nilsen et al., (2020) used Kinesoft software. While the use of accelerometry for PA measurement is clearly popular for collection of PA data with children, and considered the in-field "gold standard", more recent research has now begun to suggest the use of the raw acceleration output from accelerometers to classify activity and intensity (Crotti et al., 2020; Duncan, Eyre, et al., 2020; Karas et al., 2019; Konstabel et al., 2019;

Van Hees et al., 2016), in addition to the use of machine learning (Hagenbuchner et al., 2015). These approaches are considered to be more reliable and valid methods, yet researchers may face a number of practical challenges, including having to learn a complex analysis process (Bakrania et al., 2016). The benefits of this method address some of the limitations experienced within this review, especially when cut points, recording Hz and measurement epochs are considered. However, this does not overcome issues in the agreement on appropriate wear time, number of days of measurement and what can and cannot be constituted as an accepted day of wear, which was a prevalent issue, even in the ten articles in the current review.

Accelerometer placement at the hip was reported in 90% of the articles, once again showing a clear preference in this element of measurement practice for children. Interestingly, research has shown while there are certainly differences in measurement outcomes at different body placements, including the wrist and hip, these are not significant (Dobell et al., 2019; Rowlands et al., 2014). This suggests wrist placement may be a viable option for wear in the young child population, resulting in higher levels of wear time and compliance (Fairclough et al., 2016a), factors important for population based research and measuring intervention outcomes and success, while possibly resulting in a larger quantity of data. While accelerometry analysis and techniques require improvements to measure LPA, both SB and MVPA can be measured accurately (Dobell et al., 2019; Duncan et al., 2020) and, most importantly, these measures are considered the two most important measures when observing young children's PA. Accelerometry has previously been criticised for the inability to identify the type of activity being performed (Oliver et al., 2007b). Recent work by Duncan and colleagues (2019) has begun to try and establish cut points for certain types of activity and FMS when wearing accelerometers, and this research is an important step as it will allow researchers to identify if children are performing sufficient quality PA, while practicing essential FMS, with different types of FMS being identifiable from data outputs.

In the current review, it is important to note the lack of literature addressing all three areas (FMS, PA and balance) in a single article. Balance is recognised as one of the key subdomains of FMS and MC, yet, is discounted from a large majority of assessments, hence the need to assess locomotor and object control skills separately from balance in the current review. Both the Movement Assessment

Battery for Children and Bruininks–Oseretsky Test of Motor Proficiency batteries assess children's balance ability, and Eddy et al., (2020) reported that the popularity of the Movement Assessment Battery for Children was equivalent to the TGMD, while the Bruininks–Oseretsky Test of Motor Proficiency is to be found with less regularity in the literature. Consistently good reliability and validity was found for the TGMD and the Bruininks–Oseretsky Test of Motor Proficiency, while the Movement Assessment Battery for Children reported weaker levels of these key variables, perhaps providing a rationale for why a specific measurement battery may be chosen. However, the number and type of specific skills performed by children during an assessment can be stipulated by individual authors in line with their study aims. This was demonstrated by Nilsen et al., (2020), where a balance subset from the "Preschooler Gross Motor Quality Scale" was included, and specific skills including the skip, gallop, slide, dribble, underhand throw and the one-hand and two-hand strike were excluded from the TGMD-3 due to their lack of relevance in the specific society. Despite this, battery protocol guidelines tend to recommend the use of a full protocol for the best outcomes, reliability and validity. A clear difference in the TGMD-2 and -3 to other protocols is the sole assessment of gross motor skills, as the name suggests. As these skills are generally considered to be more important for performing and partaking in regular PA, this could be a key reason for researchers choosing this battery when examining the PA levels of children aged 4–5 years. Future work must ensure the development of a balance skill subtest. Currently, research regularly reports the relationship between locomotor and object control skills with PA, however, the association of balance with MVPA is lacking (Xin et al., 2020b). Higher balance competency may increase young children's confidence and ability to perform PA due to increased body control (Ulrich, 2007), with this evidence helping to inform the design of novel interventions.

2.5.3. Strengths and Limitations of the Current Study

Limitations of this study include the specific criteria of only TGMD protocols, as this resulted in possible evidence from other assessment batteries being missed, which may have created a clear picture of achievement at early childhood, and this has already been discussed in the "measurement" section. However, the study did allow for any objective measures of PA to be employed and, despite this criterion, all relevant articles were found to use accelerometry over methods such as pedometers. This finding does highlight the desire for higher quality and more impactful data for this age group. Richer detail regarding PA during early childhood could have been achieved by reporting all PA levels such as SB, LPA and total PA. Securing this information would inform further research about current behaviours in this age group, such as children choosing to spend more of their time in LPA, how this can be used as an advantage to practice FMS, and how intervention can be used to increase this MVPA. Nonetheless, MVPA is recognised as the most important PA level for movement behaviour for young children, which is highlighted in various movement guidelines (Department for Health and Social Care, 2019b; Goldfield et al., 2012; The Department of Health, 2012).

Examining only static balance reduced the evidence available for balance ability in young children and it would be good to consider using both static and dynamic balance measurements within further reviews. Dynamic balance contributes heavily to movement ability including motions such as twisting and turning (Gallahue & Donnelly, 2003) and this may also provide a clearer picture on overall balance ability in this age group. The current study fails to consider the impact of SES on the levels of achievement in all three review areas. It is well reported in the literature that SES is particularly impactful on the performance of FMS and PA, owing to the relationship of these variables to Newell's theory of constraints on performance (Newell, 1986). Factors such as family life, living environment and number of PA opportunities all have been shown to effect performance outcomes (Cools et al., 2011). However, the current review collated evidence from global research in one study and, in doing so, it has demonstrated the variation in child populations of the same age, and possible causes for differences between cultures. This could help examine how societal changes could create impact in other countries, such as initiatives and environmental interventions to improve PA levels and FMS competency. Moreover, this study provides important methodological consideration for future research.

2.6. Conclusions

To our knowledge, this is the first study to review FMS, objectively measured PA and balance during early childhood (4–5 years old), and thus adds key summary knowledge to the research area. Overall, there is not conclusive evidence for FMS, PA and balance achievement for young children 4–

5 years of age. While there is some promising evidence that children have the ability to perform sufficient PA, the FMS competency among the population is worrying and consistently lower than expected. Balance ability remains particularly unclear, with a wide variation in both outcomes and measurement procedures at this age. Future research should therefore focus on establishing a usable and universal balance testing procedure for this age group. Other future work to establish consistently better FMS performance and PA outcomes for children of this age, while reducing the discrepancies between genders through appropriate interventions, is also warranted.

2.7. How this evidence informs this research programme

The novel review of evidence from this chapter informed the important next steps of this research programme. To inform interventions for education settings and aid the educators that work within them, appropriate questions surrounding their knowledge and current provision were proposed, the questions were underpinned by the evidence collected within this review. Further to this, we aimed to seek information relating to what they perceived as helpful in developing children's skills in an education setting, as there appeared to be a dearth of evidence for this area, by understanding why, and if, educators believe improving children's physical skills are important. Secondly, this review provides key information about early childhood FMS competency and PA from a number of cohorts from around the globe. Although this provides a basis of achievement to begin to inform intervention, ensuring a programme of interventions is appropriate requires more information from English cohorts for this age group. Therefore, this programme of study collected a sample of FMS competency and PA levels in this age group to further strengthen the evidence required for planning effective and usable interventions in an English population. This review helped to inform the hypotheses proposed for this baseline measurement of children. Finally, this review concludes important areas for other researchers to focus on, such as measurement of PA and FMS during early childhood. These elements are key to measuring future intervention outcomes, viability, feasibility, and success, and therefore provides a basis to begin to design and implement new measures from.

Chapter 3

Educators Perspectives on the Value of Physical Education, Physical Activity and Fundamental Movement Skills for Early Years Foundation Stage Children in England

Publication:

Dobell A, Pringle A, Faghy MA, Roscoe CMP. Educators Perspectives on the Value of Physical Education, Physical Activity and Fundamental Movement Skills for Early Years Foundation Stage Children in England. Children. 2021; 8(5):338. doi.org/10.3390/children8050338
https://www.mdpi.com/2227-9067/8/5/338

Citations (4):

Akbar, Z., Awalludin, & Tohar, K. (2021). Fundamental movement skills and sensory movement strategies to support online learning in early childhood. *Journal of Physical Education and Sport*, *21*(4). https://doi.org/10.7752/jpes.2021.s4317

Eddy, L. H. (2021). *Developing a school-based universal screening tool to identify deficits in fundamental movement skills in children aged 5-11 years* [PhD, University of Leeds]. https://etheses.whiterose.ac.uk/29836/

Jayasinghe, S., Faghy, M. A., & Hills, A. P. (2022). Social justice equity in healthy living medicine—An international perspective. *Progress in Cardiovascular Diseases*, *71*, 64–68. https://doi.org/10.1016/j.pcad.2022.04.008

Ofsted (2022) Research review series: PE https://www.gov.uk/government/publications/research-review-series-pe/research-review-series-pe#fn:42

Further dissemination:

Dobell A, Pringle A, Faghy MA, Roscoe CMP 'Educators perspectives on the value of physical education, physical activity and fundamental movement skills for early years foundation stage children in England' BASES 2021 Virtual Conference (November 2021): Oral presentation.

Dobell A, Pringle A, Faghy MA, Roscoe CMP 'Educators Perspectives on the Value of Physical Education, Physical Activity and Fundamental Movement Skills for Early Years Foundation Stage Children in England' University of Derby PGR Research Café (September 2021): Extended Presentation

3.1 Introduction

The UK Chief Medical Officer's guidelines for children aged from 3 years of age and upwards state that at least 60 minutes of MVPA should be achieved each day, and young children (3-4 years of age) should also be aiming to achieve at least 180 minutes of TPA every day and reducing their SB (Department for Health and Social Care, 2019a). Current reports show that 46.8% of all school aged children (4-16 years) are reaching the "active" level of 60 minutes of MVPA in England (Sport England, 2019). Further to this, 14.4% children start school obese, and a further 13.3% as overweight, with these figures rising to 40.9% of children overweight or obese at ages 10 to 11 years old (NHS Digital, 2021), meaning these children are >91st (overweight) or >97th (obese) centile of BMI for their age. Evidence demonstrates the link between low PA and high levels of SB increasing obesity risk for children (Stodden et al., 2008), and, importantly, there is a need for meaningful PA, such as free play, active travel, and outdoor activity, to be implemented into children's daily lives to begin to establish healthy lifelong engagement.

Educators play important roles in ensuring children are physically active whilst at school (Cheung, 2020). PA is vital for physical, mental and social well-being in children, reducing the likelihood of disease and illness (Carson et al., 2017; Pate et al., 2019; Poitras et al., 2016; Reilly et al., 2003). During the EYFS (4 to 5 years old), PE and PA opportunities are also influential in developing and building children's FMS, including locomotor, object control and stability skills (Gallahue & Donnelly, 2003). FMS competency contributes to children's gross motor development, which is the gradual acquisition of control and use of the large muscle masses of the body to form different movements. Gross motor development is additionally associated with sustained PA levels in later life (Capio et al., 2012; Logan et al., 2015; Robinson et al., 2015). Therefore, early years PE and PA opportunities should allow children to practice and develop FMS, to develop healthier lifestyle behaviour trajectories and reach school specific PA guidelines of 30 min of MVPA per day (Department for Education, 2019).

Duncan and colleagues found that children aged 6–9 years old attending school in England are not competent in basic FMS (Duncan, Roscoe, Noon, et al., 2019b), mentioned within the key stage 1 national curriculum (5-7 years of age; Department for Education, 2013). In this age range, children are taking part in more sport opportunities and performing PA in small game environments, where competency in these skills is expected in line with the educational curriculum (Department for Education, 2013). Gallahue, Ozmun, and Goodway (2011) proposed the concept that children can be potentially proficient in all FMS components by the age of 6 years, however, the existing literature mentioned above suggests this is not present in an English cohort. Accordingly, consideration to adequate tuition, practice, and development of FMS should be introduced at early childhood stages to see this competency increase in line with Gallahue and colleagues' concept. Settings are a pivotal consideration when planning interventions (Eldredge et al., 2016), and as schools are important socialising agents that can facilitate increased PA, they should be considered as critical environments for developing FMS during early childhood (Gordon et al., 2013; Hesketh et al., 2014).

Chronic underfunding and resourcing in education due to reduced governmental spending over the past 10 years has seen access to PE in English schools reduce dramatically (Morley et al., 2015). Moreover, the Institute for Fiscal Studies reported an 8% decrease in spending per pupil between 2009/10 to 2019/20, due to higher class sizes and reduced teacher numbers, resulting in lower-quality education (Britton et al., 2019). Although primary PE and sport premium funding has increased during this time (Department for Education, 2014), there is a historic reduction in the commitment to provide and improve the quality of PE provision within school environments. With a continued increased emphasis on improving academic attainment, in addition to a lack of understanding of how to spend the PE and sport premium funding by teachers and school senior leadership (Lawless et al., 2019). Accordingly, this directly contributes to the low levels of FMS competency and PA levels being demonstrated by children in the literature. Another important consideration is that the EYFS is only provided with a statutory framework. Physical development of co-ordination, control, and movement is highlighted; however, the framework lacks depth around what this may include for PA opportunities and PE sessions. Indeed, the UK government does not provide a curriculum for PE before Key Stage 1 (KS1), which begins at 5 years of age in England (Department for Education, 2017), leaving individual schools and teachers to select and deliver the provision for the EYFS, despite FMS and PA being key to children's physical development, and, gross and fine motor development. These reasons can collectively render teachers inadequately equipped in knowledge, time, and resources to plan and deliver high quality PE and achieve FMS mastery, especially for the EYFS.

Constraints on performance are elements that shape, limit, or improve performance. The model of dynamic constraints by Newell (1986) explores the idea that learner/individual, environment, and task constraints are present (Figure 3.1). Examples of individual constraints include age, motivation and communication level, while environmental constraints include children's peers, parents, and cultural environment, finally, task constraints are related to the demands of the task, such as the difficulty or rules of the PA being performed. These may affect movement development and behaviours, which in turn, affect the level of FMS mastery a child is able to attain and thus can influence their level of PA achieved (Goodway et al., 2019). Seefeldt's (1980) model illustrates the importance of FMS competency and tuition for sport participation. While Stodden's (2008) dynamic association model demonstrates that higher FMS competency can increase PA in children. Finally, Hulteen's (2017) model of lifelong PA strengthens the need to acquire adequate fundamental and foundational movement skills for continued PA participation, starting in early childhood. Furthermore, consideration should be paid to the factors that influence the PA levels that children achieve, which are well established and include, demographic, social, individual, and environmental variables (Patnode et al., 2010) (further detailed in section 1.1.4). Notably, children living in areas of higher deprivation commonly report low PA levels throughout England (Sport England, 2019). Sex has also been repeatedly reported to influence FMS competency at the early years (Logan et al., 2015), as females have tended to show higher locomotor abilities than their male peers, and males are more competent in their object-control abilities than females, which was also observed in the systematic review of Chapter 1. This is despite minimal biological sex differences at these ages. To address these determinants, increasing educator's knowledge, and resources, to deliver PE and PA that is developmentally appropriate for all children will lead to improved outcomes for children's all-round health and habitual PA levels (Janssen & LeBlanc, 2010).

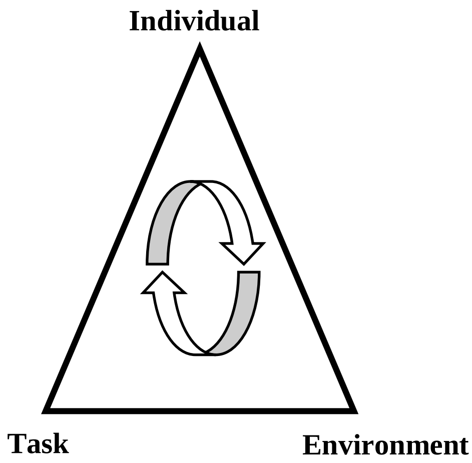


Figure 3.1 Newell's Model of Dynamic Constraints (Newell, 1986)

To achieve this, the diverse determinants impacting delivery must be considered, with public health guidance on intervention design highlighting the importance of involving key stakeholders in the development and implementation phases (Eldredge et al., 2016). Educators should therefore be considered as key players within the development of future intervention(s). However, there is a lack of research involving EYFS teachers, head teachers, and PE specialists (Domville et al., 2019; Lander et al., 2017), forming a key knowledge gap in the area. Stakeholders can provide rich insights into the practicalities of delivering interventions and this intelligence can shape PA and PE provision (Sport England, 2006). To the best of our knowledge, there is a lack of qualitative inquiry investigating key influencers of PE, PA, and FMS in English schools. Heads of schools, EYFS teachers, and PE educators have been identified as key influencers of PA in contemporary National Public Health guidance (NICE, 2009). Accordingly, the aim of this study was to capture the perspectives of these educators on the value of PA, PE, and FMS in school settings for the EYFS, including views on impact and implementation.

3.2 Methods

3.2.1 Study design

The current study was underpinned by a constructivist philosophy and explored perspectives and views through qualitative research methods and study design. Later in this section the different instrumentation that was considered are reviewed before selection was made to conduct a series of semi-structured individual interviews. These deploy a phenomenological approach were conducted to examine the interviewees experiences, perspectives, values, and opinions of the topic in question (Bryman, 2012); these opinions considered how FMS and PA are delivered in EYFS settings. Focusing on the empirical world for the educators was important in deriving the real-world experience such as the "how" and "what", not just their "why" for the different approaches and methods they took with their PE and PA delivery.

3.2.2. Participants

Following ethics approval from the host University (ETH1920-2939) and informed consent, a sample of educators responsible for the delivery of EYFS, PE, and PA participated in this study (n = 12 consisted of head teachers n = 2, EYFS teachers n = 7, and external PE providers n = 3). Participants were recruited from primary education settings around England through professional connections, word of mouth, and social media channels. The definition of educators recruited within this study included educators with a role that dealt with (or had recently dealt with) the organisation and/or delivery of PE for EYFS children in England.

The sample included a heterogeneous sample of participants (females, n = 9), with a homogenous age range, experience in primary education settings ranged from 2 years to over 30 years. There was also a homogenous sample of socioeconomic spread (SES) which can be viewed in Appendix 3.1 (Table A3.1.), the English indices of deprivation (IoD; Ministry of Housing, Communities and Local Government, 2019) was used to assess deprivation level of the schools that educators taught at. The IoD assess seven different areas or domains affecting levels of deprivation, including income, employment, health deprivation, education skills and training attainment, barriers to housing and services, living environment quality, and crime levels (Ministry of Housing, Communities and Local Government, 2019). The areas are rated from 1 (the most deprived) to 32,844 (the least deprived), with participants from 1832 to 31479 in the current study.

3.2.3 Qualitative assessments

Several qualitative assessments were considered for use in the current study. These included focus groups, self or educator report, or other observational methods by researchers such as the OSRAC-P. Each of these methods will now be critically evaluated for their appropriateness, presenting the possible strengths and limitations of each, followed by the rationale for the method chosen in the current study.

Focus groups allow participants to be engaged in discussion with fellow key stakeholders, these interactions can allow for participants to justify their answers based on the thoughts and opinions of others in addition to their own (Sparkes & Smith, 2013). Clear questions can be presented to participants, from which in-depth answers and discussion occur, with clear similarities or differences emerging (Rabiee, 2004). However, focus group discussion may mar the opportunity for all participants to give their own in-depth answers, which summarise their own experiences and views, where participants may not feel comfortable to freely interact despite a moderator trying to create the appropriate environment (Acocella, 2012).

Self-report of the PA environments and opportunities in the educators' schools allow key highlights in school environments to be reported. Report may give participants a longer time to think about and formulate their answers, with opportunity to revisit questions. A rigid set of questions ensures validity and reliability of the data collection protocol but does not follow such a realist set of answers. The questions may not allow the participant to fully explore their lived experiences, realities, views, and opinions, which are important in a constructivist approach. Discussion allows a conversation to develop and for participants to provide richer and more in-depth answers.

Observational tools are another valid consideration for exploring the school environment and impact on child PA. Using trained observers and researchers to report on child PA and the environment can help to increase the validity of the results gathered. For example, the Observation System for Recording Activity in Children—Pre-school version (OSRAC-P) can be used to assess participants PA via direct observation (Brown & Lalor, 2009). The OSRAC-P is specific to the pre-school age range (under 5 years of age), and has demonstrated good validity and reliability in previous studies (Oliver et al., 2007a). The OSRAC-P protocol codes for the type and intensity of activity being performed, while also considering other contextual information such as social and environmental factors that may influence behaviour. Children are observed for a 30-minute period, during which time there would be

60 observations, by following a 5-second observation phase, with a 25-second recording phase following immediately after. However, this method only offers a short period of time for observation. It may therefore cover either very active periods for children, or more inactive periods, thus it is harder to conclude the holistic environment that a child receives when attending school. Importantly this method is void of educator thoughts and views and simply observes what happens for the child and how the educator may influence behaviour. Although this data is important, it does not help to fully answer the research question.

Although all these methods would provide important information and data on the school environment, the influence of educators and how they perceived their school environments, semi-structured individual interviews were chosen as the appropriate method for this study. In-person and one-to-one discussions can facilitate richer detail in answers, in addition, semi-structured interviews allow for deviation from a specific schedule of questions or protocol, which reporting of environments cannot, therefore, more meaningful information can be obtained through semi-structured interviews.

3.2.4. Chosen Instrumentation

Single semi-structured individual interviews of around 20 to 45 min were used to allow for a sufficient conversation to occur between the interviewer and interviewee; some participants provided higher levels of detail than others. Semi-structured interviews allow for reliable, detailed, and comparable data to be collected (Bernard & Bernard, 2013), in addition to the interviewees' full views to be expressed and voiced. Questions were developed by using the literature (Department for Education, 2017; Duncan, Roscoe, Noon, et al., 2019b; Griggs, 2010; Xin et al., 2020b), prior knowledge collected within Chapter 1 and 2 (systematic review), and researcher's experience of FMS and PA development in young children. The decision to use not only EYFS teachers but also head teachers and external PE providers was important, since, in modern schooling within England, these can play an influential role in child development, including FMS ability, as well as the levels of PA children achieve in their school day. An example of an external provider would be a coach or PE specialist who exclusively delivers PE in school and may do so across multiple locations. Their use has increased in recent years due to the PE and sport premium funding provided to English primary school settings (Department for Education, 2014). Schools should use their expertise to support and develop primary teacher's PE delivery.

Although planned as face-to-face interviews, COVID-19 restrictions meant the researcher needed to adapt and interviews were conducted remotely on the software programme Zoom. This allowed views and perceptions to be collected nationwide and avoided the clustering of opinion in one area. Conducting interviews remotely also allowed participants to be in a familiar environment and feel at ease, whilst allowing flexibility of when to attend their interview, overall resulting in better outcomes (Saldaña, 2011). The interviews were recorded, downloaded, and transcribed verbatim.

3.2.5. Researchers

The interviews were conducted by a single trained interviewer (lead researcher, A.D.).
The interview questions were first sent to the research team to ensure appropriateness and that open questions were posed, allowing a collaborative effort from each researcher. Piloting of the questions occurred within an initial interview, where the participant deemed the questions appropriate and acceptable. The lead researcher/interviewer felt that the questions allowed for exploration of the topic in sufficient depth following consultation with the supervisory team, including reflection of the pilot interview. This process of refinement was used to ensure the questions were relevant to achieve desired information and permitted participants to provide extended and descriptive answers, allowing for high quality data to be collected (Pringle et al., 2020). The interviewer also openly asked questions not within the schedule to allow participants to elaborate on interesting points made. At all stages of the research process, regular group and individual researcher discussions were held, assuring the quality of the research processes, and confirming the trustworthiness of the data.

3.2.6. Procedure

Four main topics of question were used during the interviews. These were centred on PA and PE delivery within schools. The questions were used to assess (1) opportunities and determinants for quality PE, PA, and FMS practice and delivery in schools; (2) how PA and PE affect children both positively and negatively; (3) educator confidence and knowledge to deliver PA and FMS interventions to EYFS students within their school settings; and (4) values and feelings towards FMS, PA, and balance importance for young children. The topic areas and questions can be viewed in Appendix 3.2. Open ended questions ensured that the full views, perspectives, and knowledge could be gained from the educator's answers. The aims of asking these questions and gaining answers was to firstly, fully understand how PE and PA are currently delivered in schools for young children and the experience of educators delivering this. Secondly, to help inform the design, training, and delivery of future interventions for use in educational settings. Finally, these data can be combined with other datasets focussed on the experience children receive in English education settings in combination with quantitative statistics around PA achievement and FMS mastery. Collectively, these datasets will illustrate the current competency levels of children and enable possible barriers to participation to be identified at user level. In turn this will inform future policy and intervention design and development from the perspective of a key stakeholder and provide a comprehensive understanding of the areas investigated.

3.2.7. Analysis of Qualitative Data

Thematic analysis was used to analyse transcripts, using the six-phase process proposed by Braun and Clarke (2006), which has been widely used in PA research (Bentley et al., 2012; Dwyer et al., 2008; Roscoe et al., 2017b; Thompson et al., 2010). Transcripts were checked for accuracy and following the reading of the interviews to saturation, they were subsequently coded. Codes identified interesting points and features emerging from the interviewees within the datasets that related to the research question and topics surrounding this. Subsequent sense checking between AP and AD was completed after coding of the transcripts. Codes were grouped into themes, if an extract was coded twice, it was important that both codes sat within the same theme. Following the recommendation of Ryan and Bernard (2003), the themes were identified via repetition in topics and answers; similarities and differences in answers to the same question; reflection of the missing data within this research area; theory relating to the scientific underpinning of the questions; and, finally, the metaphors and analogies interviewees used within their answers. AD and AP refined the specifics of the themes to generate clear definitions and names, using the guidance of Braun and Clarke (2006). Initial data and themes were shared independently with the research group to confirm credibility and trustworthiness (CMPR and MAF) and following consensus that the data supported the initial themes, a final set of themes were established. These five themes were used to organise the results (Appendix 3.3, Figure A3.3). Further, the lead researcher (AD) in consultation with AP, made the decision to not use a member checking process of the transcripts, as there is little evidence to support the notion that this process increases trustworthiness of the data collected (Thomas., 2016). Additionally, the process asks more of the participant than is possibly needed and the request of research participants needs to be measured and reasonable, especially significant due to the key worker responsibilities of educators in the COVID-19 pandemic.

3.3 Results and Discussion

This study provides an overview of an educators' perspective on the value of PA, PE, and FMS in school settings for the EYFS, including views on impact and implementation. No study to date appears to have considered a qualitative view of these factors in England, making a novel contribution to the literature. The current literature tends to focus on PE for pupils at key stage 1 and above, failing to acknowledge the importance of how PA and PE could be delivered in the EYFS. The impact and influence of educators on PA and PE is key to our understanding for future research.

The results are presented by using a selection of extracts within the text and are summarised in Table 3.1. Quotes are referenced using pseudonyms for each participant followed by (H)- for head teacher, (T)- for EYFS teacher, or (E)- for external PE provider.

Table 3.1. Summary of themes and key quotes.

Theme		
Physical activity and physical education in school settings for EYFS [1]	Opportunities for PA [2]	"break times, lunchtimes and PE [3] and play opportunities" Jonny (E). "There's lots and lots of opportunities for outdoor play, and there's equipment that's rotated around the week" Lorna (T)
	Extra-curricular	"numerous different football clubs for boys and girls, multisport clubs, dance, and gymnastics that happen after school" Caitlin (T)
Benefits of PE and PA for young children	Confidence	"good self-esteem, so just being able to do those fundamental movement skills, it gives them so much confidence, so that they feel competent in something" Kristen (T)
	Excelling outside the classroom	"because there's more to you than the calculations you can do in your head or how well you can speak a different language" Melissa (T)
The barriers and challenges to achieving sufficient PA/PE for children faced by educators, parents, and children	Teacher knowledge	"Unless they've [EYFS teachers] got a PE background they lack the confidence to teach something like that (PE)" Caitlin (T)
	Sedentary Lifestyles	"kids have maybe got a tablet, and you don't move on a tablet, do you? It's just the way people parent has changed hasn't it because life changed" Leah (T)
	Deprivation	"can't afford to take them to do extra-curricular things, so they tend to sit in front of a TV all of the time even just going for a walk and climbing, things like that, they don't do" Caitlin (T)
	Parent beliefs	"She turns around to me and says, 'my mum says I don't need friends and I don't need sport to get into Oxford'" Kristen (T)
Educator knowledge of fundamental movement skills and key opportunities for development	Basic FMS [4]	"ball skills", "balance skills", and "locomotor skills" Sarah (T) and Jonny (E) "Running, jumping, hopping, throwing, skipping, and catching" were skills that eight educators mentioned.
	EYFS framework	"moving and handling" Melissa (T)
	Parent support	"you don't always have the enthusiastic parents that want to teach them" Ruth (E)
Intervention experience, needs, and training delivery	Experience	"we'll get people coming in and leading these interventions, and it's great for those six weeks" Brigit (H)
	Training delivery	"someone delivering it first for you to watch as an example of it" Leah (T) "the equipment or access to a computer programme or the notes" Karis (H)
	Intervention elements	"Rather than bespoke lesson plans, because every class, every child is different maybe an overarching view of their skill development and progression of skills document" Sarah (T) "autistic children, your children with disabilities, inclusive games with them(children)" Steven (T)
	Using relevant research	"it can be short and sharp information, and 'try this', rather than feeling like you've got to go back to a journal to read it" Brigit (H)

[1] EYFS = early years foundation stage, [2] PA = physical activity, [3] PE = physical education, [4] FMS = fundamental movement skills.

3.3.1. Physical Activity and Physical Education in School Settings for EYFS

All participants described experiences related to PA and PE opportunities in schools. Children in the EYFS "have a lot of play time in reception" Steven (T), and they have "break times, lunchtimes, and PE and play opportunities" Jonny (E), "they've got lots of equipment out to be using as well" Leah (T). "In our school, we have five-minute movements, between each lesson we'll do some form of dance, PE, go outside, go for a run" Sarah (T). Some schools have a "PE specialist who works with the children…but that's only for an hour a week" Melissa (T), while "over the last few years it's been a gripe of mine that we haven't got two hours of PE, but I finally won that battle…now we've got targeted practice for two hours a week" Lorna (T). These responses demonstrate that educators within schools believe they do have enough time to deliver PA and PE; therefore, it is a matter of getting all children to be active through improved promotion of PA and enabling better movement behaviours, rather than extending the time for PA in these settings, which would place additional pressure on educators.

Educators highlighted the large amount of play opportunities children have in the EYFS: "There's lots and lots of opportunities for outdoor play, and there's equipment that's rotated around the week" Lorna (T). In the "early years it's a lot of learning through play, but structured play" Kristen (T). There was recognition of children accessing outdoor environments and its likelihood of increasing PA engagement: The "behaviour benefits of [outdoor] physical activity" Jonny (E), are immense after "a week of wet play [the children] are agitated" Sarah (T) and "as much as a sports hall is great, the fact physical activity gets you outside, vitamin D, being in the fresh air, it's so good for the kids" Kristen (T). "They do forest school with me, moving around the forest, think[ing] about how we're moving" Leah (T). Play opportunities are of great importance in the early years and research has continually found outdoor settings to correlate with higher levels of PA engagement (Cools et al., 2011). These answers also highlight a need for adaptable activities to be engaged in an indoor environment, intending to stimulate children in a similar way to the outdoors.

The Daily Mile or a similar initiative was mentioned by Lorna (T), Leo (E), Melissa (T) and Kristen (T). The UK government actively encourage schools to include an active mile initiative as part of PA provision for children attending primary school, the popularity of this initiative and the effectiveness of government PA guidance was observed in the current study through the answers given (Department for Education, 2014). Benefits of The Daily Mile include breaks from classroom environments that can be perceived as pressurised, to increases in MVPA and fitness levels (Chesham et al., 2018; Ward & Scott, 2021). However, "just sticking a daily mile in doesn't mean they're developing all the fundamental skills that they need, obviously it helps with being active. But having [skill] focussed lessons, I think will see it improve even more" Lorna (T). This demonstrates educator awareness of the importance of the quality of the PA and PE experiences that children received, with "PE all the way through the school…rather than it being sport related, it is skills related" Brigit (H). These passages show willingness of schools to follow government guidance and policy, which could play an important role in the adoption of FMS intervention and development in schools, in the future.

Educators covered areas including the provision of extra-curricular activities for children to achieve more PA, that is commonly provided free of charge in English state schools: "We want to get 100% of the kids in each class to take part in at least one club and do one physical activity…we've got 89% of children taking part in at least one club" Steven (T), with "numerous different football clubs for boys and girls, multisport clubs, dance, and gymnastics that happen after school" Caitlin (T), and "they have two multi-skills clubs a week, they have ball skills club, they have rugby tots. So, they have an abundance of activities" Kristen (T). Ensuring adequate opportunity is available is a role schools take seriously, especially where there is an active and sports ethos. This links to the recognition of children achieving PA guidelines is important for health. Nonetheless, social norms have led to skills not being developed by girls and boys in the early years, due to the underrepresentation of the skill within a sex's stereotypical play opportunities (Schmalz & Kerstetter, 2006; Weisgram et al., 2014). Therefore, appealing to both sexes and reducing sex discrepancies in the achievement of both FMS development and PA levels, where sex differences consistently appear as evidenced in Chapter 1 and further literature (Lawson et al., 2021b; S. Logan et al., 2015) must be addressed. Establishing interventions that allow developmentally appropriate activities for all, may be a crucial step in the EYFS to set a basis to continue participating in FMS development and PA beyond this age. Before and after school provision is an easy way for both parents and educators to ensure that children are striving to reach PA guidelines. However, not all children will want or be able, to take part in these clubs as they can in their PE lessons, and schools' resources only stretch so far. Therefore, schools must be considerate of a child's circumstances to ensure PA guidelines are met within school time (Department for Education, 2019), and so that the benefits of PA can be obtained by the children in the EYFS.

3.3.2. Benefits of PE and PA for Young Children

Sport, PA, and PE are seen as opportunities for children to strive towards achievements and build intrinsic motivation by educators. Children "have a good self-esteem, so just being able to do those fundamental movement skills, it gives them so much confidence, so that they feel competent in something" Kristen (T) and "developing those personal skills, like perseverance… self-motivation…skill development [and gaining a] sense of accomplishment" Jonny (E), the children "see that they do develop, like being able to achieve new targets and pushing themselves" Leo (E). "I think it is individual goals, and it's not all about winning, it's kind of like getting your achievements and making the best out of it" Ruth (E). Further benefits include helping children to "have better social skills, [so] they can deal with conflict a lot better…and failure as well" Caitlin (T). Additionally, "Building a community" Leah (T) and "working together, collaboration, and cooperation…show them that actually, you're only as strong as your weakest link" Brigit (H), and "for me, it's so valuable for your communication skills, your leadership skills" Kristen (T). As well as opportunities to excel outside the classroom with "children who struggle with lots of things, however, can do any physical activity you throw at them" Leah (T), "because there's more to you than the calculations you can do in your head or how well you can speak a different language" Melissa (T). Early years PE and PA provide an arena for children to develop important skills. A child learning about failure and approaching a task differently is key in developing a whole range of self-management skills, which are important for undertaking regular PA and self-regulating their health behaviours.

Traditionally, PE and sports are perceived as broadly physical pursuits for the purpose and improvement of physical abilities and processes. However, PE is more than "sport" to children, demonstrated by the variety of social, communication, and academic skills aforementioned. This fits within the EYFS framework early learning goals of personal, social, and emotional development (Department for Education, 2017); therefore, these findings improve the argument for PE and PA to hold an important part in day-to-day EYFS settings. Lesson design must consider the opportunity for FMS skills to be learnt, developed, and progressed, as well as adopting the correct environment. Fostering the competence and enjoyment of PA through strong FMS at an early age will engage children in further PA opportunities through to adulthood (Stodden et al., 2008). Several educators also related their answers to physical fitness, well-being and health; "sport…it's everything, it's the social, it's the health and well-being, it's the physical" Brigit(H), "cardiovascular fitness, building muscle strength" Leah (T), "it's good for your body, keeping your body fit, eating healthy, your mind [and] your brain" Ruth (E). "I was talking to a boy in reception the other day and he was telling me about his heart beating faster, so they become more knowledgeable from having physical activity" Leo(E). In England, the Office for Standard in Education, Children's Services and Skills (Ofsted) inspect educational settings including schools. Schools hold a responsibility to educate their pupils about leading a healthy lifestyle. For the EYFS, this is assessed by Ofsted, under "personal development", and their education provides them with the knowledge to keep physically and mentally healthy (Ofsted, 2019). We propose that the appropriate teaching and development of FMS for children at the EYFS should also be considered to be part of the assessment, due to the positive associations between FMS competency, PA (Logan et al., 2015), and academic achievement (de Waal, 2019), encompassing the purpose of the school environment while meeting broader educational outcomes for children.

Finally, there was recognition of the importance and joint responsibility of the education environment to help tackle the obesity crisis. PE and PA "helps us to reduce obesity and obesity is a ridiculously growing problem, in this country, and I can only see that getting worse" Karis (H). FMS competency has been previously shown to be a predictor of weight status in children (Bryant, James, et al., 2014), strengthening the argument for high quality PE within schools that fosters FMS and enjoyment of PA for continued participation, and encouraging healthy weight status throughout life.

3.3.3. Barriers and Challenges to Achieving Sufficient PA/PE for Children Faced by Educators, Parents, and Children

Educators expressed concern about the amount of time that is dedicated to the planning of PE delivery: "PE is one of the lessons that teachers plan the least…I would say the differentiation is nonexistent in PE" Brigit (H). PE specialist teachers in England are trained to teach from the beginning of key stage 1. This approach to training PE specialists ignores ages 4 to 5 years old, despite attendance at school being commonplace for these children. Teachers said "Unless they've [EYFS teachers] got a PE background they lack the confidence to teach something like that (PE)" Caitlin (T) and highlighted how "we had like four weeks training on how to do set PE lessons, not really enough for how important it is" Leah (T). Notably, educators mentioned the lack of confidence to teach specific skills or having the knowledge to implement play-based learning for the development of FMS: "a lot of teachers shy away from it, they'll put children straight into a game, before they're ready…without any basic throwing or catching skills" Brigit (H), with a danger of providing poor instruction. Even within teacher training, set structures are promoted, which in turn may leave a teacher feeling less confident to adapt or change activities and their structure. The previous literature supports findings that teachers may have good or increased intention to promote PA but lack the resource, knowledge, or self-efficacy to appropriately deliver this (Maltagliati et al., 2021). Although it is perceived that sufficient time is dedicated in the weekly timetable to the delivery of PE and PA, it seems largely left to chance of what the content of these sessions might be, especially when a PE specialist or external coach is not involved. Increases in Government funding and the continued provision of the PE premium for primary schools in England, which includes further guidance on how best to invest these funds, should allow for continued professional development and training for EYFS teachers or qualified sports coaches, and PE specialists, to work alongside staff to enhance delivery and capability (Department for Education, 2020a; Jones & Green, 2017). This should enable educators to feel better prepared to provide meaningful PE and the development of motor skills

Both individual and environmental barriers to children achieving sufficient PA and opportunities for children to develop FMS and their gross motor development were highlighted by the educators. This included the recognition of the increasingly sedentary lifestyles that both adults and children lead: "Children [have] more access to tablets, computers, etc. I think culturally things have changed in terms of playing outside" Jonny (E), "kids have maybe got a tablet, and you don't move on a tablet, do you? It's just the way people parent has changed hasn't it, because life changed" Leah (T). Both educators demonstrated awareness surrounding the impact of an increasingly obesogenic environment, including the changes in child and adult behaviour. There was further awareness of the different home environments the children come from, making school environments a key place for PA attainment and FMS development. “We need more support from out of school. I don’t think it’s put across to parents how important physical education is” Steven (T). “I think it [FMS] probably needs teaching in the schools to be quite honest because, as I said, you don’t always have the enthusiastic parents that want to teach them” Ruth (E), and “sometimes your kids that do enjoy it [PE] don’t get the opportunities when they go home” Steven (T). Educators believed that children that came from more active homes, “your stereotypical group who have got really sporty parents” Leah (T) encouraged further PA opportunities, were likely to “be more physically able” Leah (T). These views were supported across the literature (Edwardson & Gorely, 2010; Fogelholm et al., 1999; Hinkley et al., 2008; Sallis et al., 2000), where positive associations between parental activity levels, encouragement, and weight status were consistently observed. A challenge for future research is developing interventions that involve an informational approach to encourage increased PA in both children and parents, with a suitable application for varied home environments.

The current study collected views from educators across socioeconomic spread (Table A3.1). Deprivation was mentioned as a barrier to children partaking in PA: “less children at my school where I am now take part in extracurricular sporting activities” Leah (T); and parents “can’t afford to take them to do extra-curricular things, so they tend to sit in front of a TV all of the time…even just going for a walk and climbing, things like that, they don’t do” Caitlin (T). There was clear awareness of the effect of deprivation: “80% of our children live in the poorest 20% of postcodes in the UK, and 60% have pupil premium… and a lot of the parents have got lots of fears about going outside” Melissa (T). This information enriches our knowledge surrounding low PA levels in areas of deprivation, by demonstrating the context as to why activity and free play opportunities may be so low in these communities for young children and families (Sport England, 2021). These points also highlight the need for further parental education about the PA benefits that can be achieved with few resources and little cost, especially for those from areas of deprivation. Safe spaces are needed for PA participation and skill development. Schools provide supportive educational environments, which should be used to ensure FMS ability is developed so that PA can become habitual for a child within their home environment too.

Similarly, the National Child Measurement Programme (NHS Digital, 2020) statistics for England show that children aged 4 to 5 years old from areas of high deprivation are more than twice as likely to be obese compared to their peers from areas of low deprivation: “I know that we have in reception…a height and weight check, and last year my cohort, somewhere between 20 and 25 [percent] of the cohort were classed as overweight or obese at the age of 4 and 5. Which obviously, is a really shocking statistic that a quarter of the class are overweight” Melissa (T). Although these figures are a cause for concern, it is encouraging that educators have noticed changes in the context of the broader issues and challenges society faces. Prioritising movement and PA opportunities in schools for children, especially those of low deprivation where out-of-school opportunities may be much lower, is essential to seeing improved statistics.

Although deprivation is linked to lower levels of PA in English school children (Sport England, 2019), one educator mentioned how some families of higher affluence, commit exclusively to academic rigour and this can negatively influence how parents value PE and PA for children during their education: “She turns around to me and says, ‘my mum says I don’t need friends and I don’t need sport to get into Oxford’” Kristen (T). A head teacher also commented on common behaviours of parents from areas of higher affluence: “It’s lots of parents who really want to do the best thing for their child, but they also won’t do anything that upsets their child. So, it’s… about educating and promoting, but not making parents feel bad about it” Karis (H). Where parents can give children choice about being active, children are choosing to be less active due to the changes within their environment (Tremblay, 2019). This shows a need to provide adequate school opportunities that engage all children, and educational interventions for both children and their parents across the SES. A review by Nguyen et al., in 2016 found that psychosocial support of parents in PA interventions for children were highly important to intervention success. Additional support from parents would not only aid children’s FMS, and PA, it would likely improve their academic achievement and numerous personal skills (de Waal, 2019).

3.3.4. Educators Knowledge of Fundamental Movement Skills and Key Opportunities for Development

Overall, educators showed some knowledge regarding the basis of FMS. Running, jumping, hopping, throwing, skipping, and catching were skills that eight educators mentioned during specific questions about FMS. Sarah (T) and Jonny (E) specifically grouped the FMS into "ball skills", "balance skills", and "locomotor skills", as defined by Gallahue and Donnelly (Gallahue & Donnelly, 2003), showing the strongest understanding of FMS. Jonny (E) demonstrated further understanding by stating that they are the "basic movements required to complete physical activity". "Gross and fine motor development" were mentioned by Melissa (T), Karis (H), Brigit (H), and Steven (T) as important elements of the EYFS curriculum and development in EYFS children. The terms "agility", "balance", "coordination", and "speed", as pointed out by Kirsten (T), Leo (E), and Sarah (T), were more typical of educators who were specialists in PE. The terms "moving and handling", as mentioned by Melissa (T), are used in the EYFS framework set out by the English government (Department for Education, 2017). The iteration of the EYFS framework in place during these interviews fails to highlight FMS development during the EYFS, meaning children are not always afforded the chance to learn and develop these skills until key stage 1 due to their importance not being understood at the educator level. This highlights a lack of guidance around physical development and FMS at the EYFS. The Youth Physical Development model (Lloyd & Oliver, 2012) and the Long-Term Athlete Development model (Balyi et al., 2013), both demonstrate the importance of developing FMS at the early years and support the promotion and guidance for healthy PA throughout the lifespan. Therefore, future research and government policy should focus on creating a more effective framework for educators delivering PE at the EYFS, including those not from a PE specialist background.

Educators were given the opportunity to express their thoughts on the importance of PE and FMS in the EYFS and if they felt more emphasis on physical skills and development were needed: "I think they have to be taught, and certain fundamental movement skills more so than others. So, balance and linking movements and movement skills, you will develop naturally over time, but I do think there has to be some element of teaching in there as well. Whereas ball skills, if there's no exposure to or teaching to that, then I don't think learning will take place as naturally" Jonny (E). This supports the view that locomotor skills are performed with higher competency at earlier ages than ball skills, as reported in recent reviews (Bolger et al., 2020; Dobell et al., 2020). Teaching FMS through approaches such as implementing simple learning cues and using skill questions has been successful in previous work by Foweather and colleagues (Foweather et al., 2008). While, implementation of linear or nonlinear teaching pedagogy could be a successful approach to teaching FMS in the EYFS, with Crotti et al., (2021) reporting that both approaches improved PA in a sample of 5-6 year old children. There was a concern that "every child is individual", as said by Lorna (T), relating to how some children would need more tuition than others. This was commonly related to parental involvement, as "you don't always have the enthusiastic parents that want to teach them" Ruth (E), meaning children may have not been encouraged to develop these skills from an early age at home, or within a PA or sport environment. These responses highlight the need for adaptability and avoiding a "one-size-fits-all" approach to the tuition of FMS at the EYFS. Future interventions and frameworks must have greater consideration for this factor.

3.3.5. Intervention Experience, Needs, and Training Delivery

All educators demonstrated awareness of interventions and many already had these in place in their school: "we had smart moves [a gross motor development intervention] as an intervention" Lorna (T), or "we do an intervention every morning" Melissa (T), and "we'll get people coming in and leading these interventions and it's great for those six weeks" Brigit (H). While some educators had experience of intervention delivery during their role, "I manage the smart moves programme that we run in primary schools" Jonny (E). These data show that educational settings are important places for accessible interventions for children, as well as providing key examples of successful implementation. This may include working with small groups of children or intervention in small amounts across a week.

Educators were asked what would make delivery and training easier with a novel intervention. "A day's worth of training" Ruth (E), and "I think visually seeing [the intervention]" Jonny (E), with "someone delivering it first for you to watch as an example of it" Leah (T), and "taught like the staff were children" Caitlin (T), were the main themes of appropriate training and tuition educators picked out. Interviewees stated that they found these techniques were the best way to learn about specific intervention delivery and ensure readiness and confidence to deliver themselves. Having "learning outcomes are a big one…understanding what the kids are trying to achieve" Kristen (T) "with a lesson plan" Ruth(E) was important. Others expressed the need for "the equipment or access to a computer programme or the notes" Karis(H), as well as "a clear expectation of what resources would be required…depending on cost" Melissa (T). Such physical and financial elements require continuous communication and dialogue with key stakeholders and implementers to ensure successful outcomes.

Educators also mentioned the need for the intervention to be adaptable or have a "framework and scaffold, some sort of structure" Leah (T) for staff to work from and develop individually for their classes and schools. "Rather than bespoke lesson plans, because every class, every child is different…maybe an overarching view of their skill development and progression of skills document" Sarah (T), so "if you planned it together [with the teacher] and made it bespoke and then left things, that it wouldn't just finish, so there's some longevity in it" Brigit (H). Educators continually demonstrated their keenness for intervention to be sustainable and long term in nature. This would allow their future cohorts of children to benefit from interventions and systems put in place. Finally, educators were keen to recognise "if we can teach everyone at the same time it's inclusive" Sarah (T), including "autistic children, your children with disabilities, inclusive games with them" Steven (T) it could increase the success of the intervention. Developing sessions to cater for all children is therefore of great importance to the educators of EYFS children and something which should be promoted more and require further research to identify appropriate strategies.

All educators stated that they would be confident in delivery of a new intervention or confident of the staff within their schools for intervention delivery: "We do have really good teaching assistants at the school, where there are interventions, they're able to follow those instructions" Lorna (T), demonstrating a move towards a whole school approach. Educators are keen to implement change in their school environments, provide new experiences for their pupils and develop themselves as educators. "I think people would welcome that [interventions] in schools a lot, because it is an area people are probably weaker on" Sarah (T), and "for me to do it [the intervention] and get feedback" Melissa (T) would mean educators become more confident in their delivery and ability to adapt interventions. Previous work by Lawless et al., (2019), concluded that more confident and knowledgeable staff were needed to implement interventions in primary education. Suggestions by our educators for suitable training opportunities are potentially low cost and achievable, given the availability and accessibility of digital platforms.

Educators wanted to develop their teaching practices and underpin their approaches by using relevant and recent research: "through my experience in elite sport and other stuff that I work in, scientifically backed evidence is far more prevalent, so why should it not be the case within grassroots or within physical education" Jonny (E). However, it is "more effort than it's worth for most…to find the relevant research. So, it definitely needs to be more accessible" Kristen (T), making sure "it can be short and sharp information, and 'try this', rather than feeling like you've got to go back to a journal to read it" Brigit (H). These views are a reminder for researchers to make their research as accessible as possible, so it can be understood by those who are most important and influential. Stakeholder views are not only important for the design and delivery of future interventions (Eldredge et al., 2016) but also for mainstream lessons for EYFS and PE.

3.3.6. Strengths and limitations

Although this study recruited a sample from around England, contribution was lacking from areas in the North of England. The North of England has some of the most deprived areas in England (Ministry of Housing, Communities and Local Government, 2019). Additionally, all participants were Caucasian and predominantly female. Although this is reflective of educators in England (Department for Education, 2020b), it would have been beneficial to gain perspectives from more male educators and individuals of different ethnic backgrounds, particularly for schools of different faith and religion, as it is recognised children from minority ethnic backgrounds partake in less PA (Sport England, 2019). Finally, this study was conducted during the COVID-19 pandemic, so with the reported decreases in PA in English children (Youth Sport Trust, 2020), it could be possible that educators were paying more attention to increasing PA and PE opportunities at school; however, educators were asked to discuss the pre-COVID practices. A notable strength of this study is the recognition of a wide range of factors affecting children's education and how these have been perceived by influential educators at the heart of the English school system, through helpful and insightful accounts of implementation, including what works well and why, as well as considerations for future intervention design, delivery, and sustainability. This genuine intent to consult with key stakeholders and intervene to promote meaningful change is pivotal for IM.

3.4. Conclusions

This study demonstrates the perceptions and values that educators have surrounding PE and PA within EYFS school settings. This study highlights significant multi-faceted barriers that educators face when aiding children to perform adequate PA, which include a lack confidence to teach PE and FMS and reduced parental involvement. These results show that, to improve PA, the quality of PE, and FMS tuition in the EYFS, intervention, training, and resources are required. Consideration to the cost of these activities is important, as is parental education, especially in areas of deprivation. Additionally, the format of intervention delivery and training should consider factors including outdoor delivery, remote and video training, and increasing skills educators believe require more tuition, such as object control. Notably, this study collected important stakeholder views, thoughts, and opinions on how best to increase PA and deliver interventions within school environments, which is a novel contribution to research.

3.5. How this evidence informs this research programme

This research shows that educators are informed and aware of problems and difficulties children may face in achieving sufficient PA. It also importantly showed willingness of educators to further their own knowledge surrounding FMS, but especially implementation of long-term and sustainable interventions. Important themes and key points can be observed from this study as educators form a key stakeholder group to be involved within an IM process which was previously discussed in section 1.1.6 (Figure 1.1) and will be further explored in Chapter 5. We can observe that the current problem is that although there are typical PA opportunities in each school, PA adherence and participation in children is affected by family life, parental education, and deprivation. These can clearly inform the logic model of the problem (see Figure 5.3). To change these issues and inform a logic model of change, educators feel they need; further education and a framework to increase their confidence in FMS intervention delivery, in addition to raising awareness to the children's parents for FMS and PA benefits. When considering the theme and scope of intervention, educators stated the need for intervention to be adaptable and available to all children within EYFS classes, in addition to the cost being affordable for school uptake. In terms of intervention programme design, the participants stated that a framework work that has clear and meaningful outcomes were important to them, and that they were able to quickly adapt the proposed session within a framework of ideas. Finally, the implementation and the training delivery of the intervention will be key, and educators were able to offer multiple suggestions for improving this delivery and ensuring higher levels of educator confidence across schools. With these examples including remote online session delivery, in-person live practice and opportunities for feedback, good access to appropriate equipment if needed. Collectively, this study forms a strong basis to inform IM processes and these interviews will be considered and referred to as key stakeholder contributions within the planning group during Chapter 5.

Chapter 4

Fundamental movement skill competence and physical activity of 4-5-year-old school children in central England

Current dissemination:
Within; Dobell A, Pringle A, Faghy MA, Roscoe CMP ‘Increasing physical activity and fundamental movement skills in early childhood by using school-based interventions’. University of Derby Human Sciences Research Seminar Series (January 2022): Extended Presentation

Projected dissemination:
Dobell A, Pringle A, Faghy MA, Roscoe CMP ‘Fundamental movement skill competence and physical activity of 4-5-year-old school children in central England, what next?’. BASES 2022 Conference (November 2022). 5 in 5 presentation.

4.1 Introduction

As outlined in the section 1.1.1 , PA plays an important role in preventing poor health and reducing levels of overweight and obesity prevalence during childhood (Department for Health and Social Care, 2019a; Warburton & Bredin, 2017). During early childhood, PA is largely made up of free play, structured PE environments, and further into childhood, organised sports (Condello et al., 2017). Previous literature has both proposed and found that children who perform higher levels of PA tend to be more competent in FMS and develop better MC (Bryant et al., 2014; Lima et al., 2017; Zeng et al., 2017). This relationship is also demonstrated reciprocally; whereby children with better FMS tend to perform more PA, as shown by Stodden and colleagues' (2008) model. Both relationships result in a positive spiral of engagement with PA, with the proposal that this reduces obesity risk and improves overall health outcomes (Stodden et al., 2008), further described in section 1.1.2. This relationship is mediated by additional factors, including, perceived MC and health related fitness (Hulteen et al., 2018). This relationship of higher FMS competency leading to better health related outcomes, including PA, fitness and body composition has been established (Bremer & Cairney, 2018). However, it has been noted that although positive, the relationship tends to be low to moderate in younger populations (King-Dowling et al., 2020; Logan et al., 2015), but does strengthen as these children age. This finding highlights the importance of establishing sufficient movement behaviours and competency during the early years so that the behaviours continue throughout the lifespan.

FMS form a key part of MC, and can be described as building blocks to more complex movement patterns (Logan et al., 2018), and are recognised by educators as “basic movements required to complete physical activity”, contributing to “Gross motor development” of young children (section 3.3.4). They exist as three subdomains; locomotor, object control and stability skills. Developing FMS effectively during early childhood (3-5 years of age) is important for sustained PA involvement, and successful participation in sports activities into adolescence and adulthood (Barnett et al., 2009; Seefeldt, 1980). Positive MC has also been found to improve musculoskeletal fitness in children (King-Dowling et al., 2020; Utesch et al., 2019), which leads to not only better health outcomes such as improved adiposity, better cardiometabolic health indicators (Timmons et al., 2012) and increased bone density and strength (Janssen & LeBlanc, 2010), but the ability to be a more competent mover, reinforcing life-long PA. Previous literature from English cohorts have examined FMS in preschool children (3-4 years) (Foulkes et al., 2015; Foweather, 2015; Hall et al., 2018; Roscoe et al., 2019), and children aged 6-9 years (Birch et al., 2016; Bryant et al., 2014; Duncan et al., 2019; Lawson et al., 2021), concluding that FMS competency is low, resulting in low levels of PA and positive health behaviours. Typically, children in England start school at the age of 4 years old, meaning from this age, physical and motor skill development can be achieved in a home and educational environment. School environments may be the first time some children experience more structured PA experiences in PE lessons, or through other structured practice that differs from free play environments they have previously encountered. As the systematic review of the literature in Chapter two showed, globally, FMS competency in 4–5-year-olds is considered to be low, with a lack of mastery in skills for this age group. Additionally, Duncan and colleagues (2022) have found similar results for British and Irish children, with a clear need for improvement. Both pieces of research suggest that future intervention needs to be developmentally appropriate for these children, but also evidence and theory based, while influencing key stakeholders and decision makers, such as local government, to provide the appropriate support and resources. Further to this, evidence from England and specifically deprived and ethnically diverse areas shows that FMS competency is lower in Asian populations than white and black children, an observation that persists into middle childhood (Adeyemi-Walker et al., 2018; Stratton et al., 2017). Collectively, these issues predispose children to a higher risk of both health problems and disengaging from PA as they age, and thus, should be addressed with a holistic (Eyre et al., 2022) and whole systems approaches (Pronk & Faghy, 2022).

Measurement of PA in English early childhood populations have increased in recent years (Dobell et al., 2019; Duncan et al., 2021; Foweather et al., 2015b; Hall et al., 2018; Roscoe et al., 2019a). It has become common place to use PA data collection methods that are objective, which reduce researcher, parent, and teacher burden and are found to be more accurate and reliable than proxy reports, as explored in Chapter 1 (section 1.1.3) (Cliff, Reilly, et al., 2009). Accelerometry has remained one of the most popular forms of PA assessment for children, showed by the wealth of studies employing it to measure PA (Chapter 2), and the methodology surrounding the best collection methods and parameters using these devices during public health research continues to be explored (Altenburg et al., 2022; Dobell et al., 2019; Duncan et al., 2020; Roscoe et al., 2017; Rowlands et al., 2014). Collecting PA data of children is vital for understanding if they are achieving guidelines set by both the UK government and World Health Organisation (WHO) of 180 minutes of PA per day, including 60 minutes of moderate to vigorous PA (MVPA), for those aged under five years (Department for Health and Social Care, 2019b; World Health Organisation, 2019). Additionally, the WHO recently published 24-hour movement guidelines for children aged 5 years and younger, which take into account children's PA, sedentary behaviour (SB) and sleep (World Health Organisation, 2019). Accelerometry data allows the quantity and intensity of the PA to be scrutinised thoroughly, including the thresholds of activity such as SB, light PA (LPA), and MVPA. The environment is a key factor to consider when observing PA levels with young children reported to be more active on the weekdays and during preschool time than they are at weekends and both time periods should be accounted for in the measurement of PA (Foweather, 2015; Roscoe et al., 2019). English research shows cohorts achieving sufficient PA when using accelerometers as the measurement tool (Foweather et al., 2015b; Hall et al., 2018), while other cohorts failed to meet guidelines (Roscoe et al., 2019b). Despite this, Sport England (2021) reports that only 44.9% of children aged 5-16 years are active and reaching the government guidelines. This perhaps demonstrates the decline in PA as children age, and the need to instil healthy behaviours and self-regulation of PA and exercise at a younger age.

Previously cited factors that are known to have a relationship with PA levels in children include BMI, parental influence, outdoor space, socioeconomic status (SES), and parental education level (Bingham et al., 2016). These factors present a whole host of socioecological determinants for the individual, in this case, the child. Accounting for individual and environmental factors which influence the individual both directly and indirectly can highlight key relationships that can positively or negatively affect PA, FMS, and overall health outcomes. Therefore, not only should PA attainment and FMS competency be observed, but additional information from parents could help to improve our knowledge around determinants and correlates of PA and FMS for young children.

The EYFS within English schools provides the ideal age for children's FMS to be assessed, with the results potentially informing the design and content of meaningful intervention, in addition to curriculum change and creation for this age group. Data collected for this age group could be used to the advantage of researchers, educators, parents, and other key stakeholders to design, implement, conduct, and evaluate specific interventions for these children within differing environments or communities. Within this programme of research, qualitative methods have examined the perspectives of educators for each of these key points (Chapter 3), however, quantitative evidence of FMS and PA remains sparse for EYFS English children. Although Chapter 2 showed that there is wealth of information for children across the globe, including Australia and the USA (Jones et al., 2020), it is important to consider cultural differences and timing of formal education introduction between the countries reporting FMS competency and its relationship with PA, highlighting the need for more localised cohorts of data.

A number of researchers have begun using qualitative enquiry to discover and propose appropriate ways of ensuring physical skills can be adequately assessed in a primary education environment by teaching staff, to the same degree as academic subjects are currently assessed (Goss et al., 2021). These conversations with key stakeholders help to increase awareness of the assessment of physical skills in schools and begin to develop a potential measurement tool to be used in school-based intervention and beyond. This joined up approach of using teaching staff to deliver future interventions and within FMS assessment ensures the longevity of these programmes can be achieved, which is fundamental to meaningful intervention design. Additionally, as shown in Chapter 3 and further research (Eyre et al., 2022), barriers and facilitators to PA and FMS have also been qualitatively explored, with evidence to show these exist at multiple levels, as shown in Bronfenbrenner (1979) socio-ecological model. Using further quantitative data to inform and compliment the design and methods of intervention allows for a better ‘buy in’ from the teachers leading the intervention, with quantitative and measurable outcomes being key to the assessment of the school’s teaching quality.

Considering the current PA and FMS data available for this age group, the aims of this study were to 1) measure current levels of FMS competency and PA levels of children aged 4-5 years old across central England; 2) examine the relationship between FMS competency and PA levels of these children; 3) highlight the most significant factors influencing FMS and PA levels (age, sex, location/SES, BMI).

4.2 Methods

4.2.1 Participants

Following institutional ethics approval (ETH1920-1139), parental informed consent and verbal child assent, 92 children aged 4-5 years (51 boys and 41 girls) participated in the study between March 2020 and December 2021. None of the participants had known musculoskeletal issues or developmental disabilities such as cerebral palsy, spina bifida or down syndrome. Participants were recruited through convenience sampling from five schools in the central region of England between March 2020 and December 2021. Access to participants was affected by the COVID-19 pandemic due to the closure of schools, followed by strict visitor restrictions in most settings. This resulted in an extended collection period, with a substantial pause in the period of data collection (April 2020-May 2021).

4.2.2 Study design

Data was collected in a single testing visit to each individual school. This included the complete Test of Gross Motor Skills-2 (TGMD-2) protocol to assess FMS competency, and an additional single-limb balance assessment. TGMD-2 was employed over the use of TGMD-3 due to researcher familiarity, and additionally, Chapter 2 highlighted that more evidence exists using the TGMD-2 allowing for comparison with other cohorts. Anthropometric measures were also taken to identify BMI. Wrist worn accelerometers were allocated to each child on this initial visit to the school and were returned to the researcher 5 days later, recording PA and SB over at least two weekdays and one weekend day (Foweather et al., 2015; Roscoe et al., 2019).

4.2.3 Anthropometry

Height was measured to the nearest 0.1cm using a Marsden HM-250P Leicester Height Measure (Marsden, Rotherham, UK), and body mass measured to the nearest 0.1kg while barefoot and wearing light clothing (e.g. t-shirt and shorts) using TANITA DC-240 scales (Tanita Inc., Tokyo, Japan). Waist circumference was measured at the lowest rib, using a Seca 201 Ergonomic Circumference Measuring Tape (Seca, Hamburg, Germany). These measurements were used to calculate body mass index (kg/m^2), children were then assessed by centile for age in the UK. The mean and standard deviations of these characteristics are shown in Table 4.1.

4.2.4 Fundamental movement skill and motor competence assessment

The TGMD-2 (Ulrich, 2000) is popular for in the field testing with children for FMS assessment, it is one of the most popular assessments of FMS and MC used in paediatric research settings across the globe (Eddy et al., 2020; Goodway et al., 2010). It is a valid and reliable test for children aged from three to ten years of age (Klingberg et al., 2019; Logan et al., 2018). The TGMD-2 was chosen due to the primary researcher's familiarity and experience with the test and the ability to assess a wide range of FMS and gross motor skills.

The TGMD-2 required participants to perform six locomotor and six object control skill assessments. Visual demonstrations of each skill were provided by a trained researcher before each child had a practice trial and two subsequent test trials. Verbal instruction and instructional ques were not provided to the children to ensure that it was a test of their current abilities. The six locomotor skills consisted of run, horizontal jump, leap, gallop, hop, and slide. The six object control skills consisted of a stationary strike, overarm throw, underhand roll, stationary bounce or dribble, catch, and kick. The TGMD-2 is a process-based assessment, therefore, the preferred method to observe and score skill execution was via video recording and scoring post data collection. Each skill was video recorded for every child and scored subjectively by one primary trained researcher following the competition of the whole assessment. Scoring for each skill is made up of three or four different criteria, all of which must be present for mastery of the skill (scoring criteria for the TGMD-2 can be found in the Appendix 4.1). For example, during the run the child must be able to show (a) a brief period where both feet are off the ground; (b) arms in opposition of legs, elbows bent; (c) foot placement near or on line (not flat footed); (d) non-support leg bent approximately 90 degrees (close to buttocks), on two occasions for mastery in the skill, scoring a total of 8 points (Ulrich, 2000). If the criteria were present a one was awarded, if the criteria were absent a zero was awarded. Each skill was scored twice and summed with a maximum of six to eight points per skill, resulting in locomotor scores and object control subdomain scores each scored out of a maximum 46 points, respectively. Collectively the locomotor and object control raw scores were summed, and the children's MC was scored out of a possible 92 points. Additionally, product scores were attained from the run (10m sprint speed) and the horizontal jump (jump distance). This was to establish if there was a correlation between product and process scores for the running and jump performance.

This scoring was tested for both interrater and intrarater reliability. The primary researcher had previous experience of scoring the TGMD-2 for over 5 years, and intrarater reliability was performed on a sample of 10 pre-coded videos, with the scoring occurring one week apart. While a researcher who did not par-take in any data collection and was blinded to the children and schools undertook scoring of 10% of the sample for inter-rater (112 videos). Agreement across inter and intra rater reliability was over 90%, with 80-85% or above for reliability deemed as suitable (Barnett et al., 2014).

4.2.5 Balance and stability assessment

Children undertook a basic single leg balance and stability assessment. This procedure is similar to the one-leg balance used in the Movement Assessment Battery for Children—Second Edition (MABC-2) (Brown & Lalor, 2009; Henderson et al., 2007). To identify the child's dominant/foot, they we're asked, 'what foot would you kick a ball with?' or asked to kick a ball in front of them. Children were initially given a visual demonstration of the task requirement by a researcher. Children were then allowed one practice. The child stood on their dominant foot for up to 30 seconds, with the other leg bent and held in the air above the floor. Children were asked to begin with their hands on their hips but were allowed to remove them to help keep themselves balanced. Children were also asked to focus on a spot on the wall in front of them to further help maintain their balance. Children were motivated and constantly supervised for their safety by a researcher. The amount of time a child held the stance for was measured to the closest tenth of a second using visual inspection and a handheld stopwatch. If a child was able to hold the balance for over 30 seconds, they were asked to rest from the position. If a child placed a foot on the floor or used an object (e.g., chair or table) for balance, the time was stopped. The children were then asked to repeat this balance procedure on their non-dominant leg. An average for both legs was also calculated.

4.2.6 Accelerometry

Children were fitted with an Actigraph GT3X+ accelerometer (ActiGraph, Florida, USA) to their non-dominant wrist (Chandler et al., 2016; Dobell et al., 2019) for four days of wear (Roscoe et al., 2019b; Trost et al., 2003). The wrist was chosen due to expected higher compliance than placing the accelerometer at the hip (Fairclough et al., 2016b). The ActiGraph GT3X+ is a triaxial accelerometer, measuring in three planes of motion of the limb it is placed on. Published literature class children the age of five years and below as 'preschoolers' therefore cut points and recording parameters were based on this (Dobell et al., 2019; 3-4 year olds). According to recommendations by Migueles et al., (2017) the accelerometers recorded data at 100Hz to best capture the activity of the children due to the sporadic nature of their movement behaviours (Pate et al., 2006). This is also in line with the Dobell et al., (2019) 5-second cut points, which are the only published ActiGraph cut points for preschoolers to use 100Hz at the wrist. A valid day was classed as 9 hours or more wear (Foweather et al., 2015b), and a period of 90 minutes or more of 0 counts was classed as non-wear time (Roscoe et al., 2019). Data were downloaded with 5 second epochs and was classified as SB, LPA, or MVPA according to the employed 5-second cut points (sedentary 0-288, light 289-766, moderate to vigorous ≥ 767; Dobell et al., 2019). Children were then assessed to see if they were meeting government guidelines of PA, 180 minutes of total activity and a minimum of 60 minutes of MVPA each day. An average value of SB, LPA and MVPA across at least two weekdays and one weekend day were calculated (Foweather et al., 2015), average values for weekdays only, and weekends only were also established for these PA variables.

Of the 92 participants, 58.7% of participants (n=54) provided complete and valid PA data from wear of the accelerometers, including valid wear time for the week and weekend days. A further 21 participants collected valid wear time PA for weekdays only, while in a total of 82 participants collected some PA data, however, this data was not sufficient in valid wear time across both the week and weekend days. Finally, 10 participants did not collect any PA data, due to either accelerometer issues, loss of accelerometer, or reluctance from the child to wear the device (Robertson et al., 2011). Although loss of PA and accelerometer data is common (Howie & Straker, 2016), it is recognised it is high within this study, time restriction and participant burden meant it was not feasible to ask participants to complete PA measurement more than once. Participants without valid PA for weekend and weekdays were excluded from PA analysis, and FMS and PA relationship analysis. However, their FMS competency data was used in analysis where appropriate. Data for the complete PA data is presented in table 2.

4.2.7 Measurement and classification of socioeconomic status and deprivation

Participant's parents were provided with a short participant data questionnaire (Appendix 4.2.), the included questions concerned the parental education level and home postcode. Child's sex, date of birth, and ethnicity were also collected via this questionnaire. Children were categorized by the SES status of their home postcode using the index of multiple deprivation (IMD) 2019 (Ministry of Housing, Communities and Local Government, 2019). The IMD ranks small areas of England from 1 (most deprived) to 32,844 (least deprived). Seven domains are used to calculate the number each small area receives, these include employment, education, skill and training, income, health and disability, crime, barriers to housing and services, and living environment deprivation. IMD was then ranked as low, middle, or high, by splitting the cohort in to tertiles.

4.2.8 Statistical analysis

Descriptive statistics were calculated for the whole group, in addition to separate sexes. Statistical analysis was undertaken using both Microsoft Excel and the Statistical Package for Social Sciences (SPSS), version 27 (IBM, UK), with Alpha set at $p=0.05$. The data was tested for its normality of distribution using the Kolmogorov-Smirnov test. This test returned that the data was normally distributed ($p>0.05$).

Associations between PA, BMI, and FMS were examined using Pearson's correlation coefficients. This included if there was a relationship with the balance measurement, total FMS, locomotor, and object control ability. The differences between sexes for total FMS and sub-domains (locomotor and object control) were measured using the independent *t*-test. Paired-samples *t*-test were used to examine the difference between weekday and weekend PA measures.

The sample of participants was further divided into age tertiles (table 4.5) and IMD tertiles (table 4.4) to examine the differences between children born at different points of the year, and children from differing levels of deprivation, respectively. Tertiles have previously been used to classify children in similar studies (Roscoe et al., 2019). To assess the relationship between age tertiles and IMD status (tertiles) with PA levels, FMS scores, and BMI, one-way ANVOAs were completed. Age tertile and IMD tertiles were used as fixed factors and FMS score, PA level, and BMI centile used as the dependant variables. The Tukey post-hoc test was used to analyse any differences between groups.

4.3 Results

4.3.1 Overview

Participant demographics and descriptive characteristics for all participants who provided FMS data (*n*=92) are presented in Table 4.1. The sample was slightly skewed to boys participation, which was a result of convenience sampling in this cohort. There was no significant difference between BMI or waist circumference for boys and girls ($p>0.05$).

Table 4.1 Participant demographics and descriptive characteristics

Characteristic	**All *n*=92** Mean ± SD	**Boys *n*=51** Mean ± SD	**Girls *n*=41** Mean ± SD
Age (years)	5.0 ± 0.4	4.9 ± 0.4	5.0 ± 0.4
Height (cm)	112.1 ± 4.3	111.4 ± 4.3	113.0 ± 4.2
Mass (kg)	19.8 ± 3.0	19.6 ± 3.0	20.0 ± 2.9
Waist Circumference (cm)	58.4 ± 4.7	58.4 ± 4.4	58.5 ± 5.2
BMI (kg/m^2)	15.7 ± 1.9	15.8 ± 1.9	15.6 ± 2.0
BMI Centile	48.2 ± 32.9	49.4 ± 34.0	46.6 ± 31.9
Underweight BMI %	8.7	11.8	4.9
Normal BMI %	75.0	68.6	82.9
Overweight/obese BMI %	16.3	19.6	12.2
Index of Multiple Deprivation rank	20,458 ± 7732	19,608 ± 8335	21,516 ± 6865

4.3.2 Physical activity

Of the 54 children who provided valid accelerometer data (Table 4.2), 53 children met the guidelines of 180 mins or more total PA per day, with the average TPA being 344 minutes per day when week and weekend days were combined. When further analysed, there was a significant difference between weekday and weekend TPA (p<0.05) with an average of 40 minutes more PA on weekdays. A total of 96% (n=52) children met the guideline of 60 minutes of MVPA per day, with an average of 118 minutes per day when week and weekend days were combined. Girls exhibited higher levels of PA and lower levels of SB than boys, however, these were not significantly different (p>0.05).

Table 4.2 Physical activity levels

Physical activity measure	**All *n*=54** Mean ± SD	**Boys *n*=32** Mean ± SD	**Girls *n*=22** Mean ± SD
Average Wear time (week and weekend) (min)	741.6 ± 61.3	748.0 ± 59.2	732.4 ± 64.3
Average Wear time Week (min)	739.3 ± 67.2	744.9 ± 61.7	731.2 ± 75.1
Average Wear time Weekend (min)	748.3 ± 88.4	760.6 ± 94.2	730.4 ± 77.8
Total PA (min)	346.3 ± 66.3	344.4 ± 71.3	349.0 ± 59.8
Total PA week (min)	365.5 ± 73.5[a]	362.1 ± 71.1	370.4 ± 78.2
Total PA Weekend (min)	325.5 ± 81.0[a]	324.3 ± 90.3	327.2 ± 67.2
Total MVPA (min)	118.0 ± 33.6	115.8 ± 35.8	121.3 ± 30.4
Total MVPA Week (min)	126.6 ± 39.2	122.9 ± 38.3	132.1 ± 40.8
Total MVPA Weekend (min)	108.5 ± 36.2	107.4 ± 39.9	110.2 ± 30.6
Total LPA (min)	227.7 ± 38.6	227.7 ± 42.0	227.7 ± 34.0
Total LPA Week (min)	238.9 ± 40.2	239.3 ± 40.5	238.3 ± 40.5
Total LPA Weekend (min)	216.9 ± 52.4	217.0 ± 58.7	216.9± 43.1
Total SB (min)	394.1 ± 142.4	401.3 ± 147.5	383.4 ± 136.6
Total SB Week (min)	373.8 ± 73.1	382.8 ± 73.8	360.8 ± 71.5
Total SB Weekend (min)	422.9 ± 93.0	436.3 ± 106.1	403.3 ± 67.2

[a] denotes a significant difference between total week and weekend PA

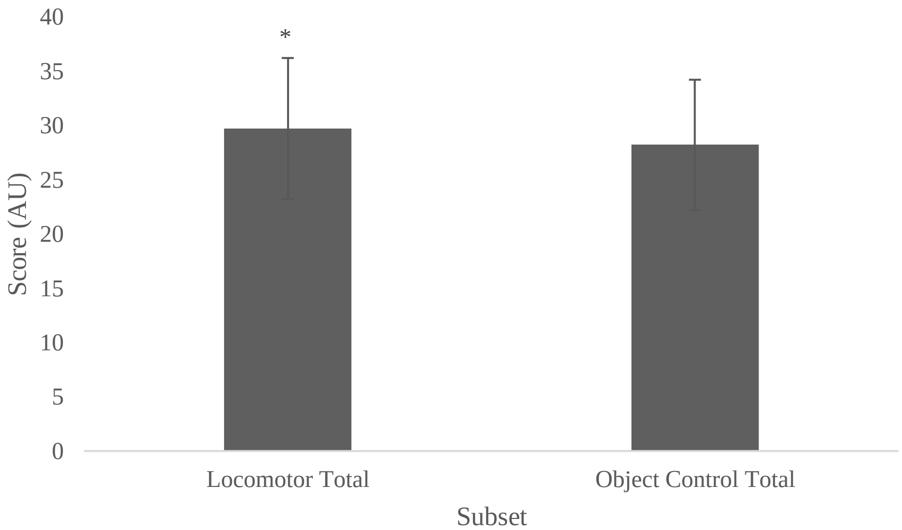
4.3.3 FMS competency

FMS competency scores across the sample and across sexes is shown in Table 4.3 for all participants with this data (*n*=92). Locomotor skill competency was significantly better than object controls skill competency for boys and girls ($p<0.05$), see Figure 4.1, and girls were significantly better at their locomotor skills than boys were ($p<0.05$). However, there were no significant differences between boys and girls object control achievement or total FMS score ($p>0.05$) (Table 4.3). There were no significant differences between sexes for balance held, jump distance or running speed ($p>0.05$).

Table 4.3 Fundamental Movement Skill competency

	All *n*=92 Mean ± SD	**Boys *n*=51** Mean ± SD	**Girls *n*=41** Mean ± SD
Total MC (/92)	57.9 ± 10.6	57.3 ± 10.4	58.6 ± 9.9
Locomotor (/46)	29.7 ± 6.5[a]	28.3 ± 6.5	31.5 ± 6.2[b]
Object Control (/46)	28.2 ± 6.0	29.0 ± 6.0	27.1 ± 5.9
Balance (sec)	11.9 ± 7.4	11.6 ± 8.0	12.2 ± 6.7
10m Running speed (sec)	3.3 ± 0.4	3.2 ± 0.4	3.3 ± 0.5
Jump distance (m)	0.9 ± 0.2	0.9 ± 0.2	0.9 ± 0.2

[a] denotes a significant difference between locomotor and object control skill score
[b] denotes a significant difference between girls and boy's locomotor skill score



[*]denotes a significant difference between locomotor and object control skill score

Figure 4.1 Subdomains of FMS measurements of the sample

4.3.4 Associations

There was no correlation between overall FMS score (TGMD-2 score) and total PA (r=0.135, p>0.05), this relationship was also revealed when examining the relationship of total FMS score with MVPA (r=0.259, p>0.05) and LPA (r=0.006, p>0.05). Although there was an inverse relationship of overall FMS score and SB (r=-0.156, p>0.05), it was both weak and insignificant. A negative and significant correlation between running score and running time was found (r=-.458, p<0.05), in addition to a positive and significant relationship with jump score and jump distance (r=0.484, p<0.05). Total FMS, locomotor and object control score were all negatively correlated (r=-0.159, r=-0.157, and r=-0.099, respectively) with time single limb balance was held, and this relationship was not significant (p>0.05).

Table 4.4 shows that a significant difference was established between the three age tertiles for overall FMS score (p<0.05), the highest age tertile scored significantly higher for overall FMS scores than the youngest and middle age tertiles (p<0.05, respectively). There was a significant difference between groups for locomotor skill score (p<0.05), with post hoc analysis revealing this difference was between the middle and highest age tertiles (p<0.05). There was a significant difference between age tertiles and the time balance was held for (p<0.05), with post-hoc analysis revealing the oldest age tertile holding their balance for significantly longer than the youngest age tertile (p<0.05). However, there was no significant differences between the object control skill scores (p>0.05), or between levels of TPA, MVPA, LPA and SB (p>0.05) for age tertiles. Children of the youngest age tertile had significantly higher BMI than the children within the middle and highest tertile (p<0.05).

Participants were allocated into IMD tertiles, analysis revealed that there was a significant difference between groups for level of MVPA (p<0.05), with the most deprived children performing significantly less MVPA than the least deprived children (p<0.05). All further analysis for IMD tertiles revealed no significant difference between groups including between BMI centile (p>0.05), SB, LPA and TPA (p>0.05), and locomotor, object control and total FMS score (p>0.05; Table 4.5).

Table 4.4. FMS and BMI split by Age Tertile.

	Age Tertile		
	Low 4-4.8 yrs (*n*=31)	**Middle 4.9-5.2 yrs (*n*=30)**	**High 5.2-5.8 yrs (*n*=31)**
	Mean ± SD	Mean ± SD	Mean ± SD
Locomotor score	29.2 ± 6.1	27.4 ± 5.8	32.6 ± 6.8[a]
Object Control score	27.5 ± 6.2	26.9 ± 5.5	30.1 ± 6.0
Overall FMS score	56.6 ± 10.5	54.4 ± 8.9	62.7 ± 9.5[ab]
BMI centile	68.1 ± 30.4	39.7 ± 29.5	35.3 ± 29.2

[a] denotes a significant difference between the highest age tertile and middle age tertile
[b] denotes a significant difference between the highest age tertile and lowest age tertile

Table 4.5 PA and FMS competency split by IMD Tertile

	IMD Tertile		
	Low Tertile <19,428 (*n*=21)	**Mid Tertile 19,428-26,902 (*n*=22)**	**High Tertile >26,902 (*n*=11)**
	Mean ± SD	Mean ± SD	Mean ± SD
Average MVPA (min/day)	104.1 ± 30.9	123.1 ± 29.8	134.6 ± 39.1[a]
Average TPA (min/day)	322.9 ± 61.9	361.7 ± 66.3	360.2 ± 67.1
Average SB (min/day)	423.2 ± 80.2	375.7 ± 100.0	381.5 ± 168.8
Overall FMS Score	57.3 ± 10.8	57.9 ± 9.5	58.5 ± 10.5
Locomotor Score	28.6 ± 6.7	30.2 ± 6.1	30.5 ± 6.8
Object control Score	28.7 ± 6.2	27.7 ± 6.1	28.0 ± 5.8
Balance held (sec)	9.8 ± 6.8	11.3 ± 7.8	15.4 ± 7.1

[a] denotes a significant difference between the highest IMD tertile and lowest IMD tertile

4.4 Discussion

The results show that children met PA guidelines, yet lacked mastery of many FMS skills, with the oldest children in the cohort performing significantly better than their younger peers. The current study observed the FMS competency and PA levels of an English EYFS cohort, while establishing if any significant relationships between these variables existed or were mediated by socioecological factors. To my knowledge it is the first study to use age tertiles for one school year of children, to examine important differences in children's FMS competency and PA levels.

4.4.1 BMI

Recently published child measurement figures in England (NHS Digital, 2021) show that boys are more likely to be overweight than girls, in both reception and when finishing primary school in year 6. The majority of the participants in this study were classed as 'normal weight' (Table 4.1), and while boys did tend to have a slightly higher BMI, there was not a significant difference between boys and girls in the current study (p>0.05). Children with higher BMI did tend to be from a lower SES background (average BMI centile 53.5), whilst those from highest SES backgrounds had the lowest BMI readings (average BMI centile 36.9), which mirrors national figures of the child measurement programme (NHS Digital, 2021), however the difference between groups in this study was insignificant (p>0.05). Weight status (BMI centile) had an inverse relationship with average MVPA, showing that higher levels of MVPA resulted in lower BMI, however, it was weak and insignificant. This finding shows the wider environment is influential on a child's weight status and that PA is just one factor that can influence a healthy lifestyle and weight status in childhood. A similar relationship of BMI centile with FMS total score was observed (r=-0.026, p>0.05). This demonstrates that although BMI can be used as a useful measure of child health status, PA measurement, and FMS competency should be considered as important key indicators to help improve lifelong health behaviours in a child population. This helps to support the requirement for an increase in further good quality provision in schools and education.

4.4.2 PA Levels

The results show that children who wore the accelerometer for the required wear time and thus provided complete PA data (59% participants) generally met the PA guidelines set by the UK government of 180 minutes of PA a day with 60 minutes of MVPA, which mediates further health benefits of PA (Carson et al., 2017). It may be argued that the children who did engage with a complete PA assessment and were compliant in accelerometer wear could be habitually more active than participants who did not wear the accelerometer sufficiently, this affects the trustworthiness of the current data. However, the data did show that children exhibited significantly higher levels of TPA, LPA, and MVPA on weekdays when they were within the school environment, rather than within the home environment on weekend days (Table 4.2). Consequently, this also saw significantly higher levels of SB over weekend periods than in week periods ($p<0.05$). This finding is in line with previous literature from preschool cohorts (Foweather et al., 2015a; Roscoe et al., 2019b). This highlights the key importance of the education setting for PA attainment in the early years and the need for enhancing meaningful PA opportunities, so that PA behaviour tracks successfully throughout childhood and beyond. Using further qualitative information to inform the design and development of the activities taking place will be key in designing future interventions, and educators should take advantage of the time children are active to enhance their skill development, which is key to gross motor development, as mentioned in the EYFS framework (Department for Education, 2021).

Enhancing skill development should ensure children remain active throughout their school life and beyond into later life, as proficiency should allow for increased perceived competence and health related fitness to be developed in children and sustained thereafter into adolescence and adulthood (Britton et al., 2020). These factors may also help children to increase their habitual PA in their home environments, with perceived competence allowing them to become more confident in differing environments for PA. This data also shows that better PA promotion is needed within the home environment, due to significantly higher SB at the weekends ($p<0.05$). Previous findings within this programme of research demonstrate that the changes in the social and physical environment for both children and parents, including the availability of technology as a use of entertainment at home for children, in addition to parental concerns over safety for their children in their local home neighbourhoods have possibly led to the reduction of PA outside of the educational setting, as suggested by educators in Chapter 3. These to data sets combine to show that changes in the home environment are needed. However, change at community level, including information and education from the school environment for parents may positively influence change rather than a direct intervention in family's homes. Further to this, a difficulty faced for young children is the lack of autonomy and choice over their PA time and performance, which could be due to more protective parenting practices such as safety concerns during outdoor play (Brussoni et al., 2012). Therefore, not only does children's confidence and competency in their FMS and PA need to be increased, which can primarily occur in the educational environment, but the additional awareness of parents in helping provide children with stimulating environments to practice skills and PA at home is imperative. Duncan et al's (2022) recent finding supports this by stating that further action should be taken outside of school settings and that a whole community approach and consideration is needed for improvements in PA and FMS (Duncan et al., 2022).

4.4.2.1 PA and Deprivation

Children who were from more deprived backgrounds according to their IMD tertile tended to exhibit significantly lower levels of MVPA than their least deprived peers ($p<0.05$), with children from the least deprived backgrounds performing an average of 30.5 minutes per day more MVPA than those from the most deprived backgrounds (Table 4.5). The most deprived children also presented with the highest levels of SB, although not a significant finding. This data supports the report by Sport England, that those from the most affluent areas achieve the highest PA rates for children in England (Sport England, 2021). There are several reasons why children from more deprived backgrounds may be less active than their more affluent peers. As found through the interviews in Chapter 3, parents of more deprived children may feel that the spaces around their home are unsafe for PA, or simply do not have the funds to afford to take children to extracurricular activities, whether these are based at school environments or outside these (club, community centres and so on). These children may also not have access to open spaces at home, for example living within flats. It was also stated in Chapter 1 how parental employment and time constraints to spend being active with their children can influence young children's PA. This once more highlights the need for well thought out PA provision aligned to the needs of all children within schools, regardless of their background to help achieve healthy PA levels. Despite this difference, all children were achieving more than adequate MVPA per day according to the guidelines provided by the Chief Medical Officer (Department for Health and Social Care, 2019).

4.4.2.2 PA and FMS competency

Although this study found children (who provided accelerometer data) to be adequately active, by meeting the 180 mins of PA a day and 60 mins of MVPA per day, they still demonstrated low levels of FMS skills. Overall, there was no positive relationship between total PA and FMS competency within the cohort sample measured ($r=0.135$, $p>0.05$), this finding also included all levels of PA (MVPA: $r=0.259$, $p>0.05$; LPA: $r=0.006$, $p>0.05$) and SB ($r=-0.156$, $p>0.05$). Although Stodden's (2008) model proposes that PA may drive the development of FMS, our findings show that this is not necessarily true and is supported by the findings of Xin et al., (2020) systematic review. These results demonstrate that although increasing PA for health is important, it may not help to improve FMS competency that is required for establishing better PA behaviours throughout childhood and into adult life, and that physically active young children do not necessarily result in more competent movers. This highlights the need to improve movement competency and enjoyment to ensure a better chance of lifelong PA engagement. Educators stated in Chapter 3, that young children have plenty of active opportunities within their school days, such as active breaks in lessons, allocated playtimes and some timetabled PE, thus achieving sufficient levels of PA. What however is not clear, is what tuition and guidance children are provided with to improve their FMS and other motor skills during these times. With educators stating that many colleagues and themselves may not feel confident to teach PE and FMS to EYFS children (Chapter 3), this may then translate in to play and PA opportunities without any or near adequate tuition of physical skills, including FMS. FMS can help children to develop stronger perceived competence (Zhang et al., 2021) which can aid in confidence and improving self-efficacy to take part in PA, health supporting behaviours, and sport as children age.

It is also important to note that children aged 4-5 years are not expected to show full mastery of skills (Goodway et al., 2019), yet they are more likely to be more active than older children (Sport England, 2021), due to the active opportunities that they are afforded across a whole school day. This means that even as children age and their skills may become more proficient, their PA opportunities may decline, creating an even stronger rationale to increase skill competency.

4.4.3 FMS competency

4.4.3.1 Age differences

Despite adequate levels of PA, the cohort had a low competency of FMS, with the average raw total score of the TGMD-2 being 58/92 potential marks (Table 4.3). The spread of the data varied from 31 to 79 points, showing large variation in a small age group. Previous literature of children slightly younger, showed an even larger variation in sample scores, demonstrating that a large range is to be expected (Roscoe et al., 2019a). Results showed a significant relationship between the running and jumping product and process measures (r=-.458, $p<0.05$ and r=0.484, $p<0.05$, respectively), illustrating that using either measure may be a good indicator of a child's proficiency at this age for these skills. With Gallahue et al., (2011) stating that mastery is achievable by the age of six years, children should be more competent in their skills at ages 4-5 years.

Despite this broad variation, a positive and significant (r=0.274, $p<0.05$) relationship was reported for total FMS score and age. Further analysis demonstrated between age differences when the sample was split into age tertiles. Children of the youngest and middle ages in their year group were significantly ($p<0.05$) worse in their total FMS score than the oldest children within the sample. Children from the middle age group were also significantly worse than the oldest children at their locomotor skills ($p<0.05$) (Table 4.4). Additionally, children from the oldest age tertile had significantly better balance than the youngest age tertile ($p<0.05$). From these results we could infer that the children who are born in the spring and summer months (March-August), and therefore are the youngest in their school year may be less proficient in their FMS than peers born earlier in the school year. This demonstrates that maturation, even at younger ages, can play a role in FMS development and competency, and is supported by previous work (Adeyemi-Walker et al., 2018; Bolger et al., 2020; Venetsanou & Kambas, 2016). Existing research in children aged 6-11 years old found that there were significant differences in children's balance ability, mirroring the outcome observed within this study (Birch et al., 2016). Birch and colleagues (2016) additionally found that throwing and catching proficiency was better for children born earlier in their school year.

It is important to consider relative age effect (RAE) when examining children's physical development and motor skills, including FMS. Maturation of children's neural pathways of movement are considered to still be developing at this age (Gidley Larson et al., 2007), in addition to a child's perceived competence and health related fitness, all of which could influence FMS competency outcomes during the TGMD-2 assessment (Stodden et al., 2008). A child's ability to learn and practice these skills, in addition to play behaviours could also be influenced by a child's level of communication skills which are still developing in the early childhood years (Craig-Unkefer & Kaiser, 2002). Information such as this should be key to informing the development of curriculum and framework at the early years, especially for physical development. Guidance and education of educators in regard to RAE in early childhood could be key to improving movement competency outcomes of children, which ultimately can lead to better academic outcomes (de Waal, 2019), health (Robinson et al., 2015), social outcomes and overall school readiness (Jones et al., 2021). When thinking about children in a school setting, educators must allow adaptation of activities for children of varying ability, however some educators do not feel prepared to do this in PE as mentioned in Chapter 3 and in previous research (Goss et al., 2021; Randall & Clark, 2019). This key finding in this study of a significant relationship of FMS development with age, further shows that EYFS educators and curriculum must think carefully for the children born at different terms of the school year.

4.4.3.2 FMS Domain differences

Similar to previous reviews of the literature (Bolger et al., 2020) including Chapter 2 of this thesis, and further English cohort studies (Adeyemi-Walker et al., 2018; Duncan et al., 2021; Hall et al., 2018), the children in this study were more proficient in their locomotor abilities than their object control abilities, with a significant difference ($p<0.05$) identified between the two FMS subdomain scores. It is thought that children find object control skills harder to develop and take longer to master due to greater skill complexity, which most likely requires further practice and tuition for a child to master the skills (Morgan et al., 2013). Despite this study's finding that locomotor ability was significantly higher than object control ability, Bryant et al., (2014) found that slightly older children struggled to master their locomotor skills, attributing this to preferred activity selection of ball games at younger ages, additionally locomotor skills use the whole body, which required higher levels of whole body coordination.

4.4.3.3 Sex differences

Analysis between the two sexes also showed that girls were better at the locomotor skills than boys ($p<0.05$), however, no further sex differences were demonstrated in the data set regarding total FMS score, object control skills ($p>0.05$), a finding also discovered by Cliff et al., (2009) and Roscoe et al., (2019a) in this age group. Differences in balance ability between gender was also not observed, a finding present in the existing literature (Jiang et al., 2018). Regardless, previous work has found that boys tend to outperform girls in object control at younger ages (Adeyemi-Walker et al., 2018; Morley et al., 2015; Webster et al., 2019), and that girls have better balance ability than boys (Chapter 2; Venetsanou & Kambas, 2016).

Very few physical differences exist between boys and girls in early childhood (Malina et al., 2004), and it is therefore commonly attributed that sex differences occur due to cultural differences and stereotypical PA choices made by the children themselves, but also the provision they are afforded by the adults who care for them (McKenzie et al., 2002; Venetsanou & Kambas, 2016; Webster et al., 2019). These conflicting findings for different subdomains of FMS, including between the sexes, between this study and the existing literature exemplify that a 'one size' fits all approach is unlikely to work in a real word setting, a notion that was echoed in qualitative research with educators of the early years and is reported in Chapter 3. Future programme design should therefore consider how an all-round and holistic approach can be used to provide focus to all FMS and be adaptable for cohorts where deficits in subdomains may be identified. This also calls attention to how FMS can be measured within an educational setting to allow for the specificity to be provided to pupils, as is currently provided within academic subjects.

4.4.3.4 FMS and Deprivation

Although no significant differences ($p>0.05$) between IMD groups were found, children from the lowest IMD tertile also scored lowest on total FMS score (Table 4.5). With recent a review (Barnett et al., 2021) finding that there is inconclusive evidence for FMS competency influencing the levels of PA children can achieve throughout childhood and beyond, it is important that this gap in PA achievement and FMS is addressed. It is also important to note the relationship that young children's FMS competency has with levels of PA are expected to be weak (Stodden et al., 2008), thus the current findings support this.

4.4.3.5 Balance and Stability

This study was one of the first English cohort studies to incorporate a measure of stability in addition to the TGMD-2 for this age group. The importance of balance measurement as part of FMS measurement has been discussed in Chapter 1 and Chapter 2, sections 2.2 and 2.5.2. On average the children were able to hold a one-legged balance for 11.9 ± 7.4 seconds. However, values varied from 1.1 seconds to the maximum of 30.0 seconds, once again, showing the wide variation in the cohort's capability. The synthesis of literature for children the same age, included in Chapter 2, showed children's balance in a one-legged stance to vary from 6.7 to 87.6 seconds, demonstrating the wide variation in measurement is a consistent finding within the data for this age group. Balance is developing rapidly at these ages as children grow at a very quick rate, making the ability to balance much harder during early childhood due to the changes in limb length (B. C. Chow & Chan, 2011; Jiang et al., 2018; Krombholz, 2006; Venetsanou & Kambas, 2011). This may bring into question the need for or successful practice of balance activities with young children. However, the recommendation to provide practice opportunities for balance skills to aid overall FMS development is still warranted, as balance is a key performance criteria within other FMS such as the landing during a horizontal jump and leap (Ulrich, 2000). Practice at an early age may also aid at later stages of childhood, as Foweather et al., (2008) saw a significant improvement in balance ability in children aged 8-9 years old after following a 9-week intervention. Although this cannot be exclusively attributed to the use of the intervention, these results help to support the inclusion of balance in future tuition.

4.4.5 Strengths and Limitations

This study was the first to use British developed ActiGraph accelerometer wrist cut points to measure the PA of the children in this study (Dobell et al., 2019). Recent work shows that a limited number of wrist accelerometer cut points are available for this age group, despite wrist compliance being higher (Fairclough et al., 2016b). Altenburg et al., (2022) reported that poor to moderate precision of measurement was found using the Dobell et al., (2019) wrist-based cut points. Overall these cut points performed better than the only other cut points available for the ActiGraph accelerometer at the wrist for this age group (Johansson et al., 2015). Therefore it could be assumed that the Dobell et al., (2019) cut points employed within this study, would perhaps give the most accurate outcomes for level of PA in a cohort of the current study's age group. These developments are important for future research, but also for overall surveillance of children's PA.

Despite this strength, when analysing accelerometer data, it was clear that a number of children had not worn the accelerometer for the whole time they were provided with them, resulting in the loss of large amounts of data. Participant compliance is an issue with the younger population (Cliff, et al., 2009), and thus was expected. However, research should endeavour to find solutions to these issues, such as a more comfortable solution to wearing an accelerometer. Research with older children has been conducted (McCann et al., 2016), but is sparse for younger children. Further to this, children with autism struggled with wearing the accelerometers, thus, further work should be done to engage these children with PA.

The cross-sectional analysis of this study means that cause rather than consequence cannot be inferred from this data, as it is simply observational at one time point, rather than longitudinal in nature, and only comments on possible relationships between the variables can be made. Similarly important to remember, is the size of the current sample is not representative of the population and that more boys took part in the research than girls, thus hinders the interpretation of the findings. The split of the sexes within this study may have been down to class cohorts and the split of girls and boys within in them. However, it could also potentially represent early stereotypical opportunity of take up by boys and girls for PA research. Parents of boys may perceive them to be more physically active and thus more likely to consent to their chid taking part in the current research study. This is a worry as it reduces our knowledge around the FMS and PA performance of girls in early childhood. Despite this, this data shows that all children should be afforded the opportunity and practice of key FMS and time to perform PA.

Unfortunately, this study took place during the two initial years following the start of the COVID-19 pandemic, this had a number of effects on the data collected, but also resulted in effective reflexive design of the protocol, which should be considered a researcher strength. It has been widely reported that PA of children during the pandemic was reduced (Yomoda & Kurita, 2021), which may have affected the PA levels recorded in this study. This calls to the attention the need for future programmes to consider their effectiveness in a post-pandemic world, but also the ability to adapt for future pandemics or similar situations. An aim of this study was to collect research data with a varied SES sample, yet, due to the restrictions surrounding COVID-19 and thus the use of convenience sampling there was a reduction in the desired range of SES. However, participant IMD rankings were able to be stratified into tertiles, to still demonstrate the effect IMD rank had on FMS and PA achievement. Nevertheless, further work should be undertaken to truly explore the effect of SES on FMS and PA of this age group. Data collection also did not occur in the same season/time of the year for the classes of children included within this study. Weather conditions and the amount of daylight can affect the levels of PA that children achieve, due to the limited time outdoors during the winter months, therefore this should be considered a limitation of the current study. Although five schools and eight different classes participated in the study, not all children within each EYFS class took up the opportunity to participate, which reduced sample size. Researchers were restricted in how much contact could be made with the parents due to COVID-19, as visiting schools for recruitment and information sessions was not viable. This meant that the researchers in this study relied on the communication from class teachers and school staff to promote the participation in the research study. In some schools this was successful, but across all schools, the uptake in the study was hindered. Not being able to disseminate the important nature of the research hindered understanding and consent of parents.

4.5 Conclusion

The current study found that children aged 4-5 years old in Central England were sufficiently active, however, they presented lower than expected levels of FMS competency. Although the evidence is limited by its sample size, the findings are matched by similar studies both in the UK and worldwide, while demonstrating the use of reliable and valid tools of measurement. A key finding to note is the effect of age tertile on FMS achievement within the current cohort of participants, as this provides key insight into the need for an adaptable framework and curriculum at the EYFS age to ensure that all children are both supported and challenged to develop their FMS and MC. This study also supported previous findings in the literature of a weak relationship between FMS and PA at the early years, which demonstrates how the separate attention to the development of skills as well as positive PA behaviours is needed for overall positive health outcomes throughout childhood and beyond. These findings should be used to inform future theory and evidence-based programmes of intervention such as IM to help benefit the development of FMS during early childhood, in addition to ensuring appropriate measurement of FMS and PA continues to develop in research and within the population.

4.6 How this evidence informs this research programme

This study presents some of the most recent information on English children's FMS and PA and will be used as key evidence in aiding the effective mapping of intervention for this age group within English EYFS school settings. A key piece of evidence to take from this study into the intervention planning process is that the results of this study suggest that maturation and age over the EYFS year group does influence how well children's FMS competency is developed. This study also established, that although children were meeting government PA guidelines, especially within school settings (weekday PA), their FMS competency was still lower than expected at this age. As children can master their FMS by the age of 6 years old (Gallahue et al., 2011), and the sample of children within this study were between 4.2 and 5.8 years of age, with very few of the sample approaching mastery, a need for FMS development to aid in future PA participation and positive health behaviours is still warranted. Finally, the evidence shows that the most deprived children in this study, performed less PA than their peers from more affluent backgrounds. When considering the socio-ecological model, the influences within the child's immediate environment in addition to less direct influences on PA must be considered to aid these children. The need for an adaptable framework is strengthened by these findings, which links to designing, establishing, and evaluating sustainable and impactful programmes of change.

Combined with the qualitative and systematic evidence already established within this PhD this chapter strengthens the evidence base and helps to guide theory-based programmes of change. A collection and combination of both qualitative and quantitative narratives is important for thoroughly informing the logic model of the problem and logic model of change within IM theory (Eldredge et al., 2016) that will be further explored in the next chapter. Further, this quantitative information allows for tangible and measurable outcomes within a programme to be proposed, based on previous evidence, in addition to best practice of measurement in this population.

4.7 Considerations during a pandemic

During the COVID-19 pandemic there was a fall in children's PA levels, as a result of school closures, fear around using public spaces and halting of sports clubs and activities (Rossi et al., 2021). This also resulted in reduced opportunity for PA and motor development research to take place.

When designing the baseline study, the methodology was critically analysed and chosen according to the environment at the beginning of this research project, September 2019. The proposed methodology that was mapped out in the initial six months of the research project consequently had to be reviewed during the COVID-19 pandemic, which effected data collection and research methodology from March 2020 onwards. The substantial time gap in data collection has already been noted within this chapter.

During periods of restricted social contact, alternative data collection methodologies that achieved similar results to the original methods were sought and implemented from January 2021 to May 2021, after which original procedures were allowed to occur. There was additional ethical consideration to be made during these times, including the safe and secure sharing of video data from participants. Although this participant data does not form part of the data presented in this thesis, it is important to discuss the implications that collecting data via this methodology incurred and how this may aid future research. The following section describe and discusses the methods used during this period.

4.7.1 Recruitment

Recruitment was purely sought through social media (Facebook, twitter, LinkedIn) and word of mouth (recruitment poster can be seen in Appendix 4.3). Efforts were made to contact influential persons (school leaders, local authority/government, social media influencers) and the media (e.g., local and national news outlets), to help disseminate information about the project, these efforts were met without response. Therefore, a key consideration in future research would be to make sure these connections are viable before attempting to use these channels. During the time that the online recruitment ran, schools were closed, and remote learning was taking place with students at home. After discussions with educational leaders and teachers it seemed unreasonable to ask children to do this task as one of their home activities, as they already had many other tasks to complete. This meant that parents had to choose for their child to do this research. Naturally this led to more physically active parents (assessed in the questionnaire) taking part with their child. This kind of selective participation is usually avoided in school settings where a whole class will be offered the opportunity to take part. Additionally, parents who were working from home were more likely to take part, such jobs were usually indicative of higher socioeconomic status, with key workers working outside the home, less likely to participate. To run a research project in a home environment requires the commitment of all parties, including parents. As previously highlighted in Chapter 3, parental involvement, knowledge, and confidence can be lacking, reducing interest in taking part in PA research. Other common reasons for not taking part would be issues such as a lack of time (Roscoe et al., 2017b).

4.7.2 Data collection procedure and limitations

Following additional institutional ethical approval (ETH2021-1243*), parental informed consent was gained for all participants of the study. Twenty participants consented to taking part in the project, but only 11 children completed the videos, and 10 parents completed the questionnaire. This completion rate of just 55% is low and highlights one of the main issues of a remote methodology even within a very small sample. Using incentives may increase the participation within a remote project, especially where a parent and child are involved in the data collection process. Offering all participants who completed the study an incentive e.g., voucher to spend, could be considered by other future studies with further funding than the current PhD.

Once parents had consented to their child taking part, they were sent ‘The FMS Project Instructions’ (Appendix 4.4). During the collection of data in the home setting both the child and the parent had to a) watch the demonstration video of the 13 skills (TMGD-2 and balance measure, identical measures to used in school settings) and for parents to read the instructions; b) child perform and parent film as many skills as possible, up to 13; c) parents upload their videos securely online with a participant data sheet (identical to the sheet used in Appendix 4.2); d) parents complete a 10–15-minute questionnaire through the software Qualtrics. Although efforts were made to make the activities as simple and as fun to follow at home, it is clear from just a simple explanation of the protocol that it was a reasonably lengthy process to complete. Additionally, it required participants to have access to a camera, some sports equipment, and an internet connection. Given that research currently needs to target issues such as the deprivation gap, especially in PA research, this protocol fails to meet these criteria, with some elements of participation considered luxuries.

The online protocol intended to replicate data that would have been collected in school settings, as set out in the methodology of this chapter. Within these settings there is usually the use of school/sports hall space, or a large outdoor area for children to perform their FMS assessment in. This is especially important for skills like the run, where there is ideally more than 10m of space, so children can run as fast as possible. A clear issue with home collection methodology, which took place from February to April (colder winter/spring months), was the use of indoor spaces which were inadequate in size for the activities. This made it harder for parents to capture their child’s movement skills or give them adequate space to do so.

Parents were asked to use mobile phones for the videoing during data collection. With the absence of a stable tripod set up used for in-person data collection and a lack of guidance on filming plane of activity, this resulted in videos and data of poorer quality. This limiting factor did make viewing some of the activities harder during analysis. There was quite a disturbance in the plane of the camera when parents were performing skills such as the catch, and throwing a ball to their child, and multiple skills were not filmed in the lateral plane of movement, making the criteria harder to score and analyse in some cases. Although these issues may seem minor, they are important to the validity and reliability of the protocol used and criteria used to score skills.

Once the skills had been videoed, they were shared with the lead researcher via Microsoft OneDrive to be scored, which overall was successful within this data collection phase. There were some minor issues to begin with when sharing access to folders for videos, and a pilot of sharing videos should be conducted before working with participants to reduce any burden on them. Additionally, not all participants had a OneDrive account, and although simple to set up and acquire, some participants did not want to do this. Researching and using the most viable and safe method for sharing of videos of participants should be discussed with the ethical committee and board at the corresponding institution to make sure that data safety and GDPR rules are followed. Skills were assessed against the criteria of the TGMD-2 and 3 batteries. The time static balance was held for, was recorded.

Chapter 5

Improving Fundamental Movement Skills during Early Childhood: An Intervention Mapping Approach

Current dissemination:
University of Derby Images of Research 2022- Physically Active 4-year-olds- Judges Choice winner:

This image shows 30 drawings from four-year-old children in Derbyshire, when they were asked about their favourite physical activity or session in PE at school. My research aims to design interventions to help children improve their fundamental movement skills, which help them to participate in physical activity as children and as they grow older. Children are important stakeholders in the design process of these interventions and their voices need to be represented. This write, draw, show and tell activity with focus groups of children allowed a rich exploration of their views and ideas.

5.1 Introduction

There is an abundance of literature supporting the relationship between FMS competency and PA throughout childhood (Engel et al., 2018; Logan et al., 2015). The earlier a child can begin mastering FMS through appropriate tuition and practice opportunities (Gallahue et al., 2011), the more positive their PA trajectories (Jaakkola et al., 2016) and health outcomes, including adiposity and motor development, will be (Bremer & Cairney, 2018). Despite this evidence, during the early years, the focus of research should be given to both FMS competency and performance of PA as separate elements of a child's health behaviours, as the literature at early childhood shows that the relationship between FMS and PA is weak (Barnett et al., 2021). This relationship was also observed in Chapter 4 (see section e.g. 4.3), demonstrating the similarities with widely reported research outcomes, that PA does not strongly correlate with FMS competency in early childhood. Although the relationship is weak in the early years, it is seen to strengthen into middle childhood and adolescence (Logan et al., 2015). This provides a strong basis and argument for dedicated provision of FMS practice and PA opportunities for a young population, to promote and instil healthy behaviours and habits.

Interventions to increase FMS competency in children are common (Engel et al., 2018; Graham et al., 2021; Logan et al., 2012b; Morgan et al., 2013) specifically during early childhood (Van Capelle et al., 2017; Wick et al., 2017). However, many interventions fail to use in-depth planning and mapping procedures to create interventions that can be implemented with long-term and sustainable approaches and which are based on the needs of key stakeholders (Bartholomew-Eldredge et al., 2016). The benefits of interventions are short lived and lack longitudinal follow ups, which brings into question the lasting effectiveness of programmes, a concern that has been expressed by early years educators in England as reported in Chapter three. Despite these issues, recent changes in the research landscape have been documented. Daly-Smith et al., (2020) evidenced a whole-school approach to increasing the PA levels of children, using a multi-stakeholder experience, a contrasting approach to previous research of academic and external-provider delivery approaches to interventions. Goss and Colleagues (2021) also provided a strong argument for the involvement of multiple stakeholders within the development of assessing physical literacy in schools, collecting key views and opinions on how to ensure physical literacy development can be achieved in these settings. Other methods recently implemented to improve the planning, production, uptake, and sustainability of interventions include collective intelligence (Ma et al., 2020, 2021). Collective intelligence is an applied systems science approach to establish structural models of the problem and structural models for a solution. Most importantly this research engaged key stakeholders of interventions, including researchers with FMS intervention implementation experience, teachers, coaches, and finally public health specialists, which mirrors that of IM. Ma et al., (2020; 2021) identified barriers to intervention implementation and thoughts surrounding possible solutions. This key literature including that shown in this programme of research, provides rich data to help inform programmes of change through effective planning. These studies demonstrate the growing evidence for involving key stakeholders when designing interventions using an iterative approach. In doing so highlighting the multiple methodological designs and applications that facilitate inclusivity and engagement of stakeholders in the research processes. Key stakeholders may be the direct recipient of the intervention; however, it is essential to consider the individuals who enable the interventions to take place, known as the implementers, adopters, and maintainers (Bartholomew-Eldredge et al., 2016). In the case of this programme of research, children, teachers, parents, coaches, and researchers, are key in the pivotal developments of novel, and effective interventions that are sustainable.

It is recognised that behaviour change, public health, and PA intervention is complex, multifaced and interactive (Bartholomew-Eldredge et al., 2016; Buchan et al., 2012). While not all determinants and components of health can be addressed within a single intervention or even a programme of interventions, the most important influences must be addressed and utilised. For example, in a feasibility trial, Langford et al., (2019) found that a parental web component of a PA intervention for pre-schoolers in the UK was ineffective, with a low number of interactions in this element of this intervention. This is just one example to highlight the importance of considering the needs of key stakeholders in the initial processes and design, while allowing periods of trialling and testing of feasibility. This iterative design of the intervention design processes will lead to programme adaptations to allow for the best possible outcomes for the end users while remaining cost effective at a public health level (Pringle et al., 2020). It is important to note that parental involvement is important to increasing the PA behaviours of young children, and further methods need to be explored and utilised to ensure engagement of parents to reach the programme goal. Iterative and cyclical review processes are essential to long-term programme design, which allow for a 'back to the drawing-board' approach, and application of different literature or theory within intervention design (Bartholomew-Eldredge et al., 2016).

As mentioned, health promotion interventions must consider the target population, their physical and social environment determinants, and as many influential determinants of behaviour as possible. For children, these factors range from family influence (Cools et al., 2011; Rhodes et al., 2020), and deprivation, to sex and ethnicity (Adeyemi-Walker et al., 2018; Eyre et al., 2013, 2022; Roscoe et al., 2019), which were highlighted in the systematic review of Chapter 2, in addition to age, stage, and maturation status as evidenced in Chapter 4. Educational environments have been considered important spaces for both PA attainment and intervention in child populations, and for some children, this may be the only environment where they attain good quality PA (Gordon et al., 2013; Sport England, 2021). Primary education settings in England have access to ring-fenced funding for PE and sport (Department for Education, 2020a). Importantly, schools have autonomy over how they decide to spend their funding and while this can include resources such as equipment and external coaching, it can also include continuous professional development and training for primary educators. Funds can be used to increase their skills, knowledge, confidence, and use of appropriate pedagogical practices within PE. However, there is little conversation involving the teachers themselves regarding their development needs. The need for better preparation of educators to teach PE and facilitate PA has been cited as an issue multiple times despite this funding (Goss et al., 2021; Lawless et al., 2019; Roscoe et al., 2017), including within Chapter 3 of this thesis. Despite a clear need for more effective guidance for PE, PA, and early childhood physical development, there is not only little statutory provision for the teachers of children but also a lack of approaches that join up schools with communities. This is with the aim of improving the FMS of children, as well as enhancing their PA. A recent expert statement suggests that policy level recognition of motor competency including FMS development needs to be provided so that adequate funding is made available to enhance the skills of practitioners inside and outside the school environment (Duncan et al., 2022). In making the case for effective provision, strengthening the proposal to policymakers and governments is key. Health based policy has been criticised for not considering the wider determinants of health behaviours (Bartholomew-Eldredge et al., 2016) and the need for processes that better consider this complexity in intervention design. To this end, IM provides the collection of key evidence and theory for designing and implementing effective intervention that address the multi-layered determinants identified by key stakeholders and involves them in an iterative process in shaping solution that best address their health needs. IM has been used to plan interventions to combat obesity in early childhood populations (Mann et al., 2015; Taylor et al., 2013; Verbestel et al., 2011), but, importantly has not been used in the context of FMS improvement before and as such is a novel contribution to the field.

Intervention Mapping is heavily influenced and informed by Bronfenbrenner (1979) socioecological model (SEM; Figure 5.1), which highlights that an individual's behaviour is influenced by several different determinants at different levels, and which interact between the levels. When considering a child's FMS competency and PA levels we can consider determinants using the layers of the SEM.

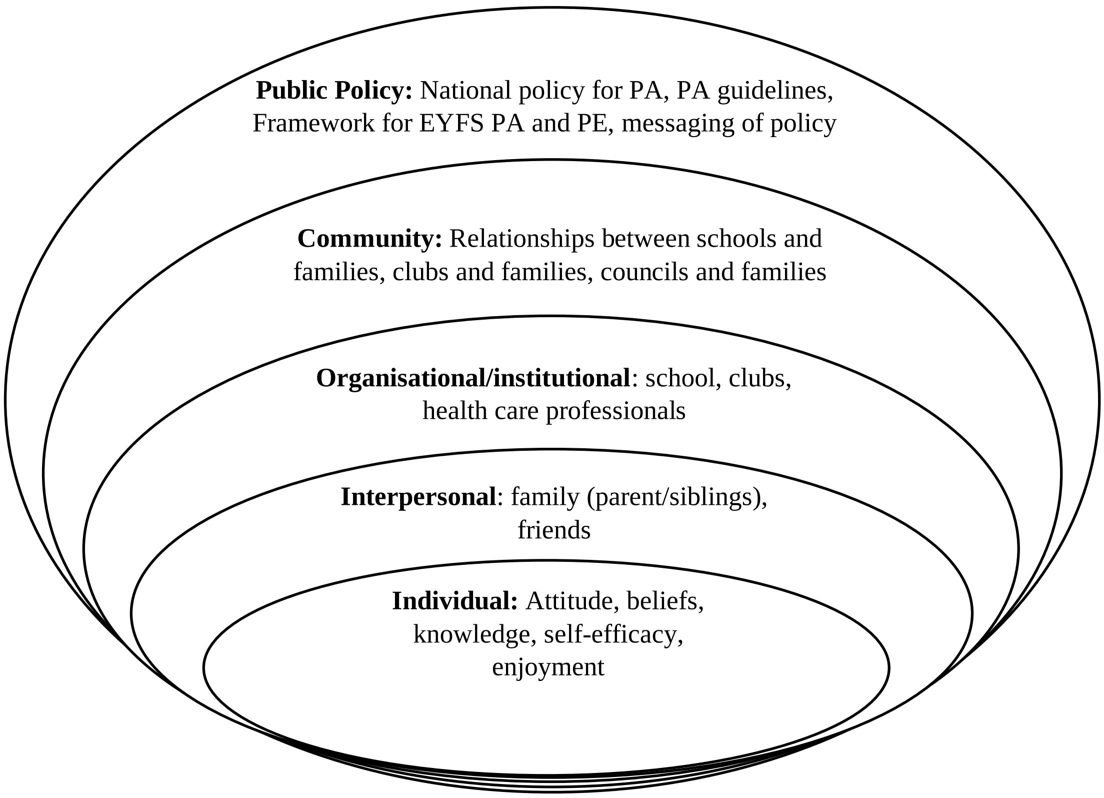


Figure 5.1. Socioecological Model according to FMS competency and PA in early childhood

1. Firstly, by looking at individual determinants, these include determinants such as a child's beliefs and attitude towards PA, in addition to their enjoyment of activity.
2. Secondly, it is also clear that these determinants can be affected by a child's immediate interpersonal environmental determinants. This includes members of a child's family, as well as their friends and peers, as knowledge and belief between these groups can be shared.
3. Thirdly, organisational, and institutional determinants are highly influential for children, especially in the early years. A setting all children experience is the school setting, and it, therefore, remains a key determinant influencing children's choices and behaviours. A sense of community can help to foster better health behaviours. Stronger relationships between parents and schools, in addition to efforts by local authorities, can determine the health of a community.
4. Finally, the highest-level determinant is public policy. When this determinant is considered, examining the policy for early PA and PE, in addition to dissemination of policy and statutory training of practitioners remain key determinants. It is therefore important that intervention focuses beyond the end recipient and includes key stakeholders.

Combining what we know about FMS and PA, interventions during early childhood, and the school environment, it is clear that these three elements should be considered important for early childhood health and PA. Although, as aforementioned, there have been multiple interventions at school level, to our knowledge there are no studies to date that have used the IM approach proposed by Bartholomew-Eldredge et al., (2016) to increase FMS competency in early childhood. Importantly this approach uses theory, evidence, and dialogue with key stakeholder groups throughout the IM process to inform initial decisions, guide development and analysis, and perform an evaluation of the interventions. Considering the evidence introduced here, we believe IM proposes a suitable and robust method to plan interventions and has been recommended as a valuable tool for early childhood intervention development (O'Connor et al., 2018). With this in mind, this chapter aims to present the initial IM process and outcomes for developing effective FMS interventions within schools for the early years age group. This also encompasses the adoption of a pragmatic approach, to retain quality as part of this PhD, and observing the ‘first-step’ in a number of processes leading to optimal and sustainable outcomes for intervention programmes.

5.2 Methods and Results- six steps

This chapter followed a non-traditional format of IM due to the time constraints of the PhD programme of research. This meant the researcher was realistic, pragmatic, and practical in the choices made when developing this IM iteration within the time and resource constraints of this PhD. Further depth and explanation on how this was achieved are detailed appropriately within each step.

5.2.1 Study Design

Intervention mapping is a six-step process proposed by Bartholomew-Eldredge and colleagues (2016), to be initially used in health promotion interventions and programmes. Each step has a series of related tasks and this was adopted as a framework to guide the research and when referring to IM, Bartholomew-Eldredge et al., (2016) are acknowledged. IM programmes are designed using a strong basis in theory, evidence and stakeholder holder involvement and requires the formation of a ‘planning group’ to shape the development of interventions in a way which is needs led and which is practical. The planning group must be made up of key stakeholders to the programme and host of interventions within it. It is believed the members of a planning group will both highlight and guide the choice of key theories and evidence to inform the programme, but most importantly relate the goals and aims of the programme to real life situations and outcomes. The planning group’s contribution is pivotal in achieving the sustainable nature of individual interventions and whole programmes that are proposed through this method.

The six-step model and associated tasks is further explained in the following sections, because IM is an iterative process, we discuss the step/tasks and the results that emerge from the deployment of the step/task, and this helps preserve the context in a way that would not be possible if the method and the results were separated. Each section states how each task within each step of the mapping process was completed and how the planning group was involved. It is important to realise that although further involvement of the planning group may have been advantageous at various stages of this study’s process, this was not always realistic for the lead researcher and the members of the planning group. In this research, this resulted in a more pragmatic approach by using several initial focus group sessions, with the planning group split into respective groups where necessary. Proposed questions for each step of the planning process could then be discussed at this first step of the IM process and this is detailed in each respective section with examples within the appendix (5.1). If there was a need for further elaboration or information of a question asked at the initial focus group, individuals were contacted separately via written email or verbal telephone discussion during later stages of the IM process. This approach was used to reduce the participant visits and consultations to as few times as was deemed to be appropriate.

The use of a planning group to convey their needs and opinions throughout this chapter, in addition to the use of the data collected in previous chapters, including the quantitative data formed in Chapter 4, Chapter 5 displays a strong mixed methods design (as demonstrated in Table 1.3). Mixing of data in the planning, collection, analysis, reporting interpretation stages of this chapter were essential and the mixed approach to the reporting of findings and the future assessment of the IM process are also demonstrated, with numerical programme outcomes, in addition to qualitative discussions with key stakeholders throughout. The aspiration is that the approach provides a comprehensive and informative account, and this aspiration is facilitated in IM (Eldredge et al., 2016)

Ethical approval (ETH2021-3572) was gained from University of Derby Science and Engineering Ethics Committee and all participants completed written and verbal assent before involvement at any stage of the IM process.

5.2.2 Step 1: Logic model of the problem

In step 1 there are four tasks. Task one involves establishing the planning group. Task two focusses on establishing the problem via a needs assessment and creation of the logic model of the problem. Task three establishes the programme context, population, community, and setting. Finally, task four states the broad programme goals.

5.2.2.1 Task 1.1: Establish the planning group

The planning group are representatives of the target population- children, environmental agents and programme implementers- teachers, members of school senior leadership teams, parents, and PA and MC researchers.

Table 5.1 Intervention mapping planning group

Key Stakeholders
Teacher
Children
Parents
Researchers
Senior leadership in schools
Others to consider in further IM iteration
Local authority, Community coaches

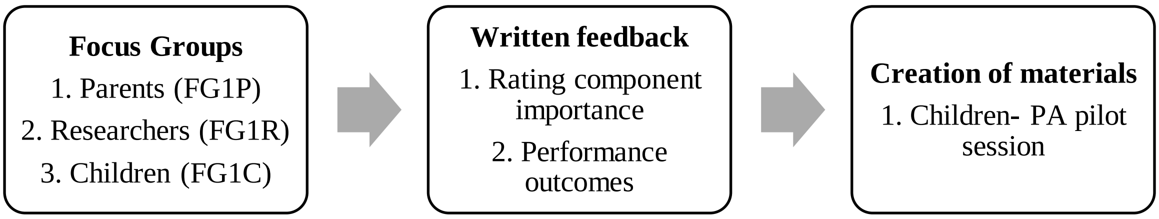
Participants of the planning group were recruited through word of mouth, social media, contacts from previous research studies, and outreach via email by the lead researcher, and where necessary gatekeeper approval to work with children in school settings was gained. Generally, the planning group were considered to be trustworthy and knowledgeable in the subject matter and, in some cases, had previous experience working with the lead researcher of the project. Children who participated in this study were recruited from two schools in the Central area of England. In reflecting critical mass and representativeness, a discussion took place in the research group to establish the appropriate sample numbers for this study. As a preliminary and small-scale mapping process, it was concluded that samples should be representative, and therefore, for every SLT member there should be 3-4 EYFS teachers (represented in Chapter 3), and for each EYFS teacher there should be around 10 children. The parents of the children recruited were also invited to participate in addition to parents who expressed an interest through social media or word of mouth. The invited researchers of the planning group on this project were invited by the lead researcher to participate and had pre-established connections through institutional relationships or networking at conferences.

Participants were provided with a participant information sheet and given the opportunity to contact the lead researcher and ask any questions they had about the research project before consenting to the participation. With the child participants, consent was first gained from the school headteacher and subsequently parents were asked to consent to their child's participation within the study. Verbal consent was also gained from the children at each visit.

All consenting participants completed the initial focus group (100%), the drop-out rate for each stage e.g. for the written feedback is detailed in each section/step.

5.2.2.1.1 Planning group protocol and involvement

Figure 5.2. shows the steps that the planning group were involved in during the IM process. As the focus groups were used to explore and complete tasks in steps 1-6, these will be explained in step 1. The following involvement of the planning group will be discussed in the appropriate steps. The researcher felt it was important to engage with the stakeholders in multiple ways to ensure all views could be expressed by both the group and as individuals. This method also helped to reduce participant burden, by splitting participation into smaller activities. At points where the lead researcher felt unsure or required further information, the planning group were contacted via email and or phone call. Further to this, the lead researcher held regular discussions with all members of the research team at each stage of the process to ensure reliable and valid research outcomes.



FG1P= focus group 1 parents, FC1R= focus group 1 researchers, FG1C= focus group 1 children

Figure 5.2. Planning group involvement flow chart

Three focus groups took place, and this followed a semi-structured approach using a proposed schedule of questions covering areas for step 1-6, the researcher's main aim was to facilitate discussion between members of the planning group and establish the key and prominent themes being consistently discussed by the members. The focus groups were recorded and transcribed verbatim. Focus group discussion follows a constructionist research paradigm which argues that there are multiple realities that create a social reality. This is especially true of this study due to the number of stakeholders involved and how they each view early childhood PA and practice.

Adult focus groups were split into two groups. Group one consisted of parents of 4–5-year-olds (FG1P). Group two consisted of PA and MC researchers (FG1R). The final sub-group of the planning group was comprised of children aged 4-5 years of age (FG1C). Although key to the planning group, specific focus groups were not held with teachers, coaches, and school senior leadership members, this was deemed appropriate as Chapter 3 collected a wealth of information from these key stakeholders. All focus group schedules and approaches were discussed as a research team to ensure the appropriate depth of information for each step/task of the IM was covered. Where focus groups did not seem appropriate to the context, other means including written feedback sheets were administered reflecting the pragmatic and reflexive approach in IM.

Traditional and formal focus groups were deemed unsuitable for young children, therefore, during their focus group discussion, children were asked to complete a ‘write, draw, show and tell’ task (Noonan et al., 2016). Children were asked to write or draw about a specific time or question relating to the IM process. For example, to inform step one children were asked to ‘write or draw about what you enjoy about PE’. Following the drawing and/or writing the children were asked to show the rest of the group their work and tell them about what they had produced. During this stage the children were further prompted by the researcher or the children’s class teacher to give as full answers as possible. This method helped to better facilitate the expression of young children’s feelings and ideas, especially during early childhood where speech is still rapidly developing (Wildová & Kropáčková, 2015). The pieces of work the children produced were photographed and assigned a participant code.

5.2.2.2 Task 1.2: Needs assessment and logic model of the problem

Within the second task of step one, a needs assessment of the literature and existing knowledge was conducted. The aim of the needs assessment was to establish the problem, who’s problem it is and who the problem was affecting, what behaviours and environmental conditions are causing or are related to the problem, and the determinants of these behaviours and environment (Table 5.2). Firstly, the problem was stated:

Problem: children are not sufficiently competent at FMS in the early years. This negatively affects their levels of PA, quality of PA and opportunity of PA social interactions, this leads to unhealthy PA habits developing, causing poor health such as obesity.

Table 5.2: Task 1.2: Key Questions

Problem	Low FMS competency in the early years
Whose problem is it?	Children, parents, teachers, school senior leadership, community provision, government
Who is the problem affecting?	Young children
What behaviours are causing or are related to the problem?	Sedentary lifestyles, poor quality PA, lack of planning and training, lack of knowledge and time to enhance this
The environmental conditions causing or related to the problem	Reduced outdoor space, poor PA facilities, incorrect use of resources, lack of time for PA, lack of training for teachers
Determinants of these behaviours and environment	Underfunding in communities and schools, poverty, lack of practitioner knowledge of FMS, cultural norms associated with PA.

FMS= fundamental movement skills, PA=physical activity

The planning group was consulted via a focus group discussion about their thoughts and ideas for areas that had been missed, overlooked, or that should be added into the needs assessment, via questions under step one and two questions- establishing the problem and context, of the focus group schedules. Each focus group schedule can be found in the appendices (Appendix 5.1). A summary of themes and comments made in the focus groups relating to step one can be found in Table 5.3. This table also provides key comments and quotes from the interviews undertaken in Chapter 3 to support step one.

Following the focus group discussion and answering of questions appropriate to step one, a final logic model of the problem (Figure 5.3) was created, this model helps to summarise the sequence used and information established in task 1.2. The logic model of the problem not only shows the personal determinants that Children face (Phase 4), but also the personal determinants key environmental agents (teachers etc.) face (Phase 4). These determinants contribute to the environmental conditions that impact on the PA/FMS behaviour of children (Phase 3) which contributes to health problems (Phase 2) and quality of life (Phase 1).

Table 5.3 Planning group Focus group themes and comments Step 1

Step one areas	Researchers' themes and quotes	Parents themes and quotes	Teachers', coaches, SLT themes and quotes
Who's problem is it?		Family and parents, school	Headteachers, teachers ('It depends on confidence'), families
Who is the Problem affecting?	'Children are arriving at school inactive'		'Obesity is um, a ridiculously growing problem in this country'
Individual behaviours causing the problem	Children are inactive at home Children are not developing their motor skills	Culture and mentality 'kids aren't as bothered' about PA High screen time and use of technology	Use of technology 'sit and look into iPads and Xboxes' 'Children having more access to, to, tablets, computers, culturally things have changed in terms of playing outside'
Environment conditions causing the problem	Teachers/staff 'undertrained' and 'not enthusiastic' Individual 'school level won't create change' in the whole system Previous Intervention 'too prescriptive'	Restriction of free play Pick up and drop off culture Lack of facilities for PA and 'things not being open' 'School provision [for PA] isn't great'	'I think if the school's got good resources… and we had funding' 'Play led but not enough specific skills' families: 'they won't do anything that upsets their child' 'There isn't really much emphasis on like developing skills'
Determinants of these behaviours	'Self-efficacy for the children would be to have a go at a new skill' Deprivation Low confidence and self-efficacy of teachers School philosophy	Education of parents and lack of confidence- 'be careful' culture Having other children to play with Money and deprivation 'after school clubs aren't free anymore'	'[Children] don't have that opportunity at home because their parents, they can't afford to take them to do extra-curricular things' 'I don't believe that there's adequate PE time'
Social assets	Family, schools can create 'awareness'	Football and multicurricular clubs 'Play with peers and older siblings'	
Information assets	Teachers could be if 'enthusiastic'	Word of mouth- 'other parents'	Teachers- depends on confidence levels 'A really good resource and you can dip into it and out'
Policy Assets	National governing bodies Change needs to come from 'policy level to get widespread effects and there needs to be an incentive to be involved'	'Schools can vary quite dramatically in their provision, time and access to PA'	'A huge culture shift I think to overcome some of that'
Environment Assets	Schools are 'equitable and accessible to all children'	Active transport to school Free play outside 'in good weather' PE 'part of the school day'	'More active lessons, much more standing up and moving round and talking to other people' 'To be outside and to be doing things outside'

PA= physical activity, PE=Physical education

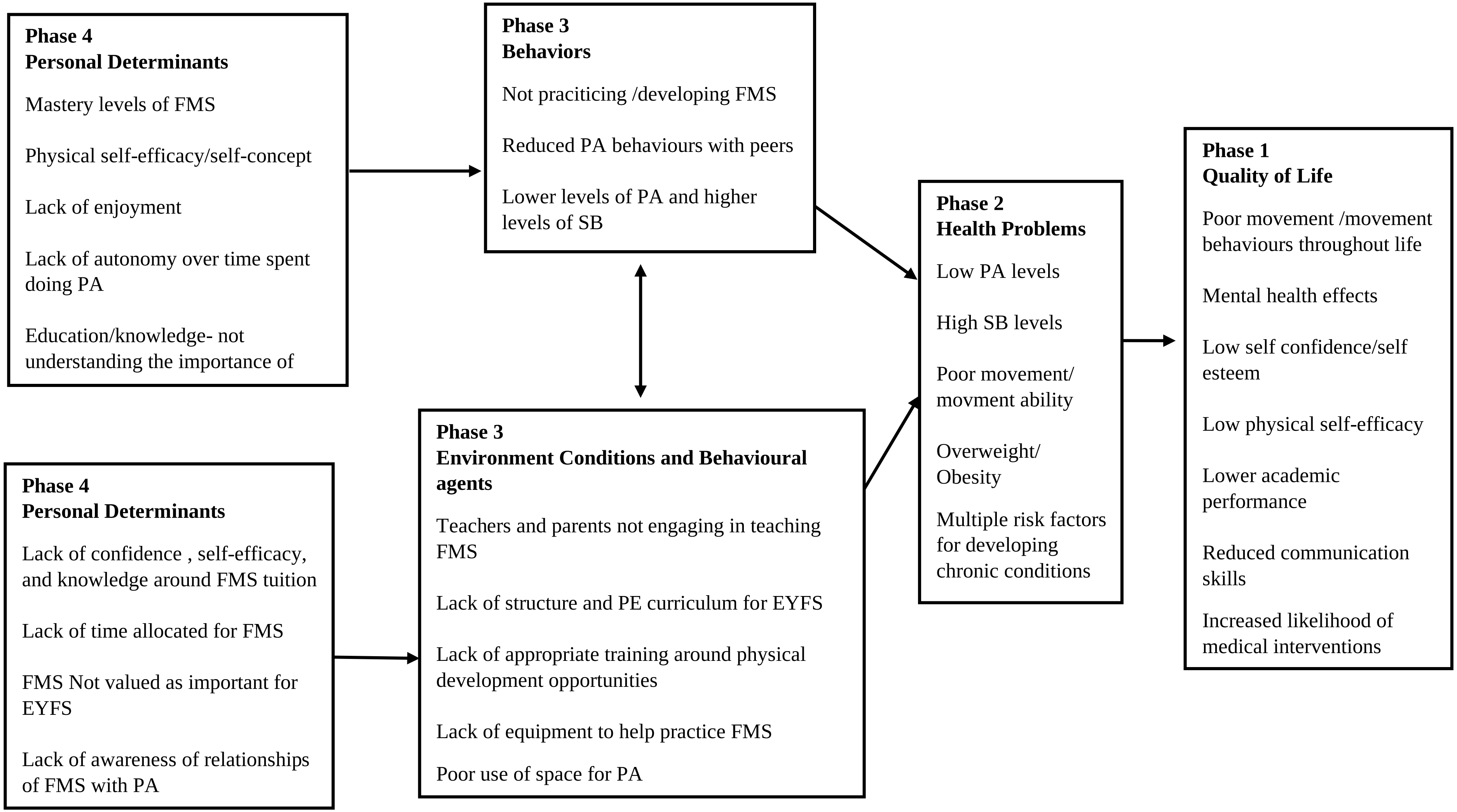


Figure 5.3 Task 1.2: Logic Model of the Problem

FMS=fundamental movement skills, PA= physical activity, SB= sedentary behaviour, PE= physical education, EYFS= early years foundation stage

5.2.2.3 Task 1.3: Programme context, population, community, and setting

The planning group was key in describing the context and setting of the interventions, as well as key population characteristics and needs. The information provided during the focus groups, expressed in chapter 3, researcher knowledge, and published literature allowed an asset assessment to be undertaken (Table 5.4). Establishing the social, information, policy/practice and physical environments to aid the success of a sustainable intervention were stated. Although each element of the asset assessment presented four areas to target, one was chosen from each element for this programme of research: Social: Primary schools, Information: School Newsletters/bulletins, policy/practice: teacher training for early years (school level during this intervention), physical environment: school spaces. It is recognised that all areas of each element of the asset assessment should be considered as critical and the iterative process of IM would allow for future development of each area. For example, Parent groups may use word of mouth about an intervention that is influenced by the CMO for the early year's guidelines taking place in a local leisure centre. It is important that the linked-up approaches of interventions within a programme consider each asset assessment element.

Table 5.4: Task 1.3 Asset assessment

Social environment asset assessment	**Information Environment Asset Assessment**	**Policy/Practice Environment Asset Assessment**	**Physical Environment Asset Assessment**
a. Primary schools **b.** Community sports groups **c.** Parent groups **d.** Youth groups/ after-school clubs	**a.** School Newsletters/bulletins **b.** Word of mouth **c.** Local authority communications **d.** Social media channels	**a.** EYFS framework **b.** PE curriculum **c.** CMO activity guidelines **d.** Teacher training for Early years	**a.** Schools spaces **b.** Local community spaces/parks **c.** Local sports teams/ leisure facilities **d.** Home environments

EYFS= early years foundation stage, CMO= chief medical officer, PE=physical education

5.2.2.4 Task 1.4: Broad Programme goals

The final task of Step 1 was to state the programme goals i.e., what does the programme hope to achieve. Using the logic model of the problem broad outcomes we aim to change through the implementation and maintenance of the intervention programme were stated:

1	Increase FMS competency of children in EYFS
2	Increase the quality of PA of children in EYFS
3	Improve the quality of FMS tuition/guidance

5.2.3 Step 2: Programme outcomes and objectives- the logic model of change

Step 2 is comprised of five tasks. Task one established the desired outcomes for changes in behaviour and the environment. Task two states the performance objectives for the behaviour and environmental outcomes. Task three lists and selects the most important determinants for the behaviour and environment outcomes. Task four creates the matrices of change, establishing change objectives for each determinant. In task five the logic models of change are formed and presented.

5.2.3.1 Task 2.1: expected outcomes for behaviour and the environment

Following the production of the logic model of the problem, expected behaviour and environmental outcomes for the programme of change could be stated. Programme outcomes are the desired changes to be made by implementing the programme, leading to the overall broader programme goals. By ‘doing the flip’ or moving from focussing on the problem to the solution, from the logic model of the problem and examining the behaviours causing poor health and health problems, several desirable behaviours which are health promoting were listed. Selection of the most important behaviours and environmental conditions were made. The decision of the most important outcomes was based on the literature and previous knowledge and findings of this PhD programme of study. These outcomes related to the problems and determinants identified in Step one. The desired outcomes for target population behaviours and environmental outcomes were stated.

Potential desired outcomes:

Behavioural:

- Increase the amount of time EYFS children engage in FMS practice at school
- Increase the amount of time EYFS children spend doing PA at home and at school
- Reduce the sedentary time of EYFS children at home and at school

Environmental:

- Increase the provision of FMS delivery by 25% at the EYFS in schools
- Increase the number of schools developing an EYFS PE curriculum
- Increase the number of teachers receiving PE and PA training

NICE (2014) recommend that brief advice is used in intervention outcomes, within this programme two main outcomes were stated and taken forwards in the next steps. Other behavioural and environmental outcomes could be chosen in future intervention iterations following evaluation processes:

Chosen desired outcomes for this intervention:

Behavioural: 1.0 Increase the number of EYFS children engaging in FMS practice at school
Environmental: 2.0 Increase the provision of FMS delivery by 20% at the EYFS in schools

The choice of engaging children in more FMS practice was identified as key. When the results of Chapter 4 are examined, the cohort of children were meeting the PA guidelines, but many children had low FMS competency. This made a clear case to focus on improving FMS over simply improving PA levels of the children. Secondly, improving the provision of FMS delivery in school has also been revealed as a key outcome. Although in Chapter 3 teachers felt as if there were enough PA opportunities in school, there was identification of a lack of support to implement FMS and some suggestion that the EYFS framework lacked guidance to provide the adequate provision.

5.2.3.2 Task 2.2: Performance Objectives for behaviour and the environment outcomes

To reach the desired programme outcomes, performance objectives for the population behaviours and their environment must be established, these should be measurable. These performance objectives are specific sub-behaviours for the children's health promoting behaviour, if the children are to perform more FMS practice, they must first engage in these sub-behaviours.

Performance Objectives for Behavioural outcomes:

1.1 Increase the % of children spending 10 % more time doing PA in school each week

1.2 Increase the % of structured and unstructured FMS related activities a child partakes in each week by 25 %

1.3 Increase the number of goals set for children's FMS and PA performance by 2 each term

These performance objectives are specific sub-environmental actions for teachers/senior leadership teams (SLT) to engage with to change the environmental conditions. If these changes are made, then schools should be prepared to deliver further FMS related activities in school.

Performance Objectives for Environmental outcomes

2.1 Increase the number of teachers facilitating FMS practice in EYFS settings

2.2 Increase the number of teachers planning for PE, PA, and FMS in schools

2.3 Increase the number of teachers aware of the benefits of providing EYFS children with PA opportunities

5.2.3.3 Task 2.3: Determinants for behaviour and the environment outcomes

Behaviours are formed by determinants of the individual, while environmental conditions are formed by the determinants within the environment which impact on people. These will determine if a child or teacher (environmental agent) will complete a performance objective (behaviour). These determinants identified for the performance objectives of this programme can be seen in Figures 5.4 and 5.5. These determinants need to be targeted to increase the likelihood of change for the individual and their environment.

Health promoting behaviour

1.0 Increase the number of EYFS children engaging in FMS practice at school

1.2 Increase the % of children spending 10 % more time doing PA in school each week

1.3 Increase the % of structured and unstructured FMS related activities a child partakes in each week by 25%

1.4 Increase the % of children setting two FMS and PA performance goals at school per term

Personal determinants

- Mastery level of FMS (skills)
- Self-efficacy and physical self-concept
- Perceived norms
- Knowledge
- Fitness levels
- Sedentary behaviour

Figure 5.4 Health promoting behaviour outcome, objectives, and determinants

Environment condition

2.0 Increase the provision of FMS delivery by 25% at the EYFS in schools

2.1 Increase the number of teachers facilitating FMS practice in EYFS settings

2.2 Increase the number of teachers planning for PE, PA, and FMS in schools

2.3 Increase the number of teachers aware of the benefits of providing EYFS children with PA opportunities

Environmental Determinants

- Knowledge
- Self-efficacy
- Social norms
- Parental beliefs
- Outcome expectations of setting
- Attitude: of school to PA, physical skills, and health

Figure 5.5 Environmental conditions outcome, objectives, and determinants

The most influential determinants were then selected from these lists according to how important they were and how changeable they are or could be with intervention. This was conducted by using three bodies of evidence, (i) research within this thesis, (ii) prior knowledge, in addition to (iii) the literature. For example, self-efficacy is largely reported as an important element of PA as children age (Peers et al., 2020). Therefore, it was deemed important to focus on within the development of this intervention. Levels of FMS competency have also been previously positively influenced through shorter term intervention (Logan et al., 2012a), therefore, we know FMS competency levels can change for children through intervention, although longer term effects have not been demonstrated as successfully. This gives scope for an intervention with a longer-term approach (e.g., over a whole school year) to be developed, keeping in mind the individual behaviour changes, while targeting environmental agent determinants to ensure better sustainability.

5.2.3.4 Task 2.4: Matrices of Change

Each determinant chosen in task 2.3 was crossed with a performance objective (Task 2.2) to create change objectives. Using this information, matrices of change objectives were constructed, this provides a system to bring all the tasks in step 2 into a consolidated place, or in this case a table, which is called a matrices, please see Table 5.5 and Table 5.6. To ensure the matrices and chosen objectives were relevant to the key stakeholders, the planning group were asked to review both the determinants and the proposed change objectives. A small written feedback task which included rating individual behavioural and environmental characteristics (determinants), in addition to perspectives on how achievable the change objectives were perceived to be was gathered (an example of the written feedback sheet can be found in Appendix 5.2). All adult participants (n=7) were contacted to provide written feedback and 71% (n=5) returned this information to the lead researcher. This feedback was used to confirm the choices made for the matrices.

Table 5.5 Matrices of change: Behavioural Outcome

Behavioural Outcome: 1.0 Increase the number of EYFS children engaging in FMS practice				
Performance objective	**Change Objectives for Personal Determinants**			
	Mastery Level of FMS	**Self-efficacy/physical self-concept**	**Perceived Norms and enjoyment**	**Knowledge**
PO.1.1 Increase the % of children spending 10% more time doing PA in school each week	**ML.1.1.** Children demonstrate greater mastery of FMS to use in PA in free play situations and environments	**SE.1.1.** Children demonstrate confidence when performing PA and chose multiple forms of PA	**PN.1.1.** Children enjoy and perform increased levels of total PA	**K1.1.** Children can describe an FMS based game learnt at school
PO.1.2 Increase the % of structured and unstructured FMS related activities a child partakes in by 25% each week	**ML.1.2.** Children demonstrate the FMS ability to participate in physical FMS games each week	**SE.1.2.** Children demonstrate confident use of skill within 2 or more game environments	**PN.1.2.** Children chose to participate in FMS based games/activities when offered during free choice play opportunities	**K.1.2.** Children know what different kinds of FMS are through physical and classroom-based activity
PO.1.3 Increase the % of children setting two FMS and PA performance goals at school per term	**ML.1.3.** Children can continue to master new FMS and PA goals set at school	**SE.1.3.** Children know how to begin to set their own goals e.g., catching a ball 3 times in a row	**PN.1.1.** Children are involved in setting individual goals with their parent/teachers for PA. E.g., walk or scooter to school once a week	**K.1.3.** Children know how to use feedback, can explain their FMS skills and goals set

FMS=fundamental movement skills, PA= physical activity

Table 5.6 Matrices of change: Environmental Outcome

2.0 Increase the provision of FMS delivery by 20% at the EYFS in schools					
Performance objective	**Change Objectives for Personal (environmental) Determinants**				
	Knowledge	**Social norms**	**Teacher self-efficacy**	**Parental Beliefs**	**Outcome expectations**
PO.2.1 Increase the number of teachers facilitating FMS practice in EYFS settings	**K.2.1.** Teachers know how to implement the provided training sessions and resources. Teachers demonstrate an increased knowledge for facilitating FMS practice in a school setting	**SN.2.1.** Teachers demonstrate that it is important their school community provides FMS practice. Their school provides environments for FMS practice	**TSE.2.1.** Teachers show increased self-confidence to lead sessions with an FMS focus, and know how to give sufficient positive and skill specific feedback, adapted to suit the ability of the child	**PB.2.1.** SLT and Teachers in schools can share information with parents about FMS and benefits behind the programme	**OE.2.1.** Teachers expect that providing better structure in existing and new PA opportunities, will improve children's PA and FMS
PO.2.2 Increase the number of teachers planning for PE, PA, and FMS in schools	**K.2.2.** Key agents (teachers and SLTs) know how to be equipped with materials and resources to improve planning, including an adaptable framework	**SN.2.2.** Teachers give FMS and PA equal status as academic subjects and highlight the PE premium use	**TSE.2.2**. Teacher can show evidence of planning for effective PA and saving time in the process	**PB.2.2.** School/ teachers share information of how PA and FMS can be improved in the home environment and prepare child for PE	**OE.2.2.** Teachers expect to use a framework and improve the quality of current PA by structuring more opportunities to improve PA/FMS
PO.2.3 Increase the number of teachers aware of the benefits of providing EYFS children with PA opportunities	**K.2.3.** Teachers can explain why PA for children is important for physical, mental, and social health, in addition to enhancing academic achievement	**SN.2.3.** Teachers can demonstrate the importance of a whole class targets and individual goals to perform a certain amount of PA per week	**TSE.2.3.** Teacher can explain effective ways to engage children in more PA outside of PE and assess their skills	**PB.2.3.** Teacher knows how to share information about the benefits of PA to parents	**OE.2.3.** Teachers expect to allocate more specific times to dedicated PA- twice a week in non-PE subjects

FMS=fundamental movement skills, PA= physical activity, PE= physical education, EYFS= early years foundation stage

5.2.3.5 Task 2.5: Logic Models of Change

Using the performance objectives and behavioural and environmental outcomes established in this step, the three logic models of change were proposed (Figure 5.6, 5.7, 5.8).

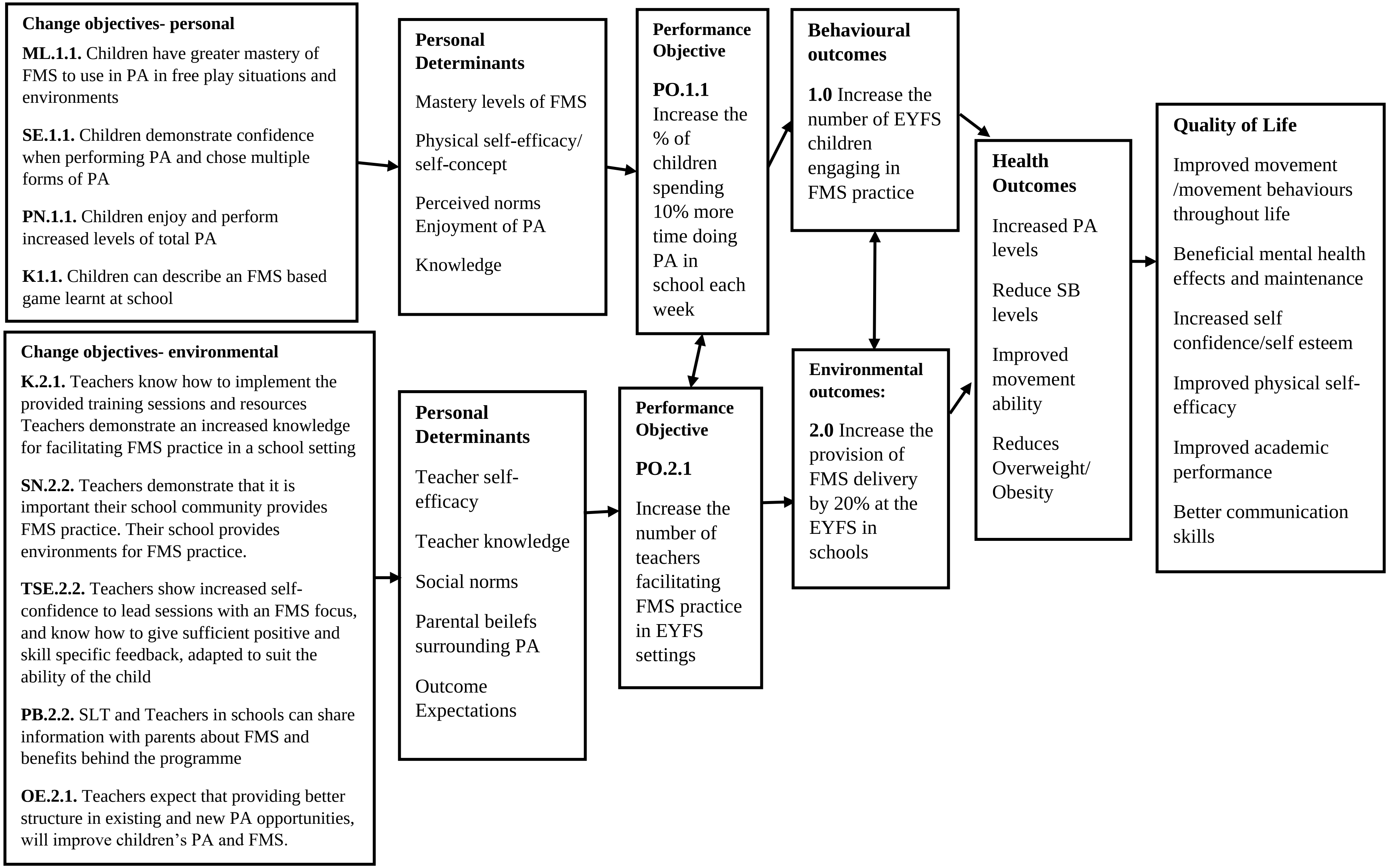


Figure 5.6. Logic model of change 1

FMS=fundamental movement skills, PA= physical activity, SB= sedentary behaviour, PE= physical education, EYFS= early years foundation stage, SLT= senior leadership team

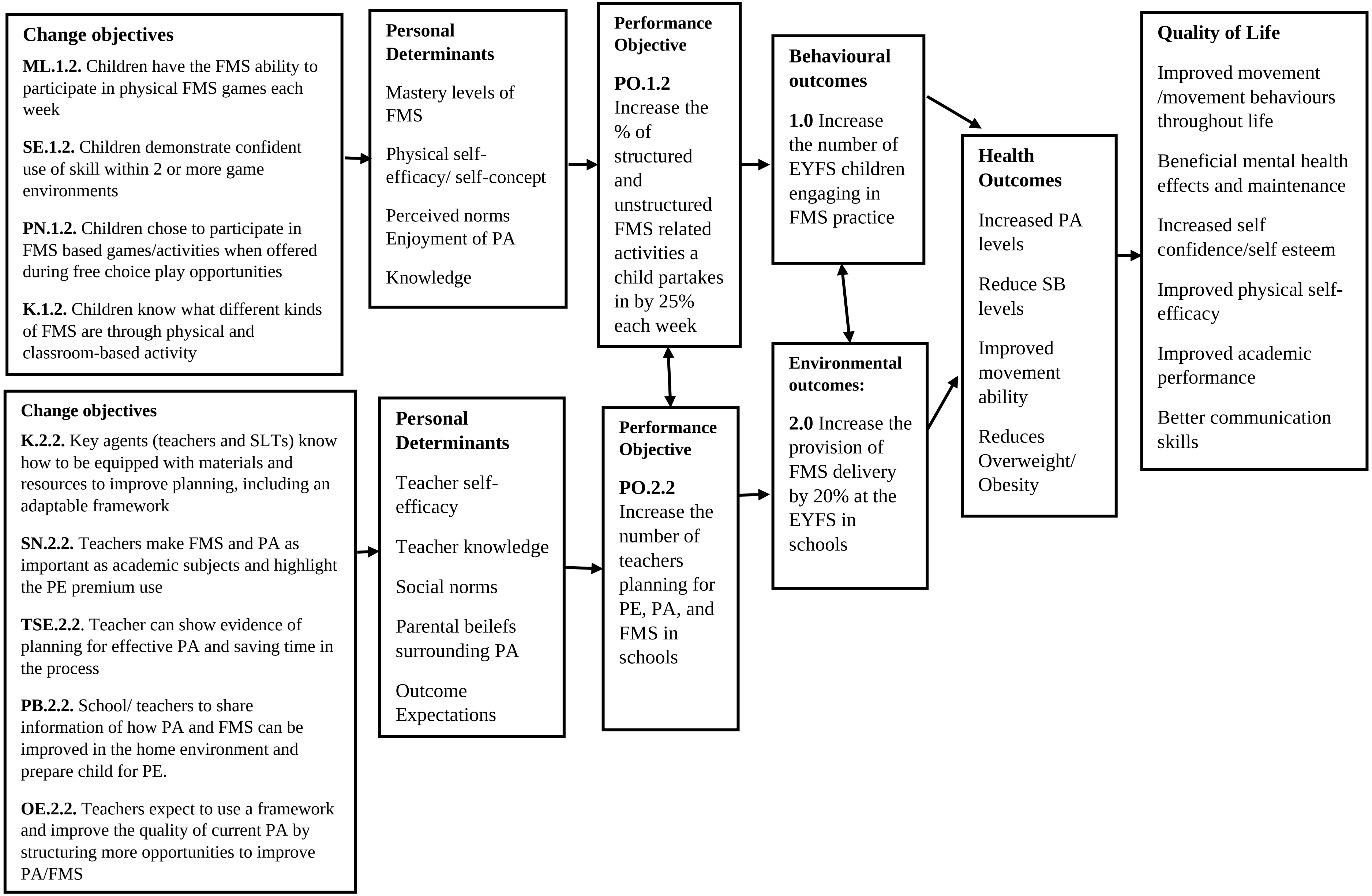


Figure 5.7. Logic model of change 2

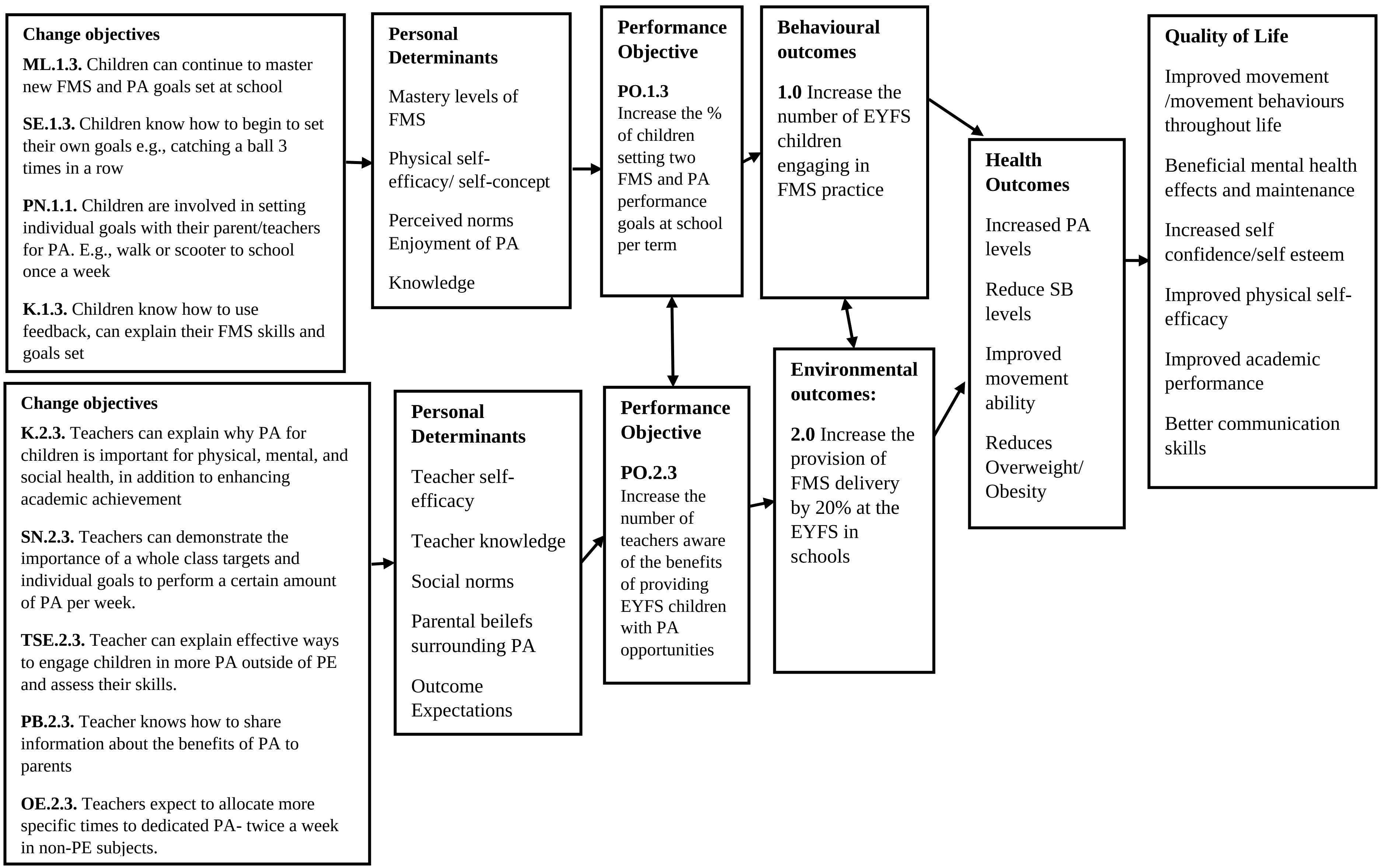


Figure 5.8 Logic model of change 3

5.2.4 Step 3: Programme design

Step three was comprised of three tasks. Task one generated the programme themes, components, scope, and sequence. Task two established the theory and evidence-based change methods of the programme. Task three applied practical applications to achieve change in the interventions.

5.2.4.1 Task 3.1: Programme themes, components, scope, and sequence

In this task, themes, components, scope, setting, and sequence of the programme of interventions were generated. These elements of IM rely on and require planning group and stakeholder input, as well as research knowledge created within this thesis and existing literature (what has and hasn't worked in the past) (Foulkes et al., 2017; Li et al., 2022; Wick et al., 2017). Within the initial focus groups (FG1P, FG1R and FG1C), the second section of discussion centred around the key elements of step three. Questions used included component and theme centred questions; 'what characters/books do you find engage children in learning', and 'When designing a multicomponent intervention, what is the maximum number of components you would suggest using'. The information from these focus groups and interviews in Chapter 3 were used to inform this step of IM and are shown in table 5.5. As established in step two, a change in both the children's behaviours, as well as their teacher as the environmental agent needs to be achieved in this programme. The following sections explain how the theme, components, scope, and sequence should achieve successful delivery of the programme.

The theme is a general organising construct for the programme, and it was decided this programme's theme should relate to the change objectives and intervention environment. This helped to establish a simple name of the programme, which made the components of the interventions recognisable. Through stakeholder engagement, additional themes that will engage the children involved were established as important, therefore, the framework that was made, was developed using suggestions of themes for activities with children to inspire their engagement.

Whole programme theme:
Early years foundation stage fundamental movement skills in school
Programme name:
The FMS School Project
Sub themes:
Framework- animals, superheroes, book characters (see Table 5.7)

Figure 5.9 Programme themes

The components are what make up the body of the intervention and therefore must be strongly related to the performance and change objectives identified in Step two. This programme was made up of two main components/interventions which are related to one another and will be discussed in further detail in Step four but are also listed below. The chosen methods and practical applications involved within each component of the intervention are detailed in Task 3.3. A framework of intervention, which describes and guides teachers to improve children's FMS with autonomy of intervention structure and implementation design, was chosen over an intervention of strict set session deliveries for teachers to follow. Within Chapter 3 educators mentioned the need for adaptability in delivery, a framework helps to demonstrate how sessions can work in the chosen setting but allow the flexibility of adaptation to individual classes and abilities. Chapter 4 provided evidence that children across a single class of 4–5-year-olds will likely need the adaptability that a framework intervention provides. Focus group sessions with researchers also highlighted the need for teachers to have ownership of the intervention to improve the possible success of its implementation, longevity, and sustainability.

Intervention components:

Intervention one:

Teacher training

- 3 sessions of training delivered by delivery partners
- Theory and practical elements of learning
- Evaluation of training

Intervention two:

Framework documentation:

- Information on FMS, PA, and health
- Physically active sessions- split by domain
- Classroom sessions
- Planning templates
- Homework ideas
- Promotion techniques in schools
- How to report on a child's FMS
- How to evaluate the intervention
- Parental packs and education

Figure 5.10 Intervention components
FMS=fundamental movement skills, PA= physical activity

Within IM the scope of the intervention must be realistic, to meet the goal of being sustainable for the implementers and maintainers, but also for use by the participants themselves. When previous literature is explored, it is common for school-based FMS interventions to last over a term (10 weeks) and to be delivered to children by an individual external to the school (researchers/coaches). Pedological literature continues to argue that delivery by teachers that work with children on a continued and regular basis is important for development of skills but also the relationships of children and teachers (Griggs, 2010). This method also helps to promote teacher education, knowledge, and self-efficacy. It was therefore important to this programme of interventions to ensure the delivery of intervention two was by teachers. The scope of this intervention could be considered in two different ways, the delivery of the intervention to teachers (training) and the delivery of the intervention by teachers within schools (framework). The scope considers who delivers the intervention, how it is delivered, the setting of delivery, how long for, and the evaluation of its elements.

Scope of programme deliver by delivery partners to teachers:

- Delivered across 3x2 hour sessions
- Made up of theory elements and active practical elements
- Supports the framework documentation
- Evaluation of training delivery

Scope of programme delivered by teachers in the school setting:

- Delivered across a whole school year of EYFS aged 4-5 years old
- Daily activities incorporated
- Reports of child achievements within each school report/end of term
- Teacher evaluation of programme end of each school year
- Delivery of parent materials across three school terms

Figure 5.11 Programme Scope
EYFS= early years foundation stage

The sequence of the intervention relates to the order of how the components should be delivered, dependant on the evidence uncovered in Step 1. As previously mentioned, this intervention is made up of two key components, and one must be delivered before the other can occur: teacher training by delivery partners followed by a school-based framework implementation delivery by teachers at the EYFS, these would both require evaluation following their delivery, carried out by the implementer.

Figure 5.12 Sequence of programme delivery
EYFS= early years foundation stage

Table 5.7 Planning group Focus group themes and comments Step 3: Task 3.1

Step three areas	Researchers themes and quotes	Parents themes and quotes	Teachers, coaches, SLT themes and quotes	Children themes and ideas
Programme Themes	'Autonomous activity' 'Children enjoy having freedom and ownership of their experiences' Previously experienced: Gruffalo, acting out story books with movements	Dinosaurs, cars/trucks, superheroes, Bluey (many agreed Bluey was a good cartoon role model) 'Working together' 'We do lots of role play as a family'	'Progress in, in actually not just sport but in physical um, in physical life' '5-minute movements' 'Simple skills'	Superheroes, book characters, cartoons, movie characters (see table 5.8 for further detail)
Programme Components	Connection between the school and home environment Improving 'teacher self-efficacy' 'Hide in fun to improve other skills' such as numeracy	'Not instructional activity' Competitive elements such as 'racing' 'Progressing through levels' 'Physical activity homework, within their existing school framework' 'Education of teachers and head teachers'	'I think maybe an overarching overview, so where their skill development is, and like a progression of skills document' 'Having new ideas and thing put into like the frame[work]' 'Having focussed lessons, um, I think will see it improve'	Games based activities for children- 'parachute', 'shark game', 'tag football'
Programme Sequence	'Keeping it simple helps the buy in' 'Keeping a connection between the home and school environment'	'Do stuff they [children] know and has structure' 'I think it should sit within the school framework, slot into regular assessments'	'Giving them [children] opportunities to practice and then keep teaching them' 'The children get different opportunities throughout the week'	
Programme Scope and duration	'Daily activity helps to keep them involved' Create as an 'enrichment' activity for the children	School to manage the programme- and 'let the children be independent in the environment' App development- 'gamification' of elements	'If we can teach everyone at the same time its inclusive' 'The teachers and the heads want something concrete to be left behind' 'If you give them [teacher] a framework and scaffold and some structure, they'd be happy to carry it on' and 'You need to be doing it 3 or 4 times a week'	

5.2.4.2 Task 3.2: Theory and evidence-based change methods chosen

With the theme, components, scope, and sequence of the programme of intervention established, initial theory and evidence-based change methods that were well suited to the ideas generated in the focus groups, according to existing literature and the researcher's own knowledge were chosen to deliver the interventions and programme. Change methods are rooted in different behavioural theories and psychological principles and are defined as general processes for influencing change at individual and environmental levels and the determinants within these. Kok et al., (2016) has specifically developed a Taxonomy of Behaviour Change Methods for intervention mapping, to help to guide the decisions made within this task, which was to choose appropriate behaviour change theories to build the specific intervention applications from. The definitions and parameters provided help with framing the scope of each method and decision to whether it would fit well with the components, scope and sequence chosen in the prior task (Task 3.1). Change methods were split into categories to address different areas of the problem. Using basic methods to begin with was important to identify the broad ways to create change for a school-based intervention, these methods were matched with practical applications (Task 3.3). The chosen change methods are shown in Table 5.9 which also presents the practical applications chosen.

5.2.4.3 Task 3.3: Practical applications to achieve change in intervention

The final task of Step 3 was to choose and start to design practical applications to be used within the individual interventions of the programme based on the change methods chosen. These applications were practical techniques that operationalise the methods chosen in task 3.2. and must fit within the intervention group(s) and the context. Therefore, this task collated information previously provided by the planning group with in FG1P, FG1R, FG1C, Chapter 3 results, and the written feedback exercises (shown in Table 5.8; measurement of the programme, programme environments and creating awareness), the performance outcomes and change objectives with logic models of change (Step 2). If there were applications which were regularly suggested by the focus groups or appeared successful within the literature, they were considered within the programme of intervention context. For example, within Chapter 3 multiple educators mentioned the need for adaptability and to build from a ‘framework’ to provide teachers with structure, it was therefore deemed a possibly appropriate method. In Table 5.9 the basic methods of change and practical applications can be seen. Where the basic methods could sit within the framework and training delivery for teachers is stated, along with further/other applications. The adaptable framework and training were further developed by choosing specific methods to change knowledge, increase awareness, change behaviours and skills, via the specific applications within them as intervention elements. The population, context and parameters of each method were stated to show how implementation could occur within school settings. The more specific methods for each of the broader applications chosen can be seen in Table 5.10. These decisions were important for the preparation of the design of the programme which was developed in Step 4 of IM.

This section begins to introduce and think about the implementers, adopters, and maintainers of the programme of intervention. These key stakeholders must be considered to achieve appropriate design of the interventions, for example, who will deliver what, and at which level? Delivery partners, teachers, children, and parents are all mentioned in the tables below. Their explicit roles will be discussed further in Step 5.

Table 5.8 Planning group Focus group themes and comments Step 3: Task 3.3

Step three areas	Researchers themes and quotes	Parents themes and quotes	Teachers, coaches, SLT themes and quotes	Children themes and ideas
Measurement of the programme	Logbooks to examine children's physical literacy Teacher to report using 'formative feedback' 'Physical development judgements are part of the EYFS, so working it into that'	'Slot into the school framework' e.g., part of reports home '[child has] confidence to take part in a new sport (activity)' 'Education of teachers and head teachers' 'Evaluating the physical and holistic development'	'Sense of achievement for the children'…'a bit of aspiration, they're trying to beat their score' 'So, they could see progression in themselves, that they were able to do that' 'We do a thing called impact report… we do it overall as a year group' 'Regardless of if it's like scientific or if it's you can catch three times rather than two times by the end of the year'	Children stated in their focus groups that PE made them feel: 'happy', 'excited', that they were having 'fun', the programme must achieve this and should be evaluated by teachers
Programme Environments	'Outdoor environments for autonomous activity' 'Indoor and classroom active breaks' Vary the environment to allow adaptation for 'wet play situations'	'Free play environments' 'Leaving the house' outdoors and unfamiliar environments 'Social environments with their peers'	'Lots of access to outdoor play and to be able to run and to walk and to ride a bike and to ride tricycles' 'Open flow through the classroom area and out into the outdoor area'	Playing Outdoors Equipment- climbing frames, parachutes, balls, sandpits, hula hoops Indoors for climbing, dancing
Creating awareness	Highlight the benefits of the programme to the teachers- 'what they're judged on' e.g., improving school readiness of the children	Something 'that physically comes home in a pack, rather than online' (for parents) 'To get support to do it at home as PA homework'	'Somebody there to disseminate that knowledge and work with them [teachers]'	Non-PA based activities to increase children's awareness of FMS skills (see Table 5.11 for detail)

Table 5.9. Behaviour change and practical applications Step 3: Task 3.3 (basic methods)

Determinants of the Problem	Behaviour change methods	Parameters	Practical applications and how delivered
Individual			
The social norm is for children to be sedentary	Change the perceived norms: Belief selection Role modelling	Knowledge of children's existing beliefs are required and simple messaging for children Attention shown to role modelling, self-efficacy to be active/use skills	Promotion in school settings (posters, children's work on display), have active based lessons Role modelling by teachers to be active with the children and provide them with increased active opportunities
Children lack knowledge about their fundamental movement skills	Changes in knowledge: Active learning Individualisation	Time bounds of school and lesson time, information available to teachers Responds to each child's needs	Framework activities: FMS based and themed activities within school learning opportunities (practical and classroom based) STEP model
Children lack mastery to perform good FMS and increase their PA	Increase children's skills: Active learning Tailoring	Skills of teachers to improve child mastery, time in school Matching children's existing skill level	Framework activities: practical based activities and planned sessions (organisation) Teacher planned sessions using STEP
Children lack self-efficacy in their movement	Increase support and goal setting: Feedback	Needs to be individual to the child and specific to their skills	Teacher to work one-on-one with the children in class Set goals with children each term
Environmental			
Teachers lack self-efficacy and knowledge to teach and provide FMS in education setting	Increase teachers' skills: Active learning Changes in knowledge: Individualisation Feedback	Existing skills and knowledge, information available in training sessions Responding to each teachers needs Specific to the teacher and their school at a given time	Provide interactive training content for teachers to engage with (multiple sessions) Framework provides opportunity to personalise session delivery and to each teacher's skills Delivery partner to review progression with framework each term

Determinants of the Problem	Behaviour change methods	Parameters	Practical applications and how delivered
Parents lack of awareness to help children practice skills taught at school at home	Increase awareness: Persuasive communication Facilitation	Relevant messages to the parents and their children Surprise and repetition Identifying barriers to participation	Advertising the intervention happening in school. Send home progress in monthly newsletter. Use as homework tasks for children to do at home with their parents
School settings and environmental agents lack knowledge to provide FMS education at the EYFS and know how it links to PA	Changes in knowledge: Active learning Tailoring	Time available to provide new knowledge Matching to the culture of school and/or SES	Videos within training for teachers to use widely in school Train teachers to match the needs of children and school (number of children, skills of children etc.)
Teachers and schools feel it is the social norm not to be aware of FMS education and practice for EYFS children	Change the perceived norms: Belief selection	Knowledge of teacher's/school's existing beliefs of PA and FMS	Role modelling (delivery partners) Testimonials of other schools using the intervention successfully

FMS=fundamental movement skills, PA= physical activity, EYFS= early years foundation stage, STEP= space, task, equipment, people, SES= socio-economic status

Table 5.10 Detailed change methods and applications for programme of intervention, Step 3: Task 3.3

Broad practical application and basic change method	**Detailed change method**	**Detailed practical application**	**Population, context, parameters**
Framework and increasing skills (active learning)- children	Guided practice- repeating behaviours several times with feedback Setting graded tasks- increasing the difficulty of task as behaviour improves Stimulus control- adding more cues for healthier behaviours	Practical sessions delivery from the framework Using the STEP model to grade the tasks in PA session Adding more cues to be active within school day	Population: Children Context: In school PE lessons/active times Parameters: Different sessions can be planned from the framework, time available to deliver the sessions
Framework and increasing knowledge (active learning)- children	Using imagery: using artefacts with similar appearance to the subject Chunking- stimulus patterns to make parts of a movement a whole	Using images of skills within classroom-based activities or images children begin to associate with the skills (e.g., animals) Splitting skills down by component parts through the activities performed	Population: Children Context: In school classroom lessons Parameters: familiarity of the images/activity to the children
One to one with children and increasing support for self-efficacy	Goal setting- prompting planning to reach goal-directed behaviours Providing cues- consistent cues throughout sessions	Teacher's set goals with children- example goals within the framework Children are given opportunity to develop their own cues to use when performing skills	Population: Children Context: In school PE lessons/active times Parameters: Children best to develop their own cues for performance
Training and increasing skills (active learning)/increasing self-efficacy- teachers	Guided practice- repeating behaviours several times with feedback Mobilising social support- instrumental an emotional social support for teachers Planning coping responses- identifying barriers and ways to overcome them	Teachers rehearse using framework and gain feedback from delivery partner during and after delivery- using own self-evaluation Teachers identify barriers within their classes within training- formulate plans to overcome these	Population: Teachers Context: Training session and regular contact with delivery partner Parameters: how much support can a delivery partner give

Broad practical application and basic change method	**Detailed change method**	**Detailed practical application**	**Population, context, parameters**
Training and changes in knowledge- teachers	Advance organisers – presenting an overview of a material Discussion- encourage debate over a topic Using imagery: using artefacts with similar appearance to the subject	Present an overview of the framework within the training for the teachers (over 3 sessions) Hold discussion within training sessions to discuss ideas proposed Videos demonstrating how skills can be performed. Videos of activities with children	Population: Teachers (and children- imagery) Context: Training session Parameters: Length of training sessions, available resources, prior knowledge for discussions
Changing social norms of schools	Public commitment- pledging to engage in healthier behaviours Cultural similarity Provide contingent rewards- praising and encouraging behaviours	School publicly says they will be running programme through newsletters, school displays, within reports Using messages from other schools (preferably local) to show the success of a programme School openly praises healthier behaviours with rewards (more time to be active)	Population: Whole school community Context: Delivery in school Parameters: socio-cultural characteristics of specific schools, praise must only follow the specific behaviour
Parent packs and increasing awareness: persuasive communication	Consciousness raising- providing information and feedback Framing- gain-framing messages and the advantages of healthy changes	Homework tasks- provide information about school tasks and reports- feedback for parents to act on Use reports to demonstrate the benefits. Parent packs of information and benefits to child and family.	Population: Parents Context: actions performed at home Parameters: gain frames to e used rather than loss frames to use positive messages. Self-efficacy of parent and child to be considered

PA= physical activity, PE=physical education, EYFS= early years foundation stage, STEP= space, task, equipment, people.

5.2.5 Step 4: Programme production

In step 4, there were four tasks. Task one refines the programme's structure and organisation of interventions. Task two prepares the plans for programme materials, followed by task three which drafts the programme message, materials, and protocols. Task four intends to produce, pre-test and refine materials created in task three.

5.2.5.1 Task 4.1: Refine programme structure and organisation

Within step four, the aim is to produce an effective programme, by refining the structure and organisation of the theoretical change methods and applications that were proposed in step three. This step organised how these systems of change would be delivered within the programme itself and the chosen implementation environments. The application created at this stage described the theme, scope, sequence of delivery and delivery channels/vehicles of this programme. At the highest level, this programme has two main interventions: teacher training, and delivery of an adaptable framework for children. These interventions are made up of multiple constituent parts (applications) to achieve the programme goals, behavioural and environmental outcomes, performance objectives and change objectives that have already been established within the previous IM steps. The channels/system of delivery, who delivers each part, and how and when they are they delivered are integral to the organisation and structure of the programme. In Figures 5.13-5.16 below the two main interventions are detailed, this is followed by Figure 5.17, which demonstrates a more detailed structure and the organisation of the programme, demonstrating where specific change methods and materials should sit within the programme and application.

What (intervention): Teacher training sessions on FMS, PA, health, and Framework delivery
Who: delivery partners (facilitators) and teachers (target group/participants)
Where (setting): In school settings or local authority settings
When (sequence): Before, autumn/winter, spring, and summer term at school (in England) = x3 times per year
How much (scope): x3 training sessions per training block
How often (scope): x3 times per year

Figure 5.13 Programme organisation questions (environmental agent)

What (intervention): Adaptable framework delivery in schools
Who: teachers (facilitators) and children (target group)
Where (setting): In schools, in the EYFS
When (sequence): delivery of the framework across a whole school term
How much (scope): delivery of an intervention application at least 3 times per week
How often (scope): designed to be used for each term of school

Figure 5.14 Programme organisation questions (individual)

Further to the intervention considerations, are the channels of delivery and communication during the interventions. These are key for disseminating the information about the intervention and delivering it effectively, these communication channels may be interpersonal or mediated. The channels targeted for the two interventions are described in the following boxes.

Interpersonal:
Training intervention:
Dissemination: Delivery partner leader, lead the training (peer leaders).

Framework:
Awareness: teachers discussing with parents, health visitors to schools promoting the intervention, volunteer parents who have previously observed success in the programme.
Dissemination: teachers working with children, children working with peers, parents aiding children, volunteer parents.

Figure 5.15 Interpersonal delivery channels for programme

Mediated:
Training intervention:
Dissemination: Written print (framework document), videos of training, social media groups (network of teachers to discuss ideas), flip charts, media presentations, recorded training session archives.

Framework intervention:
Awareness: Using videos on social media (school) to promote the intervention. A website explaining the intervention to children and parents. School newsletters and displays within the school. Written information sent to parents. Texts/app messages sent from school to parents.
Dissemination: printed materials with information, videos for children to watch, a website showing activities done at school and ones for at home. Social media groups for parents to discuss their home activities.

Figure 5.16 Mediated delivery channels for programme

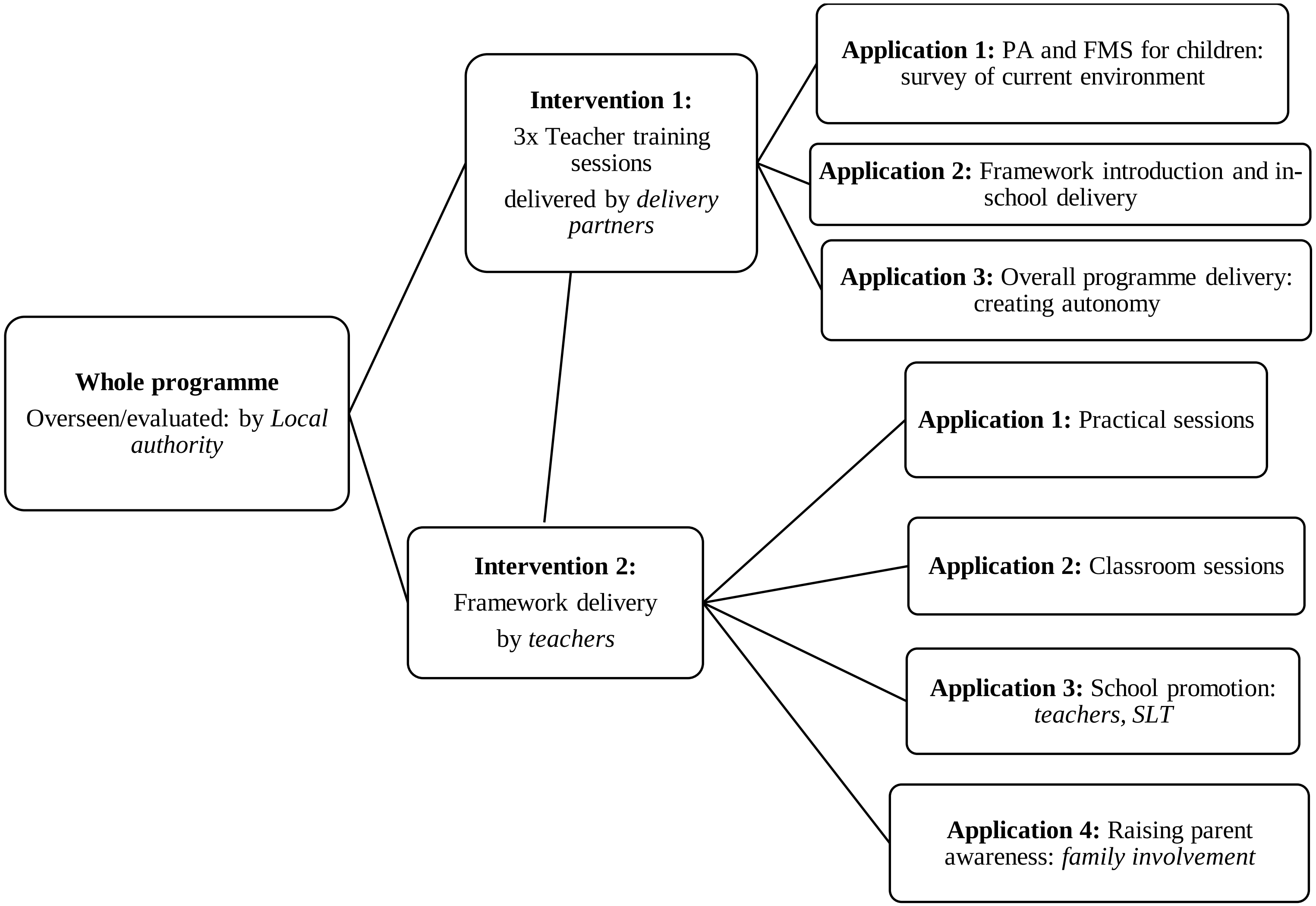


Figure 5.17 Task 4.1: Programme structure and organisation

FMS=fundamental movement skills, PA= physical activity, SLT= senior leadership team

5.2.5.2 Task 4.2: Prepare plans for programme materials

Using the information gathered in the prior IM steps and planning group input (Table 5.7 and 5.12), initial plans for the materials were produced. It is important to note that within this programme of study, specifications and working documents were not produced for all applications, as to be pragmatic in the approach and the restrictions of resources and time permitted for this programme of research. However, the planned description suggestions for these specifications were made and can be seen in Table 5.11. Full working documents were produced for: a framework booklet (FMS information practical sessions, ideas and for classroom sessions, evaluation, and assessment), 1 of 3x training session slides and 1x video. These will be further documented in the following sections and can be viewed in the appendices (Appendix 5.3 and 5.4). Other materials that would need to be drafted in the future include promotion videos of the intervention, local authority communications with schools, further parental communications, more in-depth classroom activity approaches, websites sharing information. Table 5.11 presents all the programme components, their descriptions, and the producers needed for these. Collaboration with other experts e.g., media producers and website creators would be essential in creating an intervention that would have sustainable and meaningful impact.

Table 5.11: Task 4.2 Programme material plans

Programme Component	Description	Producers	Drafted in this programme
Video of the intervention for schools	Video showing how the framework works in action. Images of the training and then teachers delivering in school settings. Feedback/testimony of previous experience of training by SLT and teachers.	Media experts (filming, production etc.)	No
Newsletter promotions	• Small snippets of information about the programme/intervention within school newsletters between staff to catch attention of other teachers/SLT. • Small snippets of information about the programme/intervention to demonstrate to parent's what schools are doing	Researcher to provide templates for schools to use in their own dissemination	No
Social media promotions	• Posts about the intervention programme posted regularly to intervention social media account to inspire teachers with weekly FMS planning with links to website to sign up to training. • Posts schools can use to promote the use of the programme in school.	Social media experts/graphic design	No
Websites about intervention	• Website with pages with the intervention resources for teachers to access. • Website with pages of engaging content for parents to use with children and to help with home activities	Website producers	No
Training sessions	Slides accompanied by verbal delivery from a delivery partner. Practical practice environments. Worksheets to complete during the sessions.	Researcher designs these materials/plans for delivery in partnership with group of delivery partners	Yes (1 session)
Framework booklet: Information about FMS	Section of booklet reiterating information delivered in the training for teachers, to refer to and strengthen their knowledge while delivering the programme/intervention.	Printing services, visual/graphic design	Yes
Framework booklet: Planning practical activities	A section split by FMS domains, providing activities lasting 5-15 minutes. All activities must have a STEP adaptation example, equipment needed, time taken, and outcomes from each activity. A planning section for teachers to plan the use of activities in extended PA/PE sessions. Homework activities for children to do. *STEP model, guided practice*	Printing services, visual/graphic design, activities designed by researchers	Yes
Framework booklet: Planning classroom activities	A section of examples of classroom-based activities that promote FMS or use stimulus to enhance children's learning. Suggested academic areas for activities. Homework activities. *Imagery and stimulus cues*	Printing services, visual/graphic design, activities designed by researchers	Yes

Programme Component	Description	Producers	Drafted in this programme
Framework booklet: Activity sheets	Training: sheets for teachers to complete related to the training content to help solidify learning and to make their own notes Framework: goal setting activity sheets for children to complete with their teacher each term to set goals about their FMS. *goals setting* Other activity sheets related to other curricular areas that will combine the knowledge of FMS for children (maths, English, art etc.)	Printing services, visual/graphic design, activities designed by researchers.	Yes (in framework)

FMS=fundamental movement skills, PA= physical activity, PE=Physical education, SLT= senior leadership team, STEP= space, task, equipment, people

5.2.5.3 Task 4.3: Draft message, materials, and protocols

Now that the components of the intervention have been established the plans to create the components were put into practice (and would be for the remaining elements in Table 5.11). Initially, the research team decided the overall message of the programme was to increase FMS and PA through structure and fun during the early years. This key message was strongly informed by the focus group sessions (FG1P, FG1R, FG1C) and Chapter 3, and was designed to engage the participants, implementers, adopters, and maintainers of the interventions. As the theme centred around improving FMS for EYFS children and the setting chosen was schools, the programme name was decided as 'The FMS Schools Project', the logo can be seen in Figure 5.18.

Figure 5.18 The FMS School Project logo

Using this central theme, materials, and protocols to support the practical applications chosen in step three and plans made in Task 4.2 were drafted. This included a framework booklet document (Appendix 5.3) and training sessions for teachers (Appendix 5.4). The booklet is a key material for both the training intervention and the delivery of the school intervention. It is divided into sections framing key intervention elements and written with teachers in mind by presenting the evidence from research and literature in a non-specialist and consumable way. Thinking about the different parts of this resources:

The first section helps teachers to strengthen their understanding FMS, PA, and health by introducing and reinforcing from the training what FMS are, by splitting visually into their domains (locomotor, object control and stability). This is further developed by acknowledging how FMS should be part of PE for children in the EYFS and linking back to health and academic outcomes for the children.

The second section of the booklet focusses on how to plan for FMS in school and how they can improve and promote it within the EYFS, as well as any key delivery methods. This information within these two sections compliments the first session of training which explores why FMS and PA are important for children's health, and how the school environment can help to improve these outcomes for children. This is achieved by first surveying the teacher's current school environment, and what they already do well, before exploring where improvements could be made.

The third section of the framework provides an array of practical activity suggestions, with many being informed by child preferences presented in FG1C (Table 5.12), the images produced within the child focus group to support these preferences can be seen in Figure 5.19. These practical sessions are split by specific FMS domains, locomotor, object control and stability. There are also sections that use a combination of skills and how to gain formative feedback from children. This is followed by a section on classroom-based activity suggestions. Throughout the focus groups (FG1R, FG1P) and Chapter 3, there was clear suggestion that activities should occur outside allotted physically active times. For example, linking another curricular area such as maths or literacy to FMS learning. Section 4 focusses on these opportunities by using techniques to increase stimulus and knowledge around FMS. These sections compliment session two of the training intervention which introduces teachers to how to use the framework activities in school as well as their own knowledge and ideas to implement better FMS.

Section five provided information to help teachers to prepare to help children set goals and to subsequently assess their improvements in FMS and PA as a whole group of children and individually. These sections were strongly informed by the voice of the parent (FG1P) and researchers (FG1R), who commented on the need for assessment to be implemented into the existing school reporting framework. Finally, section 6 laid out ideas for setting homework tasks for children with the consideration of the home environment. This section also detailed how to engage parents in aiding the success of the programme. Chapter 3 highlighted the differences in home environments, especially those of deprivation and the need for activities to be on a small scale with none or limited equipment use. This section ensured to focus on these elements so it can be achieved by all children. These two sections supported the delivery of the final session of training which focussed on overall delivery of the programme, the measures for success and how to create ‘homework’ for children and parents. The remaining materials from Table 5.11 would also be produced around the central theme to ensure continuity across materials and ‘branding’

Table 5.12 Task 4.3: Focus group themes and answers

Programme design area	**Child FG answers**	**Other FG suggestion**
Equipment	Parachutes, balls, sand pit, climbing frames, hula hoops, rackets	
Environments	Outdoors, classroom/hall spaces	‘Independent environments’, ‘getting outside’
Types of activities	Building, ‘playing with my friends’, ‘making up my own games’, games with easy-to-understand rules, dancing, football, climbing, running	‘Making things up, using their imagination’ ‘jumping off things, climbing up stuff’, games- ‘racing each other’, ‘acting out a story’, ‘education hiding in fun’,
Themes of games/activities	‘Shark game’, Dinosaurs, Zog, Thomas the Tank Engine, Spiderman, Supergirl, Superman, Paw Patrol, Rapunzel, Harry Potter,	Superheroes, role play, ‘family involvement’
Non-physical activities	Reading, literacy, doing puzzles, ‘new things’	‘Use of an app’, ‘classroom active breaks’

Figure 5.19 Drawings produced by children in FG1C about their favourite part of physical education

5.2.5.4 Task 4.4: Produce, pre-test and refine materials

The materials drafted in Task 3.4 were then produced as pretotypes for this programme of study (Appendix 5.3 and 5.4). This approach was chosen due to the time and funding constraints, which did not allow for the engagement with the required experts to produce the complete intervention materials. At a full-scale IM level, all materials from Table 5.11 (Task 4.2) would be produced, including media promotions and parent packs, and could be subsequently developed post PhD.

Once these materials have been produced, they should be pre-tested with the target population of the interventions (teachers and children) and the results of these pre-tests evaluated. Pre-testing should include the involvement of the planning group, particularly the intervention end users/participants; children, and those delivering it; teachers or parents. Testing of the structure and organisation of the programme (Figure 5.17) and individual applications and components of the interventions would enable any issues or ineffective elements to be identified and the most effective protocol and materials to be established. This refinement of materials relies on using the feedback from the planning group members. These feedback opportunities allow identification of existing strengths and weaknesses, using simple questions such as ‘does this method interest you?’, ‘would this protocol/delivery suit your setting?’, in addition to embracing stakeholder involvement and ownership of the programme. Within these testing periods, it is also key to observe the thoughts around sustainability of the interventions, such as the regularity of delivery, or the potential for other factors/determinants within the environment to disrupt this. Table 5.13 shows the pre-test plan created for all the planned materials from Table 5.11.

In this programme of study, there was scope to pre-test one element of the intervention materials with the planning group. Using section 3 from the Framework booklet a prospective session was planned, using several of the activities presented in the booklet (Appendix 5.3), this was pre-tested with two classes of EYFS children from the planning group. Class teachers were also invited to be part of the session. As part of intervention refinement, children were asked to provide formative feedback, the session leader asked the children if the session was ‘really good fun’, ‘okay fun’, ‘not so fun’. Across the two classes 67% of the children found the trial session ‘really good fun’ while 10% said it was ‘okay fun’, the remaining 23% said it was ‘not so fun’. The children were then asked what would have made the session better or what they really enjoyed. A lot of children commented on the use of equipment as fun, while other children wanted to play more sports-based games to make the session more exciting and structured. Teachers provided comments throughout the session to the session leader with a clear theme being that the session would work for some children, but other children require more rules and structure to their activity. Using this formative feedback from the children and teachers in the session, further refinement of material, such as the content of the framework activities or training session intervention with teachers were made. The remaining materials drafted and produced in Task 4.3 were not pre-tested in this programme of research due to time and resource constraints, but again this opens the opportunity for future research and intervention development post PhD.

Feedback from the planning group may be as simple as asking questions at the end of delivery of an application, or as complex as further focus group discussions. Pivotal to the decision is the availability and commitment of the planning group, participation burden should be minimised.

Therefore, evaluation methods should be well designed to fit within the pre-test delivery, rather than a standalone element.

Table 5.13 Task 4.4: Pre-test plan

Programme Application/component	**Pre-test objectives**	**Pre-test population**	**Pre-test procedure**
Video advertising the intervention for schools	Improve awareness of FMS for teachers within training and to refer to within the framework	SLT and teachers	Send link of video to watch and provide feedback on (used in training)
Newsletter promotions	Teachers know how to share information about the FMS programme with parents Teacher can share class targets with whole school and demonstrate a community for FMS practice at school.	Teachers and parents	Provide teachers with template newsletter excerpts, ask them to report the ease of editing and the interest reported by parents and staff when shared
Social media promotions	SLT and teachers can easily share information with parents about PA and FMS at home, and the benefits of the programme	SLT, Teachers and parents	Schools share the social media posts with parents (on school Facebook/apps). Parents are then asked if they have heard about the intervention (to measure effectiveness)
Websites about intervention	Key agents (teachers and SLT) are equipped with materials and resources to deliver the framework	SLT, Teachers	Teachers and SLT are asked to navigate the websites and the ease of finding materials and information they wanted/needed
Training sessions	Teachers know how to implement the framework within their school setting Teachers have increased knowledge of FMS	Teachers	Conduct pilot sessions of the training with a group of EYFS teachers, with feedback opportunities of the training content
Framework booklet: Information about FMS	Teachers can explain why PA is important for child health and academic achievement	Teachers	Provide teachers who are trained in the pilot sessions with the booklet
Framework booklet: Planning practical activities	Teachers have increased self-confidence to lead FMS sessions, with skill specific adaptations Teacher can plan effectively for FMS Children engage in the FMS activities to improve their mastery and demonstrate higher confidence in their FMS.	Teachers and children	Provide teachers who are trained in the pilot sessions with the booklet. Ask them to plan 2 practical sessions from the booklet to do with their classes. Feedback on the ease of use to plan teacher sessions. Children can give formative feedback at the end of the sessions (if they enjoyed them, if they were fun etc.)
Framework booklet: Planning classroom activities	Teachers can use framework to allocate more FMS based activities to improve PA/FMS Teachers make FMS and PA as important as other academic subjects Children know about different kinds of FMS and can describe an FMS game from school	Teachers and children	Provide teachers who are trained in the pilot sessions with the booklet. Teachers can plan to use classroom activities twice a week with their classes and feedback on the success in other curriculum areas. Children are tasked with homework tasks to do a game/activity at home with their parents to show what they have learnt/understood from the programme.

Programme Application/component	Pre-test objectives	Pre-test population	Pre-test procedure
Parent packs/information	SLT and teachers can easily share information with parents about PA and FMS at home.	SLT, Teachers and parents	Teachers are asked to share the information packs with parents when homework is set for the children. Parents are asked if the information helped them to complete the homework with their children (Likert scale e.g., helped a lot, somewhat helped, did not help nor hinder, did not help, very unhelpful)
Framework booklet: Activity sheets	Children are involved in setting PA and FMS goals and can begin to set their own goals Teacher can demonstrate the importance of FMS targets for children	Teachers and children	Provide teachers who are trained in the pilot sessions with the booklet. Teachers can plan to use the goal setting sheets with the children once a term. Feedback on the ease of use, suitability.

EYFS= early years foundation stage, PA= physical activity, SLT= senior leadership team, FMS= fundamental movement skills

5.2.6 Step 5: Programme implementation plan

Step five has four tasks. Task one is to identify the potential adopters of implementation for the programme. Task two states the outcomes and performance objectives for the programme use by the adoptees. Task three creates matrices of change objectives for use with the programme. Task four designs the implementation interventions to be used.

5.2.6.1 Task 5.1: Identify potential adopters of implementation for the programme

Step five requires the key people and stakeholders for intervention success (effectiveness) to be identified. This process used the planning group's previous inputs and answers to questions at the initial focus groups (FG1P, FG1R, FG1C) and Chapter 3 interviews, to help in identifying three key groups of constituents, the implementers, adopters, and maintainers of the programme.

Implementers are considered those who will put the interventions within the programme into practice, in this case the teacher training and the framework intervention delivery. For interventions to be successfully adopted, they need to be specific to the groups/setting of adopters of the programme, such as schools, clubs, and local authorities. Finally, the implementers and adopters will work together to become maintainers of the programme of change, especially where positive changes are observed, leading to specified programme objectives and outcomes.

Within this programme, four key stakeholders were identified:

Implementers: Local authorities, delivery partners
Adopters: Teachers, School senior leadership teams (SLT)
Maintainers: Local authorities, delivery partners, teachers, School SLT

Stakeholders may not exclusively have a singular role in the intervention delivery, as can be seen from above. Local authorities must engage with schools and leadership teams to get them on board with the intervention, and then to train their staff to use the intervention/programme, thus, making them implementers. Consequently, they must have a method of dissemination of the training, this is via delivery partners. Delivery partners may have different roles in different local authorities but are likely to be public health staff, health visitors, or PA and sports-based professionals. Importantly it is not specified to who this would be and give authorities the freedom to choose, which may ultimately result in better sustainability. These delivery partners must ensure the maintenance of a relationship with a school and teacher of the training intervention. The adopters of the programme are those based within the school settings, hosting and delivering the programme. Teachers are the ‘frontline’ staff to this intervention, by delivering it to children, with aided support of their school SLT. These staff must be trained by the implementers. Finally, all roles come together to be the maintainers of the programme. A local authority must commit to keeping delivery partners available for the training of teachers. School SLT and teachers must commit to continuing to deliver the programme through future classes to help change social norms and beliefs, while increasing FMS mastery in EYFS children through the programme.

Considerations to the maintenance of a programme such as the funding for and higher-level policy, to ensure time and sufficient structure is in place to allow for the interventions are pivotal. Therefore, members of school SLT, local authority, and additionally national government should be considered as key maintainers of the programme and influence at later iterations of the IM process.

5.2.6.2 Task 5.2: State outcomes and performance objectives for the programme use

For the implementers, adopters, and maintainers, main outcomes were stated for the dissemination, implementation, adoption, and maintenance of the interventions. These outcomes were then split down into performance objectives, in a similar way to the tasks in Step two. These were also informed by questions used within the focus groups, with a focus on the sustainability of the programmes and their implementation. For example, parents were asked ‘Other than increasing children’s physical activity and physical skills, what other outcomes do you feel are essential to improve through the programme of interventions?’. The outcome and performance objectives are stated in Table 5.14.

Table 5.14 Outcomes and Performance objectives for programme use

Outcome for programme dissemination/implementer (Local authority)
3.0 Increase the number of delivery partners delivering The FMS School Project training
PO.3.1 Increase the number of schools receiving The FMS School Project information
PO.3.2 Increase the number of local authorities using delivery partners for The FMS School Project training
PO.3.3 Increase the number of local authorities planning to use delivery partner for The FMS School Project training
Outcome for programme implementation and adoption (delivery partner)
4.0 Increase the number of schools delivering The FMS School Project framework
PO.4.1 Increase the number of schools receiving The FMS School Project training
PO.4.2 Increase the number of schools planning to receive The FMS School Project training
PO.4.3 Increase the number of schools interested in using The FMS School Project training
Outcome for programme maintenance (teachers and school SLT)
5.0 Increase the number of Schools using The FMS School Project framework for more than one school year
PO.5.1 Increase the number of teachers evaluating The FMS School Project framework at the EYFS
PO.5.2 Increase the number of SLTs granting the appropriate funds for The FMS School Project
PO.5.3 Increase the number of schools providing the appropriate time for The FMS School Project framework
Outcome for programme maintenance (local authority and delivery partners)
6.0 Increase the number of delivery partners delivering The FMS School Project training for more than one school year
PO.6.1 Increase the number of delivery partners/local authorities evaluating The FMS School Project training
PO.6.2 Increase the number of local authorities granting the appropriate funds for The FMS School Project training delivery
PO.6.3 Increase the number of local authorities providing the appropriate time for The FMS School Project training

FMS= fundamental movement skills, SLT= senior leadership team, EYFS= early years foundation stage

5.2.6.3 Task 5.3: Create matrices of change objective for the programme use

Using these outcomes and performance objectives for the programme, further matrices of change (as in step two) were produced (Table 5.15, 5.16, 5.17, 5.18) to provide the implementers, adopters, and maintainers, with change objectives to aim for, making the programme tangible, implementable, meaningful, and measurable, with the proposal for the assessment of these objectives was made within the evaluation plan in step six.

Table 5.15: Task 5.3: Matrices of change: Dissemination

3.0 Increase the number of delivery partners delivering The FMS School Project training			
Performance objectives for programme dissemination	**Change Objectives for Determinants**		
	Knowledge	**Skills and self-efficacy**	**Perceived Norms**
PO.3.1 Increase the number of schools receiving The FMS School Project information	**K.3.1.** Local authorities know how to disseminate information clearly and effectively about the programme and its components	**SSE.3.1.** Local authorities can confidently disseminate the benefits of the programme to schools in the local area	**PN.3.1.** Local authorities can explain that is its normal to keep in contact with schools about FMS education
PO.3.2 Increase the number of local authorities using delivery partners for The FMS School Project training	**K.3.2.** Local authorities know the scope, sequence, theme, and components of the programme	**SSE.3.2.** Local authorities show they can identify the correct delivery partners to provide the programme training in schools	**PN.3.2**. Local authorities can explain it is normal to use this kind of training in schools and for public health improvement
PO.3.3 Increase the number of local authorities planning to use delivery partner for The FMS School Project training	**K.3.3.** Local authorities know the benefits of using delivery partners for The FMS School Project training	**SSE.3.3.** Local authorities can plan to employ or identify existing employees as delivery partners	**PN.3.3.** Local authorities can explain that is expected that delivery partners are employed to deliver intervention training

FMS= fundamental movement skills

Table 5.16: Task 5.3: Matrices of change: implementation and adoption

4.0 Increase the number of schools delivering The FMS School Project framework			
Performance objectives for programme implementation and adoption	**Change Objectives for Determinants**		
	Knowledge	**Skills and self-efficacy**	**Perceived Norms**
PO.4.1 Increase the number of schools receiving The FMS School Project training	**K.4.1.** Delivery partners know how to explain the scope, sequence, theme, and components of the programme (training and framework) to teachers	**SSE.4.1.** Delivery partners demonstrate the ability to plan the training delivery and offer support to teachers and SLT in schools	**PN.4.1.** Delivery partners explain that good continued professional development and training of teachers is important for children's development
PO.4.2 Increase the number of schools planning to receive The FMS School Project training	**K.4.2.** Delivery partners can explain the training and framework of the programme	**SSE.4.2.** Delivery partners demonstrate how to disseminate training to teachers and SLT in schools	**PN.4.2**. Delivery partners explain good FMS of children at school is the result of sufficient continued professional development and knowledge
PO.4.3 Increase the number of schools interested in using The FMS School Project training	**K.3.3.** Delivery partners know how to communicate with schools and SLT about the programme delivery	**SSE.3.3.** Delivery partners can make a case for The FMS School Project training and framework	**PN.3.3.** Delivery partners explain that other schools have successfully implemented The FMS School Project

FMS= fundamental movement skills, SLT= senior leadership team

Table 5.17: Task 5.3: Matrices of change: maintenance

5.0 Increase the number of Schools using The FMS School Project framework for more than one school year			
Performance objectives for programme maintenance	**Change Objectives for Determinants**		
	Knowledge	**Skills and self-efficacy**	**Perceived Norms**
PO.5.1 Increase the number of teachers evaluating The FMS School Project framework at the EYFS	**K.5.1.** Teachers can explain the evaluation methods of the programme to identify success and areas of improvement	**SSE.5.1.** Teachers can demonstrate the ability to evaluate the programme over the whole year, including its individual component.	**PN.5.1.** Teachers can explain schools like ours are providing The FMS Schools Project framework to children at the EYFS
PO.5.2 Increase the number of SLTs granting the appropriate funds for The FMS School Project	**K.5.2.** SLT can explain how to use the PE primary funding for The FMS School Project	**SSE.5.2.** SLT can use the appropriate funding for equipment and the training of staff	**PN.5.2**. SLT can explain that successful FMS School Project programmes in their school are a result of the correct funding
PO.5.3 Increase the number of schools providing the appropriate time for The FMS School Project framework	**K.5.3.** SLTs and teachers can explain how to use time effectively for FMS development in EYFS children	**SSE.5.3.** SLT and teachers can use timetabling and planning in the school year for The FMS School Project	**PN.5.3.** SLT and teachers can explain that successful FMS programmes have sufficient time within the school year allotted to them

FMS= fundamental movement skills, SLT= senior leadership team, EYFS= early years foundation stage

Table 5.18: Task 5.3: Matrices of change: maintenance

6.0 Increase the number of delivery partners delivering The FMS School Project training for more than one school year			
Performance objectives for programme maintenance	**Change Objectives for Determinants**		
	Knowledge	**Skills and self-efficacy**	**Perceived Norms**
PO.6.1 Increase the number of delivery partners/local authorities evaluating The FMS School Project training	**K.6.1.** Delivery partners and local authorities can explain the evaluation methods of the programme to identify success and areas of improvement	**SSE.6.1.** Local authorities can demonstrate the ability to evaluate the training programme over the whole year	**PN.6.1.** Local authorities can explain areas like ours are providing The FMS Schools Project training to teachers
PO.6.2 Increase the number of local authorities granting the appropriate funds for The FMS School Project training delivery	**K.6.2.** Local authorities explain how to allot funding for employment of delivery partners for The FMS School Project training	**SSE.6.2.** Local authorities can use the appropriate funding for employment and training of delivery partner staff	**PN.6.2**. Local authorities can explain that successful FMS School Project programmes in their area are a result of the correct funding
PO.6.3 Increase the number of local authorities providing the appropriate time for The FMS School Project training	**K.6.3.** Local authorities can explain how to use time effectively for The FMS School Project training	**SSE.6.3.** Local authorities can allow delivery partners appropriate time to plan, prepare and deliver The FMS School Project training	**PN.6.3.** Local authorities can explain that successful FMS School Project training have sufficient time to train teachers in schools

FMS= fundamental movement skills

5.2.6.4 Task 5.4: Design implementation interventions

With the outcomes and performance objectives, and the adopters, implementers, and maintainers of the programme identified, the design of implementation interventions was decided upon. In Table 5.19 the change objectives of dissemination, adoption, implementation, and maintenance are supported by theoretical methods and practical applications. Further, it is important to consider the delivery channels used within these applications. The intervention delivery channels range from providing written communications to local authorities (LAs), to the advertisement of the intervention to potential school users through social media. As with the previous practical applications and components, the collaboration and engagement with experts would be important. Some of the maintenance objectives link closely the main training and framework interventions as discussed in section 5.2.5.3 (page 182). For example, a teacher must evaluate the programme at the end of the year to ensure that sustainable maintenance is achieved. Even though this action is a key part of maintenance, the information for the activities would be provided in the training and framework documentation seen in the two main interventions. Many of the theoretical methods suggested support the method of facilitation by providing local authorities and teachers with materials to help them achieve adoption, implementation, and maintenance.

Delivery channels

Mediated: Local authority communications with schools (monthly newsletters, meetings, conferences, emails). Using videos on social media to promote the intervention. A website explaining the intervention and how to sign up.

Interpersonal: Local authority communications with schools via health workers/visitors.

Table 5.19: Task 5.4: Implementation interventions

Change objectives	Theoretical methods	Intervention applications
Dissemination (of training) Disseminate information and benefits clearly about the programme to schools	Persuasive communication Tailoring Individualisation	Local authority communication with schools (visits). Advertisement on social media, videos, newsletters, websites.
LAs know the scope, sequence, themes, and components of the programme and which delivery partner in LA will be appropriate	Persuasive communication Tailoring	Written materials Website with information about intervention and for LA DPs to sign up
LA can employ delivery partners and explain why it is normal to use them for this kind of intervention	Persuasive communication Discussion	LA advertising to existing members of staff. Focus groups with staff to identify appropriate staff member roles
Adoption and implementation (of training) DPs know how to explain the scope, sequence, themes, and components of the programme to teachers and explain why it is good CPD	Persuasive communication Individualisation	Local authority communication with schools (visits). Advertisement on social media, videos, newsletters, emails
DPs can explain the training and framework of the programme	Advance organisers Active learning	Written training materials Practical training for DPs
DPs can communicate with schools and SLT and make a case about programme delivery and training	Modelling Discussion Persuasive communication Tailoring	Practical training for DPs Scenario practice (Communications as above)
Maintenance (of framework) Teachers can demonstrate the evaluation methods of the programme to identify success and areas of improvement	Participation Active learning Facilitation	Teacher uses evaluation materials provided in the framework Draft reports for SLT that teacher can populate with outcomes
SLTs can explain how to grant the appropriate funds for the intervention and equipment from the PE premium	Facilitation Advance organisers	Information for SLT about the use of funding and PE premium use for programme (by paper and on a website) DP visit school to help plan funds for delivery
SLT and teachers can explain and use time and timetabling effectively to allow for a whole school year of the FMS Schools project	Participation Persuasive communication Belief selection	SLT see the benefits of the programme within their schools DP visit school to help plan time for delivery

Change objectives	Theoretical methods	Intervention applications
Maintenance (of training) DP and LA know how to evaluate the delivery of the training programme	Participation Active learning Facilitation	DP/LA uses evaluation materials provided in the training Draft reports for LA to populate with outcomes LA see the benefits of the programme for schools
LA can allocate funding for employing DP and delivery of training	Participation Persuasive communication Individualisation	Guidance documents for LA on allocations of money for delivery of DP and training. Adjustments according to previous results (e.g., more or less funding)
LA can allow DPs appropriate time to plan, prepare and deliver successful training	Facilitation	Guidance documents for LA on allocations for DP planning and delivery time of training

DP=Delivery partner, LA=local authority, SLT= senior leadership team, CPD= continued professional development

5.2.7 Step 6: Programme evaluation plan

Finally, within step six, there are four tasks, and the aim was to produce a plan to evaluate the whole programme and the effectiveness of individual interventions. The purpose of the evaluation is to establish if the programme of interventions has had the desired effect on the target population(s) (teachers, and children), known as the effect evaluation. It is not only important to assess impact or effectiveness, but also important to include process evaluations, which examine how the intervention was implemented and adopted in the desired settings (schools). Process evaluation helps identify the key implementation characteristics and may help to uncover issues within the interventions, this may help answer why the desired effect on the population is or is not achieved.

5.2.7.1 Task 6.1: Effect and process and evaluation questions

Therefore, the first task of the evaluation plan is to write effect and process evaluation questions for the programme. These can be seen in the boxes below for each intervention (training and framework)

Effect questions

1. Has the programme improved children's physical self-efficacy and academic performance?
2. How much does the PA level and FMS mastery of the children completing the programme change from pre to post intervention?
3. What was the impact of the programme on teacher's knowledge and self-efficacy to teach and plan for FMS at the EYFS?
4. What was the impact on the children's knowledge and enjoyment of FMS?
5. What was the structure of FMS delivery like in the participating schools before the intervention?

Figure 5.20 evaluation effect questions

Process questions

1. What parts of the intervention worked well and why, what did not work as well and why regarding the implementation?
2. What element of the interventions have been sustained post-intervention?
3. What aided dissemination and adoption of the programme?
4. How often are teachers planning and using the framework in schools?
5. If schools have continued to use the programme, why?
6. Have the participants (children) enjoyed the delivery of the intervention in schools?

Figure 5.21 evaluation process questions

5.2.7.2 Task 6.2: Indicators and measures for assessment, Task 6.3: Evaluation methods, and Task 6.4: Evaluation execution

Once the effect and process questions had been established, identification of the indicators and measurements for these variables were chosen (Table 5.20 and 5.21). The choices for indicators and measurements of how to evaluate the programme/interventions were also informed by the focus group discussions (FG1P, FG1R, Chapter 3). Further, the planning group were asked to suggest important 'real-world' outcomes to the programme of interventions that effect both the user, implementers, and adopters (Table 5.20). Finally, the methods of evaluation were chosen (qualitative and quantitative) and the proposed plan for effect and process evaluations were created (Table 5.21 and 5.22). The plans were designed to be easy to follow and implement in the school settings, with the activity designed for participants (children), implementers, adopters, and maintainers (local authority and teachers) to complete. The process evaluation was guided by the REAIM framework (Glasgow et al., 1999; Chapter 1 section 1.1.6), which allowed evaluation in each of the following areas: Reach of interventions, effectiveness of the interventions, adoption of the interventions by the appropriate and targeted settings, implementation of the interventions, and the proposed maintenance of the intervention.

Based on the consultation, the literature and the researcher's own knowledge the chosen evaluation methods for this programme of interventions consist of:

- Card sort activities
- Surveys
- Interviews
- Observations
- Device based measures (accelerometery)

Each of these methods may capture more than one element of evaluation which can be observed in Tables 5.21 and 5.22. The card sort for the participant (child) process evaluation can be viewed in Figure 5.22. This card sort uses simple statements that children might make about the programme when it is run in their school setting. A child /group of children would have a discussion with a researcher/teacher about what card they think represents the best part about the intervention, a method similar to that used in the paediatric card sort (Berg & LaVesser, 2006), where a children indicates what they can and can't do from a set of visual cards. Other card sorting activities may use images of FMS and ask the children to name these (improving children’s knowledge). A teacher card sort can also be viewed in the Appendix (5.5), which also assesses the process of using the intervention within their school setting.

Table 5.20 Step 6: Planning group Focus group themes and comments

Step six areas	Researcher's themes and quotes	Parents themes and quotes	Teachers, coaches, SLT themes and quotes
Assessment methods	'The methods need to be fun and simple, especially for the children' 'Process evaluations and formative feedback' 'Logbooks- physical literacy tracking, self-reflection'	'Real-world success measured better using a qualitative questioning approach [for adults]' 'Offer children new opportunities and observe the uptake'	'For me to do it [the intervention] and get feedback [from a delivery partner]'
Reporting	'Schools can use the images from a children's write, draw, show and tell activity' 'Evidence of grants being used for the programme' Using tools that are being developed by researchers to be implemented in schools.	'Sit within the school's existing reporting framework' 'Should be integral and made compulsory' 'Schools reporting, they are using the programme to educate their staff'	'Having learning outcomes are a big one' 'a clear expectation of what resources would be required…depending on cost'
What should be assessed?	'How did the people using the intervention find it?' 'The enjoyment and development of the children using the programme' 'parent's expectations of the programme'	'The quality of the PE [framework sessions] being provided in school' 'Culture change within schools by the senior leadership team' 'children's confidence to take part in new sport'	'The longevity in it' 'PE is one of the lessons that teachers plan the least, so this should be assessed' 'We should also develop our practices [teachers]

PE= physical education

Table 5.21 Step 6: Programme evaluation plan- effect

Variables	Indicators and time frame	Methods and execution
Quality of life	1 school term:	
Physical self-efficacy	Rate physical self-efficacy higher	Questionnaire
Academic performance	Improved academic performance	Teacher assessment/observation
Health outcomes	1 school year:	
Better PA levels	Weekly PA increases	Accelerometry measurements
Better movement ability	Can complete more complex movement tasks	Class based assessment- reported in survey
Behavioural outcomes	1 school term:	
Practicing FMS	Better FMS mastery	Observational assessments
Increasing PA levels with peers	Spends more time in moderate-vigorous PA	Accelerometry measurements
Environmental outcomes	1 school term:	
Teachers engaging with FMS teaching	Frequency of framework use	Survey/tracking
Structure for EYFS FMS and PE	Planning for sessions completed	Survey/tracking (submission of evidence)
Determinants of change	1 school year:	
Knowledge (T)	Can identify FMS domains and activities related to them	Interview
Self-efficacy (T)	Has confidence to use framework and plan sessions from it	Interview
Enjoyment (C)	Can name an activity they enjoy completing related to the framework	Card sort
Knowledge (C)	Shows knowledge of different FMS	Card sort

PA= physical activity, FMS= fundamental movement skills

Table 5.22 Step 6: Programme evaluation plan- process

Variables	Indicators	Methods and execution
Programme implementation		
Dissemination	Number of schools completing the FMS School Project Training	Local authority survey of schools delivered to
Adoption	Number of schools using the FMS School Project framework in practice for a term	Survey of schools who have received training
Implementation		
Completeness	3 training sessions delivered	Survey/tracking numbers from LA
	Practical, classroom and home activities used from framework in schools	Tracking by teachers in schools
Fidelity	All elements in training are covered using designed materials	Observation of training sessions
Continuation	1 year of use in schools and LAs	School/LA survey
Programme users' evaluation	Enjoyment to deliver, ease to deliver,	Teachers/SLT/DP/LA- interviews, teacher card sort.
Programme user's barriers	Issues with delivery, barriers to use	Teachers/SLT/DP/LA- interviews
Intervention exposure		
Participant exposure (use of materials)	Number of time framework deliver used per week	Survey/tracking
Participant evaluation	Child enjoyment, child identified benefits/feelings	Card sort

DP=Delivery partner, LA=local authority, SLT= senior leadership team, CPD= continued professional development, FMS= fundamental movement skills

Figure 5.22 Task 6.4: Child Process Evaluation Card Sort

5.3 Discussion

This PhD programme was the first to begin to plan an FMS intervention for early childhood populations using IM (see sections 1.1.5 and 5.1), by iteratively planning and developing interventions in collaboration with key stakeholders. The thorough and rigorous process of IM enabled the researcher to develop a practical and feasible plan for future intervention for this age group and their specific health behaviours. This section of the chapter will summarise the emerging outcomes from the current IM process with a socio ecological focus, while highlighting areas for future development which could be conducted after this PhD programme of research.

The following chapter framework embraces the principle of IM, which is to intervene, therefore the structure will follow:

- What is the problem?
- What can be changed?
- How can it be changed?
- What is the design of change?
- Who needs to be involved in change and how?
- How can change be evaluated?

What is the problem?

This chapter collated evidence from Chapters 2, 3 and 4 and existing literature to identify that children are under achieving in their FMS proficiency at the age of 4-5 years old, and by using previous knowledge from IM (Eldredge et al., 2016), a planning group, and existing literature, the behaviours and determinants leading to this issue were identified. Importantly and as evidenced in Chapter 3, children have a lack of opportunity to develop FMS, both at home but also at school, where educators' practice is not well structured, guided, or informed by their own continued professional development or training. This is underpinned by a lack of knowledge, self-efficacy of delivering FMS, and the expected social norms of FMS and physical development structure for teaching at the EYFS (Chapter 3; Griggs, 2010; Howells & Meehan, 2017; Lawless et al., 2019). These interpersonal and community level influences shown in the SEM, play a crucial role in enhancing a child's opportunity and environment to progress their FMS proficiency within. On the other hand, children have low FMS competency, likely to be personally determined by their enjoyment of PA (Morano et al., 2016), self-efficacy in their movement (Peers et al., 2020) and knowledge of FMS. Therefore, the current landscape at an educational/policy and personal level leaves children lacking in FMS proficiency, leading to insufficient levels of PA as they age, and potentially poor health outcomes in childhood and adulthood.

What can be changed?

From this programme of research, we know not only does the individual need to change, but also their environment and environmental agents within it (these can be interpersonal, community or even policy level), providing a multi-level approach to intervention. To address the current problem, creating the supportive environments for children to practice their FMS within is essential. The majority of children in England attend school at ages 4-5 years old (GOV.UK, 2020), meaning there is an opportunity in this community level influence to intervene, due to the contact with children and ability to train staff and educators within these settings. This helps to identify that for the current IM process, the targeting of teachers at the EYFS of primary schools in England is crucial. It is also important to consider socialising agents, such as the home environment and family level intervention in future work (Cools et al., 2011; Zeng et al., 2019). The focus group discussions conducted with the planning group in section 5.2, also identified the possible implementation of home-based elements of interventions, 'bringing the intervention into the home', or interventions exclusively outside the school setting that could be used within the current or future programmes. Existing literature has explored the reduction of childhood obesity in the home setting by using IM (Mann et al., 2015; Taylor et al., 2013) and thus indicates the use of FMS intervention outside educational settings to be a possibility. Although the home is an important environment to target health behaviours, these environments are harder to intervene in due to broad variation of domains individual homes. Socio ecological approaches take a holistic and all-encompassing lens that serves to identify the influential determinants and relationship of determinants across the layers of the model, recognising the varying levels of influence on an individual (Sections 1.1.4; 5.1; Bronfenbrenner, 1979), making it a part of a complex evaluation approach. A child's parents/carers actions are important influencers in their choices and behaviours, and they want 'to get support to bring it into the home'. Therefore, a further iteration of the IM process would strongly consider how to positively influence FMS environments outside of school setting, such as the home and parental support. Consideration of the variation in SES would be pivotal in the success of these future programmes because, as established in Chapter 1 (sections 1.1.1 and 1.1.4), children from lower SES background reportedly spend less time doing PA, therefore it is likely these children spend less time practicing FMS. These children are also more likely to be overweight or obese (NHS Digital, 2021), meaning that the need to improve their physical competency through such programmes will be pivotal to the future health and heath behaviours.

Well in advance of the intervention delivery, the identification of the determinants is critical to intervention success and prescribing outcome and performance objectives (Eldredge et al., 2016). Determinants during the current IM process were identified not through purely scientific knowledge, but the inclusion of a planning group of key stakeholders. In doing so, this approach prioritises a 'real world' voice to the discussion that is from their perspective and in doing so embracing the principle in IM of participation and iteration.

With the EYFS of school as the key environment for intervention, the critical factors to change in this environment are determinants of the environmental agents, the EYFS teacher(s). This includes the teacher's knowledge, self-efficacy, social norms, and their outcome expectations of the proposed intervention, which were all explored in Chapter 3 (sections 3.3.3, 3.3.4. and 3.3.5). Parental attitudes and beliefs around school provision should also be considered an important determinant of the environment to target. Parental attitudes are particularly influential on their child's behaviours, including their motivation to perform PA (Xiang et al., 2003), and thus may be influential on their attitude to PA ad PE in the school setting. Examination of this element begins to target the parent populations, paving a path for possible future intervention with parent populations of this age group, linking also to the home environment once more.

Individual behaviours should still be considered important within this intervention, despite the children's young age and lack of autonomy over the choice of activities in their day-to-day life. Similar to the environmental agents, the determinants of the children's behaviours; children's enjoyment of

FMS, knowledge of what FMS performance and activities are, and their self-efficacy of their FMS and physical performance is important to think about when aiming for change for this population group.

While this IM process focussed on the teacher level intervention, the researcher felt there would also be a need for an intervention at a senior leadership team (SLT; headteachers, governors, deputies) level (organisational level). These individuals may not implement the intervention but are influential and make decisions that facilitate engagement with the intervention. The intervention at SLT level would be similar in terms of information to influence teacher training programmes; however, this would be based around the key benefits of improving children's FMS and how to promote this not only at the early years, but as a whole school. The primary PE and sport premium funding (Department for Education, 2014) provides important funds for schools to focus on implementing this kind of provision and intervention for staff and children. Therefore, the developments around the specific use of funding (Lawless et al., 2019) and how best to support the EYFS staff in the delivery of the intervention proposed in this programme of study would be key factors.

There would also need to be intervention with local authorities and QUASI non-governmental organisations such as Sport England and The Youth Sports Trust, from the researcher level to engage these key stakeholders within the intervention at community level. This would require persuasive techniques, including meetings and planning processes to identify how the intervention would be delivered within local areas, such as what kind of delivery partners could be utilised to train the staff in schools, additionally this communication must focus on the evidence, context and outcomes specific to that local area (Kneale et al., 2019). This prompts the use of a systems science approach, and creating a causal systems map of how this intervention is to be implemented beyond the school level needs to be established (Pronk & Faghy, 2022). This approach is similar to the 12 local delivery pilots delivered by Sport England (Sport England, 2022), promoting a whole systems approach by using local places and people to deliver more PA, while understanding the barriers to people getting or remaining active within the specific areas. The pilots promote the inclusion of local people as key stakeholders in addition to reflecting, testing, and learning from the processes that they put in place, reflecting key IM principles.

How can it be changed?

Identifying the determinants of behaviours and the environment, there is a clear vision to what needs to be changed for the individual and their environment. By establishing broad programme goals, behavioural and environmental outcomes, performance objectives and change objectives, by giving a broad to narrow and specific approach, intervention methods and applications can be planned (Tables 5.3 and 5.4).

It is easy to say, 'the self-efficacy of teachers to provide FMS specific teaching needs to increase', but how do we go about this process? This is where small and manageable change objectives should be established. As seen in the Matrices of Change (Tables 5.3 and 5.4), we can ensure that teachers improve their own self-efficacy, by identifying ways for them to understand how to identify improvements needed in FMS of children, giving them the appropriate means of planning sessions, and more effective ways they can engage their children in FMS practice.

Likewise, for children, we know their mastery level of FMS needs to be improved, but what are the potentially effective methods for achieving this within the proposed intervention? By increasing the time children have for PA at school, we may see greater improvements in their FMS (Hulteen et al., 2018; Stodden et al., 2008a), partnered with setting goals that are FMS focussed, while providing better structured environments for FMS practice through the target changes for the environmental agent (teacher).

What has emerged from this IM process is the need to identify the most influential determinants of the behaviours and environments, from multiple sources of knowledge, the literature, and the planning group. As the first IM study to do so for this age group, it should be considered that the most influential determinants are identified in future IM iterations, and that some determinants may be considered as less important in future iterations.

What is the design of change?

Intervention design can and should take many forms and be ultimately informed by behaviour change theories to enhance change and improve the chance of change in the individual or group (Michie et al., 2011). Within this IM process, targeting multiple behaviour change theories (Kok et al., 2016) to address several intervention areas is important. In effect, a number of mini-interventions to create behaviour change is proposed as part of a programme. This programme of intervention helps to suggest multiple ways to intervene with the end users (children) and the implementers (teachers) and their different determinants using practical applications. A key resulting outcome from both this PhD and the intervention, is the preparation of a framework for teachers to use. This is the intervention that can be used to directly target the change in children's behaviours. The planning group involved in this chapter decided that a framework will help to provide guidance, support, and structure, but will simultaneously enhance autonomy and ownership of the intervention (Kayser et al., 2014) for both the teacher and the children, by providing scope for adaptation for each individual situation. A framework must be supported by the enhancement of educator's knowledge, self-efficacy, and expectations of using a framework delivery. Therefore, the supporting intervention includes the training of teachers for framework delivery in school settings (Lander et al., 2017).

Intervention design should be pragmatic and realistic to the users and adopters, this ensures that the intervention can be effectively implemented in the desired setting with the target population (Bartholomew-Eldredge et al., 2016). With this in mind, the intervention is designed to ensure teacher burden and workload will be minimally increased when implemented in school settings, and this is identified as important in Chapter 3. This was also highlighted as what should be a key intervention strength, during the evaluation process of the intervention by the parent focus group. The materials that support and make up fundamental elements of the interventions proposed in this programme have been designed to: a) support the training delivery within this intervention (recapping knowledge taught and provided in these sessions), and b) be quick and easy to use in educational planning, delivery, and evaluation of the programme by providing pre-made materials.

The key design elements from this programme of intervention include (detailed further in Table 5.9 and 5.10):

- FMS promotion in school environments
- Improving FMS at the EYFS framework (The FMS School Project Booklet)
- Teacher training sessions

- Parental communications

The FMS School Project Booklet provides a section of activities focussed on physically improving Children's FMS. Using previous literature and intervention techniques to inform this section was important. Que words were successfully used by Foweather et al., (2008) to improve children's FMS performance, additionally the STEP model has been widely used in coaching and educational practices to allow for inclusive teaching (UK Coaching Learning, 2019). This section also approaches the use of different pedagogies in the FMS sessions by giving linear and non-linear examples for teacher to choose and use (Crotti et al., 2021).

Who needs to be involved in change and how?

In the spirit of the IM principles, although seemingly simple on the surface, intervention requires the collaborative efforts of many stakeholders to improve the possibility of success, as highlighted by the systems science approach (Pronk & Faghy, 2022). In the spirit of IM, this programme of intervention has a strong focus on improving the provision in schools by using teachers as adopters, implementers, and maintainers of the intervention, with children as the end users and the desire to ultimately change their PA and FMS behaviours. However, other key stake holders include but are not limited to (from intrapersonal to organisation and policy level stakeholders):

- Parents- although parents have no direct role to play within the intervention and its delivery, they can enhance the success and outcomes achieved during the intervention period by engaging with the resources provided to them within the intervention. Engaging directly with parents is at the discretion of each individual school, and with all interventions will have varying degrees of success. Despite this, communication with parents and the role they can play, should be considered as a critical, especially in future work.
- School SLT- these key stakeholders must agree that using the intervention, training of their staff and use of the framework intervention is sustainable and worthwhile within their school.
- Local authorities- these are key partners in the adoption of the programme by schools. Without local authorities, there is no initial platform to deliver and market the intervention from. Their influence on schools within the local authority should be key in ensuring sufficient and

successful intervention uptake. In the long-term, dependant on intervention success and stakeholder opinion, local authorities may stipulate a mandatory need for the intervention in schools at EYFS level.

- Delivery partners- these stakeholders are key players within the local authority set up, by providing the training sessions for the intervention, for teachers. They additionally should support schools and teachers beyond the training, ensuring the successful implementation within school environments.
- Public-policy makers at government level- ultimately the highest and possibly most influential level this intervention could reach, would be to effecting public policy. The requirement for a statutory FMS intervention or framework at the EYFS could be pivotal to ensuring healthier and more active lifestyles for children from an early age. This programme could still be delivered locally but be evaluated at a national level, much in the way children are assessed in literacy and mats skills.

How can we evaluate change?

When evaluating the changes of progression or regression and success achieved by the intervention, both the process of delivering the intervention and outcomes specific to the intervention should be considered. Within IM this is provided in depth, by curating questions, followed by practical techniques for the evaluation implementation. Using the RE-AIM framework (Glasgow et al., 1999) and evaluating the reach, efficacy, adoption, implementation, and maintenance of the intervention at the individual and community level helps to focus the evaluation. Future work should use this framework at policy level too. For example, working with government policymakers, mentioned as key stakeholders previously, to implement policy change for the early years and early years curriculum in relation to more specific FMS tuition, guidance and practice for this age group would be a critical policy level change. The reach of the policy change and effect at the delivery level (early years settings); the efficacy of the policy change for the teachers and children involved (did it achieve what it set out to- increase teacher knowledge, delivery and confidence; increase children’s FMS competency and likelihood to continue with good PA habits); the adoption of the policy by local authorities, schools and educational settings;

the implementation of what the policy prescribes or recommends; and finally the maintenance of policy use both at government level, local authority level and school level, will be essential to constructive evaluation processes.

This IM plan developed the outcome evaluation around the most important variables to be changed during the intervention, according to the environment, individual behaviour, and their determinants, and these are listed below. Future intervention should consider if the intervention approach being used targets the elements listed below, while considering how these may be evaluated (Table 5.21 and 5.22):

- Environmental outcome: teachers planning to teach FMS
- Behavioural outcome: children practicing FMS
- Determinants: improving teachers, parents, and children's knowledge of FMS, increasing the self-efficacy of the teachers to deliver FMS content/activity in school settings, providing children with an enjoyable intervention/FMS practice

During the process evaluation, attention should be paid to how the intervention was delivered at implementation and in practice. This evaluation process should provide important information about:

- The completeness of delivery- was the programme delivered as intended with all its elements, if not, why?
- Continuation of the intervention: once implemented in the school setting, was it continued successfully and appreciated by the adopters, maintainers, and users of the programme?
- Participant exposure: did the participants of the intervention receive the appropriate dose of the intervention? (section 1.1.5)

These elements of process evaluation may help explain important answers as to why the intervention did or did not work (Bonell et al., 2012; Section 1.1.5). The methods for evaluation at process and outcome level should be pragmatic and realistic, this intervention avoided using overly scientific measures of progress, as these are unrealistic in school settings. Observations, questionnaires, and conversations with key stakeholders of the intervention, including the use of card sorting activities, are deemed to be important in these processes.

5.4 Conclusion

This study aims to provide an important and well-informed basis for the development of future interventions. By considering the socio-ecological model when designing the current intervention, the researcher's attention was focussed on the individual and the influence of their interpersonal environment, organisational environment, community environment, and policy environment on their behaviours and health outcomes. The identification of these influences and knowledge built within this programme of research has played a key role in the aims of the intervention and the outcomes to be achieved. This IM study shows that initial intervention may aim to aid children and their interpersonal and organisational environment at school and teacher level, to provide better structure and opportunity to develop FMS, which may lead to improved levels of PA, and positive changes in health outcomes.

Chapter 6

Thesis Synopsis

6.1 Key findings

The aims of this thesis were to a) systematically review the literature available about 4-5 year old's FMS, and accelerometer measured PA levels, including the variation in measurement methods employed, b) investigate educators perspectives on PA, FMS and PE for EYFS children, c) assess a sample of English EYFS children's FMS competency and PA, finally, d) use previous literature and empirical data sets collected in this thesis to produce the first attempt of using IM to develop appropriate interventions to aid FMS development and PA participation in early childhood.

This thesis collectively aimed to develop a programme of intervention to improve PA levels and FMS of children aged 4-5 years using IM, by collecting and curating evidence and theory. The key findings of this thesis demonstrate that:

i) Children across the globe are inactive and demonstrate low levels of FMS competency and mastery in several skills. The lack of consistency in FMS measurements and measurement tools create discrepancies between reported outcomes, in addition to the lack of stability FMS data for this age group.

ii) Educators in England feel that their schools are physically active places, however, many teachers need increased support and better opportunities to provide FMS interventions and tuition in school settings. Educators also provided valuable key stakeholder insight for future design and implementation of FMS interventions.

iii) Children in Central England show sufficient levels of PA when measured using accelerometry, yet their FMS competency shows low levels of mastery when measured using the TGMD-2. This evidence suggests the need for intervention for this age group is still needed to warrant improvements in FMS and sustaining sufficient levels of PA as they age.

iv) FMS interventions during early childhood must be planned in depth, using theory, existing literature, and the involvement of key stakeholders via IM. This thesis explored all steps of IM with key stakeholder engagement, to develop a pretotype model. The physical implementation, piloting, and trialling of this programme of intervention is now required to complete IM cycle.

At the end of chapters 1-4 a link to the narrative of the PhD has been made to show a clear link to how each chapter maps to one another, with Chapter 5 collating most of the evidence gathered through this programme of research, during the IM process. Chapters 2-5 included individual discussions of the results from these chapters, therefore the purpose of this chapter is to discuss the individual findings in context of the thesis, to establish future research direction, practical applications, and key stakeholder recommendations.

6.2 Main findings and implications

6.2.1 FMS and PA measurement and assessment in early childhood

Measurement and assessment of FMS and PA of children in the UK has continued to increase over the past two decades (Eddy et al., 2020; Klingberg et al., 2019). As children grow, their physical capabilities increase, and Gallahue & Donnelly (2003) state that mastery of FMS is achievable by the age of 6-7 years. Therefore, the early years remain an important time to measure and observe these developments, especially as children enter formal education settings, and perhaps their first experiences of structured PA opportunities and PE lessons. The importance of understanding MC and FMS proficiency at this age cannot be understated. Children need to be physically competent to move both throughout their childhood and thus throughout their entire life course. Physical competency including the mastery of FMS allows individuals to be physically active and elicit numerous health benefits that are both physical (Janssen & LeBlanc, 2010), psychological (Rodriguez-Ayllon et al., 2019; Wu et al., 2017), and social (Timmons et al., 2012).

There are a number of proposed FMS and MC assessments for researchers to choose from when working with children as explored in Chapter 1 (section 1.1.3), these assessments include: The Dragon challenge (Stratton et al., 2017), the BOTMP (Bruininks & Bruininks, 2005), Athletic Skills Track (Hoeboer et al., 2016), MAB-C (Henderson et al., 2007), Children’s motor skill protocol (Williams et al., 2009) and these have been used and discussed at depth within literature. A review by Eddy et al.,

(2020) found that there were 24 assessment tools for assessing FMS in school-aged children. Some tools have been created to be specific to the country of origin such as the KörperKoordinations Test für Kinder (Kiphard & Schilling, 1974), which is used for assessment in the Netherlands. This helps to give better specificity of results to the children being measured, an important factor during physical skill development (Hulteen et al., 2017). Many other tools such as the TGMD-2 (Ulrich, 2000) have been used globally by researchers to gather information on children's FMS competency, from the ages of 3-11 years old. The systematic review (Chapter 2) focussed primarily on outcomes from the TGMD-2 and 3 to aid in the synthesis of results and the skills measured also reflect key movements identified in the PE national curriculum in the UK (Department for Education, 2013) from Key Stage 1 onwards. This makes the TGMD-2 and 3 an attractive tool to use in school settings due to the transferability of assessment into teaching materials which can inform teaching practices. Despite this choice, it became clear within the systematic review that protocols are not always used in their specified or traditional formats within individual studies, affecting the reliability and validity of the protocol (Hulteen et al., 2018). For example, some studies observed just four or five specific skills of locomotor and object control (Duff et al., 2019; Jones et al., 2011) or scored using different criteria (Foweather et al., 2015b). While this is pragmatic and realistic for research, especially when working in educational settings, it creates discrepancies and differences between results and outcomes. Therefore, a clear picture of measurement and assessment cannot be observed in this area of research. Despite this, measurement and assessment tools do provide insight for future research and intervention areas that focuses on assessments, and existing measurement methodologies can be used to inform the improved intervention evaluation and assessment methods (see section 6.2.4). Currently, researchers are aiming to develop more appropriate measurement tools with stakeholders in the public spaces, including schools (Eddy et al., 2021; Essiet et al., 2022; Goss et al., 2021) around physical development and literacy with children. This insight and conversation will allow the most appropriate tools to be developed for use in these environments. These tools should then be pre-tested and used in intervention contexts.

In Section 1.1.3, PA measurement during early childhood was discussed, summarising that accelerometry offers an accurate representation of children's PA levels. A clear preference on accelerometry measurement was shown in Chapter 2 with 80% of articles included, using ActiGraph accelerometry, likely due to their ease of use with younger populations (Dobell et al., 2019; Evenson et al., 2008; Johansson et al., 2015). The same could be observed with accelerometer placement at the hip placement site (90%). These outcomes offer insight into the use of these tools during research studies. However, accelerometery is likely to become unrealistic at population level intervention due to the lack of accessibility of accelerometry at population level, including the processing of accelerometry data. Therefore, although accelerometry may be popular, future intervention development must identify the use of accessible measures of PA in children. Accelerometry issues were subsequently highlighted by the findings in Chapter 4, where only 58.7% of the cohort provided valid accelerometry data. Showing that accelerometry validity is under threat in child populations due to issues with wear compliance and exacerbated by loss of devices. In combination with accessibility, considerations to other measurements must be made. Although Chapter 5 highlights the use of accelerometry as a PA measurement device for product outcomes, it is recognised that at a larger scale explorations of PA outcomes must be appropriately designed and tested empirically. Additionally, focus on other measurement and evaluation variables of both product and process intervention elements (Table 5.21 and 5.22) in addition to PA measurement should be utilised.

The novel contribution of the systematic review remains in the age group chosen (4-5 years old), where children should be showing a good development of FMS, but with scope to further develop the skills as they age toward 6 years old and potential mastery. This age is also characterised by the current guidelines of 180 minutes of PA per day, compared to just 60 minutes for children aged 5 years and above (Department for Health and Social Care, 2019a). This review intentionally chose narrow inclusion criteria (Section 2.3.2), to allow for a more detailed narrative discussion of the results. Using these data, it was identified that measuring FMS and PA in the current age group and population is a small part of a complex puzzle needed to create the adequate programmes that yield broad improvement. Yet, these must be based on valid, and reliable measurement and must be used to ensure that decisions are evidence based and flexible to incorporate behaviour and environmental change and that it is identified where they may begin to fit in.

6.2.2 FMS and PA outcomes in early childhood

The first three studies (Chapters 2-4) revealed the importance of increasing PA in early childhood and the achievement of this in school settings. Chapter 2 highlighted that globally there is an under achievement of FMS competency, accompanied by varied measurements of PA levels. Chapter 3 allowed a qualitative exploration of the benefits of FMS and PA for children through the view of educators, with many recognising strong social benefits and health benefits to the children too. Although Chapter 4 was able to demonstrate most participants achieving PA guidelines via objective wrist-worn accelerometry measurement, it also highlighted that children attained low levels of FMS competency. The literature continues to argue the importance of strong FMS competency for continued PA involvement as children age, where the relationship between FMS and PA strengthens (Hulteen et al., 2018; Stodden et al., 2008b), while strong FMS can also improve children's fitness and positively affect their weight status (BMI) (Barnett et al., 2021). These relationships demonstrate a greater need for increased FMS competency during the early years, to ensure that the PA involvement and health of these children is established.

Chapter 2 and 4 revealed that FMS competency is low in children aged 4-5 years old. As discussed in section 6.2.1 and in depth in chapter 4, adopting the TGMD-2 as an assessment allowed two FMS domains of locomotor and object skills to be explored. Locomotor skills were increased relatively to object control skills for both boys and girls ($p<0.05$), reflecting the findings of Chapter 2 and previous literature. This suggests that perhaps more focus is given to children's locomotor skills when they are younger, and possibly perceived as easier to develop. Future intervention approaches should focus on developing skills wholly and holistically, but this important information should be shared with educational practitioners, to highlight the need for object control skill development. Girls were also significantly better at locomotor skills than boys in the results of Chapter 4, which was also observed in some of the results of the studies examined in Chapter 2. This accentuates the need for adaptability in tuition and provision within groups of children, with this being further supported by the result of Chapter 4 and the use of age tertiles across the group of participants. The oldest children in the sample were more likely to be competent at their FMS skills ($p<0.05$). With both sex and age influencing the differing achievement of children in possibly just one class in a school, the use of differing pedagogies and teaching methods must be recognised in intervention development and design (see section 6.2.4). Outcomes for balance and stability measurement throughout this programme of research (Chapter 2 and 4) have shown that children aged 4-5 years of age show wide variation in their achievement. Balance forms part of many locomotor and object control activities and thus activities to practice and refine balance and stability skills should be incorporated into children's PA and FMS opportunities. Therefore, the framework (Appendix 5.3) produced in Chapter 5 includes a whole practical sessions section on balance and stability, to highlight to educators the need for this skill development.

As aforementioned, PA levels in the sample of children in Chapter 4, were generally good, by meeting the PA guidelines, results also showed that PA levels were higher during the week days than the weekends, a finding previously matched in the literature (Foweather et al., 2015a; Roscoe et al., 2019b). Education settings are therefore a place where children are more active than within their home environment, which can be viewed as a positive finding. This finding should be used to educators' advantage by incorporating an increased level of tuition and skill development opportunity within these active school days, as prescribed by the components and materials produced in Chapter 5; further improving PA levels and FMS competencies in children. This finding shows that successful home interventions need to be subsequently developed to ensure PA is sufficient throughout the week and weekends, therefore this should be a focus for future research, by possibly using IM methods used within this PhD. Maintaining these good levels of PA from early childhood should remain a focus into middle and late childhood.

6.2.3 FMS and PA in education settings

Differences in knowledge of educators in promoting FMS in school settings and confidence to teach FMS were outlined in Chapter 3. Despite a relatively small sample size, this chapter demonstrated differences in the knowledge that individual educators had, and the discrepancies in the provision between settings at state school level. The barriers and opportunities for PA participation for children at the EYFS from an educator's perspective, were also explored in this thesis. A crucial element to recognise is the limited time that schools have with children, therefore, not only is there a need to promote awareness of PA and health, but the need to promote better physical competency of these children, in the form of FMS mastery. An environment that better facilitates competency and promotion of positive health, will mean that children are better physically prepared for PA environments both within and outside of the school environment. The school and education environment provides a setting where all children in England can attend, and what could be termed as a 'level playing field' for them to develop their skills under the correct tuition when appropriate intervention, as mapped out in Chapter 5, is delivered.

The findings of Chapter 3 support the findings of Griggs (2010), with a number of educators in the current programme of research interviewed, stating that they use external school coach provision to deliver PE and PA sessions at school, or the interviewed participants themselves being coaches external to school. Although valuable coaches are key players in the school environment, they lack the ability to target a 'whole school' approach to PA promotion and FMS performance. This was of further concern where educators in Chapter 3, mentioned that interventions that had taken place in schools, were delivered by individuals external to the school (coaches, researchers). This lacks a systems approach to address health problems, which has been established as important to future development of interventions (Daly-Smith et al., 2020; Pronk & Faghy, 2022), by best promoting sustainability for interventions in complex settings. Whole system approaches have proved to be successful in their use for increasing PA in different communities, including the 12 pilots introduced by Sport England (Sport England, 2022). Whole system approaches to improve PA in children have also been developed, JU:MP, one of the 12 Sport England delivery pilots (Hall et al., 2021), is a pilot that aims to engage children aged 5-14 years of age in North Bradford in the UK. The international society for physical activity and health (ISPAH) (2020) state that system-based approaches are needed for increases in PA to be seen. By uniting the expertise of those across the different layers of a system (or those shown in the socioecological model; figure 5.1), a better enthusiasm for PA can be formed. A key element is bringing together a collection of key stakeholders, just like what was represented in Chapter 5 but at a larger scale, especially working with stakeholders who may previously not have engaged in improving the PA agenda of a local area. Reflecting on this, teachers of EYFS classes, rather than external coaches, offer pre-existing knowledge and relationships with children within the intervention, pre-existing and strong relationships with parents of the children, and finally a relationship and influence on the decisions made by the SLT of their school, which has been identified as critical to school intervention sustainability by a systematic review (Herlitz et al., 2020). This leaves teachers in a more advantageous position to promote FMS in schools, as well as delivering an intervention. Therefore, this supports this position by intervening at the teacher level and child level, by improving the teacher's skills, knowledge, self-efficacy, and confidence to teach FMS and deliver PE effectively to children, overcoming the barriers identified in Chapter 3 and in Eyre et al.'s (2022) research. And enhancing the skills of systems already in place, over introducing new members of the system (external coaches). This promotes future opportunity to intervene at the community and policy level, progressing to the whole systems approach recommended.

As mentioned in section 6.2.2, children are sufficiently active according to accelerometry measurement while they are attending school (Chapter 4). This quantitative finding was supported by the qualitative comments of the educators, from Chapter 3 with children "have[ing] a lot of play time in reception", suggesting that plenty of time is allotted for the PA performance of children. However, what these comments did not highlight was the recognition of FMS tuition within PA opportunities, or the type of play that is encouraged. A lack of tuition by EYFS teachers was mentioned "a lot of teachers shy away from it, they'll put children straight into a game, before they're ready…without any basic throwing or catching skills". This is where the argument for intervention becomes clear, and the need for educators to prescribe more than play for PA opportunities for children aged 4-5 years of age if children are to remain active individual's as they age.

With these findings in mind, future interventions should focus not only on the improvements of the children, but also the improvements of the teachers. As detailed in Chapter 5 (section 5.2.3) there are determinants of a child's behaviour but also of their environment, and these include their teacher's knowledge, self-efficacy, and social norms. With these determinants explored in detail during interviews in Chapter 3, Chapter 5 set out to improve these determinants, by setting performance and change objectives to achieve during intervention delivery (Table 5.6). By improving the environment of the intervention as well as end users (children) individual level influences, intervention begins to aid at multiple levels of the socio-ecological model.

6.2.4 Intervention design

Intervention design and delivery are very complex processes, as Chapter 5 demonstrated. By using a socioecological approach, the exploration of the possibility to intervene at multiple influential levels was explored, with a specific focus to the individual and organisational/institutional level influences within the interventions proposed in the programme in Chapter 5. Within these areas of focus alone, the design of the interventions and programme components was detailed and expansive, as shown in tables 5.9, 5.10 and 5.11. Interventions focussing on behaviour changes should employ theoretical based strategies to base design and components around, these were then supported by methods previously seen within the literature or based on similar approaches.

Thought should be given to the approach of providing the practical opportunities within an intervention and the teaching approaches that can be used in an education setting to support this. This element of intervention is important as it influences both the change for the teacher but also the children. Previous work by Foweather et al., (2008) and Crotti et al., (2021) have explored different approaches to guiding and teaching children to improve PA and FMS. Foweather (2008) focussed on simple learning cues and skill questions to engage children in the tuition process of FMS. While Crotti (2021) and colleagues compared the use of linear and non-linear teaching pedagogies to help improve PA in children, with the sessions having a focus of FMS tuition. Non-linear approaches should have the inclusion of frameworks such as Space Task Equipment People (STEP; UK Coaching Learning, 2019) and recognise constraints according to Newell's stages of motor learning (Newell, 1986). Linear approaches are considered more traditional in nature, aiding children to progress through the stages of learning (cognitive, associative and autonomous) proposed by Fitts and Posner, (1967). Bedard et al., (2018) also used direct instruction techniques to improve FMS competency in 3-4 year old children. With literature supporting the use of varied methods, frameworks should be flexible in design and reflect this. Therefore, a practical framework guide produced in Chapter 5 (Appendix 5.3), utilises-learning cues (for teachers to use and children to learn), and the STEP model for adaptation of activities.

Training sessions (Appendix 5.4) also encourage teachers to integrate their own experiences and knowledge to develop their own intervention from the materials. This section highlights how a linear or non-linear approach to tuition is more suitable to them and their class. The ownership and adaptation of an intervention was highlighted as important to educators in Chapter 3.

Programmes of intervention should be designed with the evidence of the population, but also underpinned by theoretical approaches. Iterative processes should then follow the design and pre-testing of materials to assess if change is sought through the specified mechanisms (Eldredge et al., 2016). Linked to the introduction of better tuition within school settings is the design and use of future assessment tools, or the intervention evaluation. Looking at the evidence, Chapter 4 results showed a relationship between the running ($r=-.458$, $p<0.05$, a high running TGMD-2 score produced a faster 10m running time) and jumping ($r=0.484$, $p<0.05$) product and process measures, illustrating that using either of these measures can be a good indicator of a child's proficiency at this age for these skills. It is thought that process measures may be more useful in early childhood, as children are still developing their strength, power, and flexibility (Lloyd & Oliver, 2012), and this process evaluation better concludes the quality and execution of children's FMS. Process measures used for evaluation also allow for identification of where a child or cohort of children may be deficient in certain elements or criteria of a movement. This information should be used to inform intervention and create specific activities to address the deficiency and provide better tuition and practice opportunities to this specific group of children, allowing ownership of the intervention by both the teacher and children. However, product measures are more easily implemented to determine progress in children's skill development, such as the speed they can run 10m, allowing more tangible outcomes, which may help to motivate the children and their teachers in their PA and FMS practice opportunities. It is also likely that product measures are a much simpler tool to use in school settings where time is restricted, therefore a balance must be sought between process and product assessment. This programme of research has considered this in the framework by suggesting real time teacher assessment of skills followed by opportunities to set skill goals with children that can be based around a product outcome, e.g., catching a ball ten times in a row. The future iterations of the programme of intervention following testing and implementation periods will be able to best comment on the most viable, realistic, and successful measurement of the intervention.

Overall, intervention/programme design should consider the diverse and multilayer influence from the perspective of key stakeholders, with a varied number of components of intervention at each level of the SEM. It is unlikely one single intervention or component will instil change in an environment without other interventions playing a contributing role. This is reflective of calls for interventions to work more widely with differing stakeholders including public health authorities, local and national government, and community groups (Duncan et al., 2022) and at different socio-ecological influence levels. The hope is that collectively these approaches used within a joined up and well thought out and planned programme of intervention will influence change.

6.2.5 Intervention implementation

When approaching implementation of a novel FMS intervention, the individual, interpersonal, organisation/institutional, community, and policy influences should be considered wholistically, with implementation considered and possibly needed at all levels of the socioecological model (Bronfenbrenner, 1979). To aid the implementation of a new FMS intervention for EYFS children in schools, the discussion and dialogue with key stakeholders was critical. Both Chapter 3 and 5 explored the views, opinions, and needs of educators, parents, and children. A focus group of researchers (Chapter 5) was also key in intervention implementation, by using practical first-hand experience of intervention implementation success, importantly the failures, and strategies. Implementation without due consideration to the target users, implementers, and adopters would likely be unsuccessful, as it does not consider the determinants of individual behaviours and the influence of the environment. By establishing these key elements, theory-based behaviour change intervention strategies can be implemented and subsequently tested by the target users, implementers, and adopters. Without this thorough thought, the implementation would represent a lack of realism and pragmatism in its approach, which this research has encouraged and is encouraged in the guidance (Eldredge et al., 2016).

Chapter 5 used IM to begin to establish an intervention to improve FMS at the EYFS in school settings. Intervention implementation should be based around the programme goals and performance and change objectives, with clearly identified strategies and programme components to achieve these. The implementation of a programme of intervention will require the support of people in organisations and institutions as well as higher level environmental agents, including those at policy level (section 5.3), to achieve the widest spread change, encompassing the socio-ecological model approach. The individual, interpersonal, organisation and community level implementation for the programme of intervention planned in Chapter 5 will now be discussed:

At the child (individual) level, implementation should focus on the most practical parts of the intervention such as the delivery of the practical tuition sessions, improvement in knowledge sessions (classroom based) and establishing a dialogue with children's key interpersonal influence, their parents/carers. By targeting opportunities to intervene throughout the school day and possibly have effect in the home environment which may be crucial to seeing change occur, this increases exposure to the intervention and gives repeated opportunities for children to practice and improve skill competency, knowledge and self-efficacy (section 1.1.2 page 32).

At a school (organisational) level, implementation should focus on establishing who the implementers, adopters, and maintainers of the intervention within the school are. With Herlitz et al., (2020) concluding that knowledgeable, skilled and motivated staff and senior leadership team (SLT) are needed for the successful use and sustainability of intervention in school settings, the implementation should focus on ensuring that these individuals/groups within the school are identified in the first instance. As discussed in Chapter 5 there will need to be a commitment from a SLT of a school to provide adequate funding for the intervention to take place, due to the training of the teaching staff. As seen in Table 5.17 teachers and SLT must work together to become maintainers of a programme of intervention by achieving change objectives within the school environment. For example, SLT members should be able to explain how best to use PE primary funding to provide the intervention within their school setting. Achieving this will lead to better knowledge, understanding and self-efficacy to use and implement intervention in their school setting.

The organisational level should also focus on the quality of the tuition being provided within the intervention to the children. To ensure the correct quality of intervention is provided, the need for evaluation of intervention is critical. Step 6 (section 5.2.7) of the IM process highlights the need for effect and process evaluation, and at an organisational level, the effect of the intervention on the children and the teachers delivering it should be assessed (Figure 5.20). Additionally, the process of delivery should be evaluated, by examining how the intervention was delivered. Elements of evaluation should include amount of exposure to the intervention (number of sessions), the variety of resources used to deliver the intervention from the framework booklet, and how easy or hard teachers felt it was to deliver and to prepare for the intervention delivery. These evaluations allow the identification of the area(s) for adaptation and improvement at a whole intervention level (from local authority level) or at a more local level of the individual school. Allowing adaptation at local level allows more 'ownership' of the intervention and alignment to needs which has been promoted by both educators in Chapter 3 and researchers in Chapter 5. It is believed this type of adaptability will allow for better implementation, maintenance, and sustainability of intervention, key outcomes of using IM.

At a local authority (community) level implementation should focus on increasing accessibility of opportunities to targeted settings and groups of the population within a community. Local authorities should use existing relationships with educational settings/schools to demonstrate why there is a need for the intervention. Awareness should be increased through various means, included those outlined in Table 5.11, such as video media and websites. This kind of dissemination is a key element of implementation intervention (Table 5.15). Once awareness of the problem to be addressed and the proposal of the intervention have been raised, local authorities should be able to implement the correct delivery partner to these educational settings. Relationships with those delivering the intervention at community level need to be maintained from the beginning of implementation and onwards, therefore the use of a delivery partner may help to achieve this. This individual or organisation can be used as a key contact for the school, as well as providing support to the teachers using the intervention. As seen in Table 5.18, local authorities and delivery partners need to be able to work together to maintain the proposed programme of intervention and for it to be a success. Their knowledge must include how to not only deliver the intervention, but to allot the specific funding to it, to demonstrate to schools how it has been used in other settings, to evaluate the process of delivering the intervention training to teachers, and to help evaluate the outcomes of the intervention in school.

6.2.6 Brief recommendations for key stakeholders:

Considering the outcomes, results and topics covered in this discussion there are several recommendations for key stakeholders who have been important to this current PhD or could be important in future intervention and research development (e.g., policy makers). Recommendations for each of the groups who are identified as key stakeholders are briefly detailed in the following section:

Teachers: Should use training and intervention opportunities and encourage school leaders to consider their use to help improve child outcomes. Engagement with local authority and community facing delivery partners in the intervention delivery should be utilised as support to the intervention, maximising its potential for success and change, reflecting the systems science approach (Hall et al., 2021; Lakerveld et al., 2020; Pronk & Faghy, 2022). Teachers should evaluate the use of the intervention in a school setting. This information should be fed widely into the programme at a local level and potential nationwide framework delivery/design.

Parents: parental awareness needs to be improved, with a wider cultural change toward PA and knowledge of FMS as the most successful outcome for this group. This begins with messaging at the school level, wider campaigning, and awareness. The message that can be delivered from the materials proposed in Chapter 5 (Table 5.11), are the importance of FMS delivery in school, to bring to a similar level of recognition of academic subjects such as literacy and maths. Homework opportunities in The Framework Booklet (Appendix 5.3) do not require parents to have prior knowledge of the area but to be willing to facilitate the practice opportunities that children need. Minimising parental burden was highlighted as a key element of new intervention by parental stakeholders (planning group) in Chapter 5, and therefore should be considered in future approaches at parent level, this includes at higher policy level change.

School senior leadership teams: should examine the use of the PE premium funding or similar initiatives and the training of their staff in the EYFS. Examination of current skills, competencies, and confidence of staff should be evaluated, with strong consideration to appropriate intervention strategies to improve these. Schools should also continue to work with research key stakeholders to develop evaluation tools to use with the children within their setting. There is still a scarcity of appropriate tools to measure FMS for the EYFS in a school and non-clinical setting, as identified in Chapter 2. The combination of the programme of intervention in Chapter 5, could positively influence levels of FMS mastery seen in this cohort in both Chapters 2 and 4.

Local authorities: need to work with schools to encourage the use of funding for an FMS intervention programme designed to improve EYFS staff skills, knowledge, and self-efficacy, through effective partnerships, rather than using external provision that does not enhance teacher knowledge or skills to deliver PE, PA or FMS, seen commonly in these settings (Griggs, 2010). Local authorities should ensure that the skilled individuals for intervention dissemination are employed (Table 5.15), which would lead to successful implementation and potential scaling of future programmes, holding a conversation with these agents as to their needs is important as this research shows. Local authorities must also be involved in the intervention evaluation process both at the local authority level (how was the intervention training delivered to school staff, how many schools are actively using the intervention), and the individual school level (giving schools the opportunity to feedback successes and areas for improvement), to feedback into the local delivery model. Collectively, this information can inform policy development to ensure intervention outcomes and practical anecdotal reports of the practicalities to delivering the programme are guided nationally.

Policy makers: Should begin to engage in creating policy in the curriculum for the early years focussing on FMS provision and education. This should be supported by evidence that this is important to child development and wellbeing, and trials of interventions to improve FMS, such as the one planned in this thesis. Trials of intervention should be appropriately but realistically funded to determine how interventions would be scaled across local authorities or nationally.

Advice on how the provision of the Primary PE sports premium and future initiatives can be used to support these programmes of intervention should be provided to schools, with suggestion to invest in appropriate training and development opportunities for teachers and children. This would also cover the intended use of the premium to upskill teachers. Policy may also include wider changes at the whole school level, as well as the EYFS to sustain the changes implemented at this age, these policy changes should be made in conjunction with educators and researchers, in the hope this will promote a whole school approach and change (Daly-Smith et al., 2020).

Future research with children: There is still considerable work to do to address prominent gaps in the literature and scientific understanding. Chapter 2 highlighted the lack of balance assessments for children, in addition to the variation in the measurement of PA in this population. A more 'joined-up' approach between researchers and research groups should be considered so that results from these studies can be pooled to represent larger groups of the research population.

Chapter 3 highlighted the value of engaging in conversation with key stakeholder, especially in realising the extent of a problem and possible causes/determinants to the problem, and to establish the design of interventions which seek to reduce or remove the problem. Further dialogue with teachers and school SLT members should continue to take place, not only for intervention developments, but also assessment developments in the field. A more comprehensive assessment for FMS in the school setting is still required, which can be implemented by teachers within curriculum PE lessons, and effectively report outcomes to parents (Eddy et al., 2021). This would not only aid the research area, but the intervention development and implementation area, by providing the most appropriate tools to be planned into intervention use and assessment. Assessment methods should follow a similar design of being adaptable and enhancing ownership and adaptability to encourage teacher/school take up.

Although Chapter 4 helped to increase the evidence base of FMS competency for children in central England, data in this area is still very scarce. This provides the case for further evidence for children in this area and of this age to be collected. It is recognised that this comes with many challenges around recruitment of school settings and participants. This leads to the argument that better relationships with researchers and universities with education settings, schools, local government and national government are needed to enable the recommendations in this thesis to occur. Establishing more successful relationships with public facing bodies may also enhance the general view of research and research with children, leading to better intervention conceptions, IM processes and successfully implemented interventions.

Chapter 5 provides a strong basis for further researcher involvement in the design, implementation, and maintenance of effective intervention programmes in schools and at other levels of the socioecological model. Researchers help to provide the protocol for intervention, its implementation, and importantly its evaluation, which is important to wider dissemination to not just the wider scientific field but the general public to ensure that societal norms are challenged and ultimately changed for the better. Therefore, researchers should aim to continue to use intervention IM processes where appropriate (health behaviour changes), appreciating the influences at each level of the socioecological model (Bronfenbrenner, 1979) and reflecting a systems science approach (Pronk & Faghy, 2022). The in-depth approach which deeply considers interventions in 'the real world', by being pragmatic and involving key stake holders has a number of strengths (as explained in section 5.1) which avoid the pitfalls of previous interventions including long-term implementation, success and sustainability.

6.3 Strengths and limitations of this programme of research

Each chapter provided individual commentaries on each individual study approach according to the strengths and weaknesses of study design, data collection and synthesis of results. There are some notable strengths of the current work, but also important weaknesses to comment on to inform and improve future work in this area of research.

Chapter 2 explored the FMS competency of 4-5-year-old children reported in the literature from across the globe between 2000-2020. One major limitation of this study was the choice to include studies using only the TMGD-2 and 3. As discussed throughout this thesis in both the introduction (Chapter 1) and this general discussion, there is a plethora of FMS tools available to test this age group (The Dragon challenge (Stratton et al., 2017), the BOTMP (Bruininks & Bruininks, 2005), Athletic Skills Track (Hoeboer et al., 2016), MAB-C (Henderson et al., 2007), Children's motor skill protocol (Williams et al., 2009) the TGMD-2 and 3 (Ulrich, 2000, 2016)), with the TGMD-2 offering some notable strengths, such as being one of the only tools designed for normally developing children. Yet the tool lacks a stability-based measurement and can be time consuming to conduct with young children. Despite this, the use of the TGMD-2 and 3 in this study allowed comparison with the results of Chapter

4, which was employed to measure children's FMS competency in central England. By doing this, a clear distinction could be made around what skills for this age group required the most attention. This was used to inform programme materials created in Chapter 5. The TGMD-2/3 assessment also provided critical skill elements for mastery which were subsequently used in Chapter 5 materials (Appendix 5.3 and 5.4).

Within Chapter 2, only the reporting of MVPA was included in the review of literature. This offers limited knowledge around children's actual PA levels, but has been common to only report MVPA due to the associated benefits with health outcomes ages (Ekelund et al., 2012; Warburton & Bredin, 2016), and this was representative of the literature found in this systematic review. However LPA and TPA should also be reported, as LPA can be important in developing and mastering object control skills for children (Foweather et al., 2015), while TPA has been associated with FMS in the early years (Jones et al., 2020). Mastering FMS at an early age can lead to greater PA involvement as children get older, and therefore should also be encouraged. Therefore Chapter 4, measured and reported TPA, LPA and MVPA of children who provided PA data, despite this, no significant relationship between FMS and MVPA or LPA was revealed in analysis. PA data in Chapter 4 was identified using wrist based Actigraph GT3X cut points (Dobell et al., 2019), which were calibrated using British preschool children. This study is one of the first conducted in British populations to use these cut points in practice to identify PA levels in children. Despite this, a large limitation of Chapter 4 was the number of children providing valid accelerometer data (58.7% of participants). This reiterates the issue of participant compliance at younger ages (Cliff, et al., 2009) and thus more research must be conducted into how to make accelerometery a realistic measurement tool for this population.

Chapter 4 was unable to provide data from a varied SES sample, this was mainly due to the use of convenience sampling and difficulties with access and recruitment due to the COVID-19 pandemic. Despite efforts made to engage with schools from more deprived locations, this was met with no or little response. Future research should aim to work closely with local authorities to encourage participation in research in school settings. This could involve policy level involvement where government policy could encourage engagement with researchers to ensure that school settings can be led by the most up to date and evidence-based practices. Universities and funding bodies should also consider the option of funding incentives such as payment for participation, or renumeration of extra pay for staff completing training in interventions/studies, with the hope of encouraging more settings such as schools to take part in research projects. Despite these issues a better spread of SES was represented by the educators who were interviewed as part of Chapter 3, this was also evident in the responses provided by the educators, demonstrating awareness of the issues in this population group. A sample was recruited from around England for this study but did lack contribution from educators based in the North of England where some of the most deprived communities in England are located (Ministry of Housing, Communities and Local Government, 2019), as well as lack of representation from male educators. It is important that knowledge of these educators' perspectives is also gained, as these could inform important iterations and changes of the IM process presented in Chapter 5. For example, local authorities in the North of England may require differing provision to those in the South or Midlands.

The COVID-19 pandemic hindered recruitment for Chapter 4 which led to increasing the data collection period, which also brought questions of seasonal variation in PA for those children that were involved. Despite extending the time period, just under half of the originally projected sample size was collected, reducing this research's validity and representation of the population. Difficulties in recruitment also highlighted how key researcher engagement with schools and children's families are. In several schools low up take of research participation was seen and this could be attributed to the reduced face-to-face contact the researcher was able to have both with the school and parents. Important lessons should be learnt from this and strategies for increased participant engagement in early childhood research should be sought.

However, a strength of this research is the insightful accounts of educators on what works, why and how, and what does not work well and why, and this openness is key to moving forward. A further strength is the learning of how you do this type of research during an unprecedented pandemic. Recognising that some PA settings still have access restriction for researchers, e.g., day centres and care homes, this research provides important and informative insights of how issues of research access can be addressed in other contexts.

Chapter 5 although novel in its nature, cannot be considered a complete IM process. As mentioned throughout this chapter, not all programme materials or full steps were drafted or completed, for example, the pre-testing of materials created in Step 4. Although this may be considered a limitation, Chapter 5 provides a strong basis for continued research and post-doctoral research of the full IM process. It is also unrealistic to expect a full scale IM project that involves the participation and effort of key stake holders to be conducted without renumeration or payment for time (National Institute for Heath and Care Research, 2022), which would usually be seen in a PhD context.

Strength should be noted in the ‘mixing’ of four data sets using a holistic IM approach that considers diverse determinants, bottom up, from the perspective of key stakeholders with the aspiration to facilitate change. The use of a mixed method approach provides an informative basis to develop intervention. With that in mind, this research provides an opportunity to share findings with a diverse range of agents of change through multiple pathways and media, to have a positive beneficial impact. In doing so, as aspiring to a key IM principle of ‘intervening’.

6.4 Researcher reflection

A PhD should not only reflect the original contributions to the topic and scientific knowledge, but also reflect the growth of the researcher, through any lessons, challenges, and successes throughout the process. This brief section will discuss these elements from a personal perspective, with a critical lens of appraisal of the research and researcher strengths and weaknesses to summarise the project.
This research process has taught me about:

- The complexity of research and research processes
- The difficulties and challenges of research with the general public
- Research during a pandemic and the change in the research landscape
- How PhDs need to have a ‘narrow’ focus and researcher development

Research is a multi-stage process that requires thorough and in-depth planning, which should be written into protocol and standard operating procedures. This is important for research replication in future studies, but also to evaluate the processes of the protocols, identifying strengths and weaknesses of the chosen methods. For example, Chapter 5 of IM followed a six-step process, with each step made up of four to five different tasks. It was important to show how each step and task had been completed, or in this programme's case could be completed, so that research in the future, such as the completion of the IM process involving pre-testing of materials can be conducted.

I began this PhD having conducted only quantitative research, believing that this was 'the best kind of science'. However, mixed methods research has allowed me to explore new methods of data collection used within this current project (Chapter 3 and 5). Surprisingly to me, the rich insight from qualitative research has allowed me to develop a new perspective surrounding how research should be conducted. If the general public are to be the end users of programmes, interventions and research outcomes, then we must use their perspectives in the form of qualitative enquiry, and patient and participant involvement where appropriate. This layer of information adds further complexity to research and its development but is pivotal to making outcomes accessible to not just the research community but the public, who are the intended recipients of change interventions.

This research project has highlighted to me the difficulties that are faced when researching with the general population. Although this type of research is vital to improve public health and innovation, research with the public can be challenging for a majority of reasons. Sharing of personal information and participation within testing and measurement protocols will be unappealing to many, despite the warranted need for this information to help improve population health. This PhD came with the added challenge of not being able to offer incentives to participation within the research projects, which can help boost participation levels. Additionally, school environments can be particularly difficult settings to recruit due to such a large number of commitments in curriculums and timetables. This also ultimately leads to convenience sampling in these areas of research, which reduces its ability to represent the population accurately.

To add further complexity, six months into this PhD programme the world went into its first COVID-19 lockdown. The implications of this change in circumstances were severe for the research that had been originally planned, and ultimately led to low recruitment numbers represented in the observational study in Chapter 4. This situation forced me as a researcher to be reflexive, flexible in my approach, and imaginative. In a positive light, this created the opening for a systematic review to be researched and written in depth, leading to a successful publication with over 10 citations before the end of this PhD. The ever ongoing and changing circumstances, meant that the flexibility in approach was maintained for the following three years. I believe that a true researcher's strength is determination and willingness to try multiple avenues to engage potential participants and collect the data essential to a project's success, which I feel was demonstrated within this PhD programme particularly in section 4.7. Research in this kind of environment is novel and not explored within the literature, offering an opening to suggestion for future possible and similar situations.

As a PhD researcher, I have become aware of how it can't all be done by one person or even one research team. During conception of the research project and exploration of the literature, I realised there are many directions that could have been followed, that may add important evidence to an area, or impact (that key word in the academic research world). Narrowing my focus during my PhD to the chosen project area, as I discover more and more about the area is more difficult than I had imagined. However, this knowledge helps to give you a vision for how to develop future research and where key avenues of research exploration lie. Each time I have written 'future research should consider' a new research hypothesis and methodology has been formed in my mind. I think this desire for exploration of the research area is what has allowed me to develop as a critical researcher.

6.5 Conclusion

In conclusion this thesis aimed to improve understanding the of PA and FMS for children aged 4-5 years of age and how subsequent interventions in the educational setting should be designed, developed, and implemented for change and sustainability. The findings help to extend the existing knowledge base in this area, in particular the development and implementation of impactful interventions for this age group. The research has several novel contributions, including being the first to use IM for FMS intervention, and secondly research conducted during the COVID-19 pandemic.

Firstly, the findings from this PhD show that children are not sufficiently competent in their FMS skills, summarised by a systematic review of global literature for this age group and observational baseline data at a more local level. Therefore, the subsequent recommendations made from this PhD provide the basis and beginnings for future research, which are informed not only by data and empirical evidence, but by stakeholder opinion and knowledge to form a realist view. Importantly the completion of the IM process presented in Chapter 5 may help to begin to successfully improve the FMS of children, this will lead to better health outcomes such as reduced adiposity and improved physical and mental health during childhood and beyond.

References

Acocella, I. (2012). The focus groups in social research: Advantages and disadvantages. *Quality & Quantity*, *46*(4), 1125–1136. https://doi.org/10.1007/s11135-011-9600-4

Adamović, T., Kosanović, R., Madić, D., Ribarić-Jankes, K., Sovilj, M., & Đoković, S. (2015). Correlation between Balance Ability and Speech-Language Development in Children. *Collegium Antropologicum*, *39 Suppl 1*, 11–20.

Adeyemi-Walker, L. J., Duncan, M., Tallis, J., & Eyre, E. (2018). Fundamental Motor Skills of Children in Deprived Areas of England: A Focus on Age, Gender and Ethnicity. *Children*, *5*(8), Article 8. https://doi.org/10.3390/children5080110

Adolph, A. L., Puyau, M. R., Vohra, F. A., Nicklas, T. A., Zakeri, I. F., & Butte, N. F. (2012). Validation of Uniaxial and Triaxial Accelerometers for the Assessment of Physical Activity in Preschool Children. *Journal of Physical Activity and Health*, *9*(7), 944–953. https://doi.org/10.1123/jpah.9.7.944

Almalki, S. (2016). Integrating Quantitative and Qualitative Data in Mixed Methods Research—Challenges and Benefits. *Journal of Education and Learning*, *5*(3), 288. https://doi.org/10.5539/jel.v5n3p288

Altenburg, T. M., de Vries, L., op den Buijsch, R., Eyre, E., Dobell, A., Duncan, M., & Chinapaw, M. J. M. (2022). Cross-validation of cut-points in preschool children using different accelerometer placements and data axes. *Journal of Sports Sciences*, *0*(0), 1–7. https://doi.org/10.1080/02640414.2021.1994726

Amelia, H., Hendratno, H., & Jannah, M. (2019). The Effect of Playing Bridge Beams on the Coordination and Balance of the Body of Early Childhood. *International Journal for Educational and Vocational Studies*, *1*(1), 72. https://doi.org/10.29103/ijevs.v1i1.1499

An, M., Yi, C., Jeon, H., & Park, S. (2009). Age-related changes of single-limb standing balance in children with and without deafness. *International Journal of Pediatric Otorhinolaryngology*, *73*(11), 1539–1544. https://doi.org/10.1016/j.ijporl.2009.07.020

Anguera, M. T., Blanco-Villaseñor, A., Losada, J. L., Sánchez-Algarra, P., & Onwuegbuzie, A. J. (2018). Revisiting the difference between mixed methods and multimethods: Is it all in the name? *Quality & Quantity*, *52*(6), 2757–2770. https://doi.org/10.1007/s11135-018-0700-2

Bakrania, K., Yates, T., Rowlands, A. V., Esliger, D. W., Bunnewell, S., Sanders, J., Davies, M., Khunti, K., & Edwardson, C. L. (2016). Intensity Thresholds on Raw Acceleration Data: Euclidean Norm Minus One (ENMO) and Mean Amplitude Deviation (MAD) Approaches. *PLOS ONE*, *11*(10), e0164045. https://doi.org/10.1371/journal.pone.0164045

Balyi, I., Way, R., & Higgs, C. (2013). *Long-Term Athlete Development*. Human Kinetics.

Barnett, L. M., Minto, C., Lander, N., & Hardy, L. L. (2014). Interrater reliability assessment using the Test of Gross Motor Development-2. *Journal of Science and Medicine in Sport*, *17*(6), 667–670. https://doi.org/10.1016/j.jsams.2013.09.013

Barnett, L. M., Morgan, P. J., van Beurden, E., & Beard, J. R. (2008). Perceived sports competence mediates the relationship between childhood motor skill proficiency and adolescent physical activity and fitness: A longitudinal assessment. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 40. https://doi.org/10.1186/1479-5868-5-40

Barnett, L. M., Ridgers, N. D., & Salmon, J. (2015). Associations between young children's perceived and actual ball skill competence and physical activity. *Journal of Science and Medicine in Sport*, *18*(2), 167–171. https://doi.org/10.1016/j.jsams.2014.03.001

Barnett, L. M., Salmon, J., & Hesketh, K. D. (2016). More active pre-school children have better motor competence at school starting age: An observational cohort study. *BMC Public Health*, *16*(1), 1068. https://doi.org/10.1186/s12889-016-3742-1

Barnett, L. M., Telford, R. M., Strugnell, C., Rudd, J., Olive, L. S., & Telford, R. D. (2019). Impact of cultural background on fundamental movement skill and its correlates. *Journal of Sports Sciences*, *37*(5), 492–499. https://doi.org/10.1080/02640414.2018.1508399

Barnett, L. M., van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2009). Childhood motor skill proficiency as a predictor of adolescent physical activity. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, *44*(3), 252–259. https://doi.org/10.1016/j.jadohealth.2008.07.004

Barnett, L. M., Vazou, S., Abbott, G., Bowe, S. J., Robinson, L. E., Ridgers, N. D., & Salmon, J. (2016). Construct validity of the pictorial scale of Perceived Movement Skill Competence. *Psychology of Sport and Exercise*, *22*, 294–302. https://doi.org/10.1016/j.psychsport.2015.09.002

Barnett, L. M., Webster, E. K., Hulteen, R. M., De Meester, A., Valentini, N. C., Lenoir, M., Pesce, C., Getchell, N., Lopes, V. P., Robinson, L. E., Brian, A., & Rodrigues, L. P. (2021). Through the Looking Glass: A Systematic Review of Longitudinal Evidence, Providing New Insight for Motor Competence and Health. *Sports Medicine*. https://doi.org/10.1007/s40279-021-01516-8

Bartholomew-Eldredge, L., Markham, C., Ruiter, R., Fernandez, M., & Kok, G. (2016). *Planning Health Promotion Programs: An Intervention Mapping Approach* (4th ed.). Jossey-Bass.

Bedard, C., Bremer, E., Campbell, W., & Cairney, J. (2018). Evaluation of a Direct-Instruction Intervention to Improve Movement and Preliteracy Skills among Young Children: A Within-Subject Repeated-Measures Design. *Frontiers in Pediatrics, 5*. https://www.frontiersin.org/articles/10.3389/fped.2017.00298

Bentley, G. F., Goodred, J. K., Jago, R., Sebire, S. J., Lucas, P. J., Fox, K. R., Stewart-Brown, S., & Turner, K. M. (2012). Parents' views on child physical activity and their implications for physical activity parenting interventions: A qualitative study. *BMC Pediatrics*, *12*(1), 180. https://doi.org/10.1186/1471-2431-12-180

Berg, C., & LaVesser, P. (2006). The Preschool Activity Card Sort. *OTJR: Occupation, Participation and Health*, *26*, 143–151. https://doi.org/10.1177/153944920602600404

Bernard, H. R., & Bernard, H. R. (2013). *Social Research Methods: Qualitative and Quantitative Approaches*. SAGE.

Bhadoria, A., Sahoo, K., Sahoo, B., Choudhury, A., Sufi, N., & Kumar, R. (2015). Childhood obesity: Causes and consequences. *Journal of Family Medicine and Primary Care*, *4*(2), 187. https://doi.org/10.4103/2249-4863.154628

Bingham, D. D., Costa, S., Hinkley, T., Shire, K. A., Clemes, S. A., & Barber, S. E. (2016). Physical Activity During the Early Years: A Systematic Review of Correlates and Determinants.

American Journal of Preventive Medicine, *51*(3), 384–402. https://doi.org/10.1016/j.amepre.2016.04.022

Birch, S., Cummings, L., Oxford, S. W., & Duncan, M. J. (2016). Examining Relative Age Effects in Fundamental Skill Proficiency in British Children Aged 6–11 Years: *Journal of Strength and Conditioning Research*, *30*(10), 2809–2815. https://doi.org/10.1519/JSC.0000000000000526

Bisi, M. C., Pacini Panebianco, G., Polman, R., & Stagni, R. (2017). Objective assessment of movement competence in children using wearable sensors: An instrumented version of the TGMD-2 locomotor subtest. *Gait & Posture*, *56*, 42–48. https://doi.org/10.1016/j.gaitpost.2017.04.025

Bolger, L. E., Bolger, L. A., O'Neill, C., Coughlan, E., O'Brien, W., Lacey, S., Burns, C., & Bardid, F. (2020). Global levels of fundamental motor skills in children: A systematic review. *Journal of Sports Sciences*, 1–37. https://doi.org/10.1080/02640414.2020.1841405

Bonell, C., Fletcher, A., Morton, M., Lorenc, T., & Moore, L. (2012). Realist randomised controlled trials: A new approach to evaluating complex public health interventions. *Social Science & Medicine*, *75*(12), 2299–2306. https://doi.org/10.1016/j.socscimed.2012.08.032

Boyle, D. E., Marshall, N. L., & Robeson, W. W. (2003). Gender at Play: Fourth-Grade Girls and Boys on the Playground. *American Behavioral Scientist*, *46*(10), 1326–1345. https://doi.org/10.1177/0002764203046010004

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bremer, E., & Cairney, J. (2018). Fundamental Movement Skills and Health-Related Outcomes: A Narrative Review of Longitudinal and Intervention Studies Targeting Typically Developing Children. *American Journal of Lifestyle Medicine*, *12*(2), 148–159. https://doi.org/10.1177/1559827616640196

Brian, A., Getchell, N., True, L., De Meester, A., & Stodden, D. F. (2020). Reconceptualizing and Operationalizing Seefeldt's Proficiency Barrier: Applications and Future Directions. *Sports Medicine*, *50*(11), 1889–1900. https://doi.org/10.1007/s40279-020-01332-6

Britton, J., Farquharson, C., & Sibieta, L. (2019, September 19). *2019 annual report on education spending in England*. The IFS. https://doi.org/10.1920/re.ifs.2019.0162

Britton, U., Issartel, J., Symonds, J., & Belton, S. (2020). What Keeps Them Physically Active? Predicting Physical Activity, Motor Competence, Health-Related Fitness, and Perceived Competence in Irish Adolescents after the Transition from Primary to Second-Level School. *International Journal of Environmental Research and Public Health*, *17*(8), Article 8. https://doi.org/10.3390/ijerph17082874

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Brown, T., & Lalor, A. (2009). The Movement Assessment Battery for Children--Second Edition (MABC-2): A review and critique. *Physical & Occupational Therapy in Pediatrics, 29*(1), 86–103. https://doi.org/10.1080/01942630802574908

Bruininks, R. H., & Bruininks, B. D. (2005). *Bruininks-Oseretsky Test of Motor Proficiency: Manual*. Pearson Assessments; AGS Publishing.

Brussoni, M., Olsen, L. L., Pike, I., & Sleet, D. A. (2012). Risky Play and Children's Safety: Balancing Priorities for Optimal Child Development. *International Journal of Environmental Research and Public Health*, *9*(9), Article 9. https://doi.org/10.3390/ijerph9093134

Bryant, E. S., Duncan, M. J., & Birch, S. L. (2014). Fundamental movement skills and weight status in British primary school children. *European Journal of Sport Science*, *14*(7), 730–736. https://doi.org/10.1080/17461391.2013.870232

Bryant, E. S., James, R. S., Birch, S. L., & Duncan, M. (2014). Prediction of habitual physical activity level and weight status from fundamental movement skill level. *Journal of Sports Sciences*, *32*(19), 1775–1782. https://doi.org/10.1080/02640414.2014.918644

Bryman, A. (2012). *Social research methods* (4th ed). Oxford University Press.

Buchan, D. S., Ollis, S., Thomas, N. E., & Baker, J. S. (2012). Physical Activity Behaviour: An Overview of Current and Emergent Theoretical Practices. *Journal of Obesity*, *2012*, 1–11. https://doi.org/10.1155/2012/546459

Cambier, D., Cools, A., Danneels, L., & Witvrouw, E. (2001). Reference data for 4- and 5-year-old-children on the Balance Master: Values and clinical feasibility. *European Journal of Pediatrics*, *160*(5), 317–317. https://doi.org/10.1007/PL00008438

Canadian Society for Exercise Physiology. (2020). *Canadian 24-Hour Movement Guidelines for the Early Years (0–4 years): An Integration of Physical Activity, Sedentary Behaviour, and Sleep*. https://csepguidelines.ca/wp-content/themes/csep2017/pdf/PAR7972_24Hour_Guidelines_EY_En-4.pdf

Capio, C. M., Sit, C. H. P., Abernethy, B., & Masters, R. S. W. (2012). Fundamental movement skills and physical activity among children with and without cerebral palsy. *Research in Developmental Disabilities*, *33*(4), 1235–1241. https://doi.org/10.1016/j.ridd.2012.02.020

Carson, V., Lee, E.-Y., Hewitt, L., Jennings, C., Hunter, S., Kuzik, N., Stearns, J. A., Unrau, S. P., Poitras, V. J., Gray, C., Adamo, K. B., Janssen, I., Okely, A. D., Spence, J. C., Timmons, B. W., Sampson, M., & Tremblay, M. S. (2017). Systematic review of the relationships between physical activity and health indicators in the early years (0-4 years). *BMC Public Health*, *17*(S5), 854. https://doi.org/10.1186/s12889-017-4860-0

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical Activity, Exercise, and Physical Fitness: Definitions and Distinctions for Health-Related Research. *Public Health Reports*, *100*(2), 6.

Chandler, J. L., Brazendale, K., Beets, M. W., & Mealing, B. A. (2016). Classification of physical activity intensities using a wrist-worn accelerometer in 8-12-year-old children. *Pediatric Obesity*, *11*(2), 120–127. https://doi.org/10.1111/ijpo.12033

Chesham, R. A., Booth, J. N., Sweeney, E. L., Ryde, G. C., Gorely, T., Brooks, N. E., & Moran, C. N. (2018). The Daily Mile makes primary school children more active, less sedentary and improves their fitness and body composition: A quasi-experimental pilot study. *BMC Medicine*, *16*(1), 64. https://doi.org/10.1186/s12916-018-1049-z

Cheung, P. (2020). Teachers as role models for physical activity: Are preschool children more active when their teachers are active? *European Physical Education Review*, *26*(1), 101–110. https://doi.org/10.1177/1356336X19835240

Chow, B. C., & Chan, L. (2011). Gross motor skills of Hong Kong preschool children. *Scholarly Articles for Asian J. Phys. Educ. Recreat Physical Fitness, Physical Activity and Sedentary … - Esmaeilzadeh - Cited by 51 Secular Trends and Contemporary Differences in … - Hong - CitAsian Journal of Physical Education and Recreation*, *17*(1), 71–77.

Chow, J. Y., & Atencio, M. (2014). Complex and nonlinear pedagogy and the implications for physical education. *Sport, Education and Society*, *19*(8), 1034–1054. https://doi.org/10.1080/13573322.2012.728528

Chung, R. J., Mackie, A. S., Baker, A., & Ferranti, S. D. de. (2020). Cardiovascular Risk and Cardiovascular Health Behaviours in the Transition From Childhood to Adulthood. *Canadian Journal of Cardiology*, *36*(9), 1448–1457. https://doi.org/10.1016/j.cjca.2020.05.041

Cliff, D. P., Okely, A. D., Smith, L. M., & McKeen, K. (2009). Relationships between Fundamental Movement Skills and Objectively Measured Physical Activity in Preschool Children. *Pediatric Exercise Science*, *21*(4), 436–449. https://doi.org/10.1123/pes.21.4.436

Cliff, D. P., Reilly, J. J., & Okely, A. D. (2009). Methodological considerations in using accelerometers to assess habitual physical activity in children aged 0–5 years. *Journal of Science and Medicine in Sport*, *12*(5), 557–567. https://doi.org/10.1016/j.jsams.2008.10.008

Condello, G., Puggina, A., Aleksovska, K., Buck, C., Burns, C., Cardon, G., Carlin, A., Simon, C., Ciarapica, D., Coppinger, T., Cortis, C., D'Haese, S., De Craemer, M., Di Blasio, A., Hansen, S., Iacoviello, L., Issartel, J., Izzicupo, P., Jaeschke, L., & Boccia, S. (2017). Behavioral determinants of physical activity across the life course: A 'DEterminants of DIet and Physical ACtivity' (DEDIPAC) umbrella systematic literature review. *International Journal of Behavioral Nutrition and Physical Activity*, *14*. https://doi.org/10.1186/s12966-017-0510-2

Condon, C., & Cremin, K. (2014). Static Balance Norms in Children: Balance, Temporal, Stance, Tandem, Single Leg. *Physiotherapy Research International*, *19*(1), 1–7. https://doi.org/10.1002/pri.1549

Cools, W., De Martelaer, K., Samaey, C., & Andries, C. (2011). Fundamental movement skill performance of preschool children in relation to family context. *Journal of Sports Sciences*, *29*(7), 649–660. https://doi.org/10.1080/02640414.2010.551540

Cooper, A. R., Page, A. S., Wheeler, B. W., Hillsdon, M., Griew, P., & Jago, R. (2010). *Patterns of GPS measured time outdoors after school and objective physical activity in English children: The PEACH project*. 9.

Cooper, J., Murphy, J., Woods, C., Van Nassau, F., McGrath, A., Callaghan, D., Carroll, P., Kelly, P., Murphy, N., Murphy, M., Irish Physical Activity Research Collaboration (I-PARC), Bauman, A., Cullen, B., Brolly, C., Bengoechea, E. G., Mansergh, F., O'Donoghue, G., Lavelle, J., Mutrie, N., … Muppavarapu, V. (2021). Barriers and facilitators to implementing community-based physical activity interventions: A qualitative systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 118. https://doi.org/10.1186/s12966-021-01177-w

Costa, C. L. A., Cattuzzo, M. T., Stodden, D. F., & Ugrinowitsch, H. (2021). Motor competence in fundamental motor skills and sport skill learning: Testing the proficiency barrier hypothesis. *Human Movement Science*, *80*, 102877. https://doi.org/10.1016/j.humov.2021.102877

Craig-Unkefer, L. A., & Kaiser, A. P. (2002). Improving the Social Communication Skills of At-Risk Preschool Children in a Play Context. *Topics in Early Childhood Special Education*, *22*(1), 3–13. https://doi.org/10.1177/027112140202200101

Craike, M., Wiesner, G., Hilland, T. A., & Bengoechea, E. G. (2018). Interventions to improve physical activity among socioeconomically disadvantaged groups: An umbrella review. *International Journal of Behavioral Nutrition and Physical Activity*, *15*(1), 43. https://doi.org/10.1186/s12966-018-0676-2

Creswell, J. W. (2012). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed.). Sage.

Crocker, P. R., Eklund, R. C., & Kowalski, K. C. (2000). Children's physical activity and physical self-perceptions. *Journal of Sports Sciences*, *18*(6), 383–394. https://doi.org/10.1080/02640410050074313

Crotti, M., Foweather, L., Rudd, J. R., Hurter, L., Schwarz, S., & Boddy, L. M. (2020). Development of raw acceleration cut-points for wrist and hip accelerometers to assess sedentary behaviour and physical activity in 5–7-year-old children. *Journal of Sports Sciences*, *38*(9), 1036–1045. https://doi.org/10.1080/02640414.2020.1740469

Crotti, M., Rudd, J. R., Roberts, S., Boddy, L. M., Fitton Davies, K., O'Callaghan, L., Utesch, T., & Foweather, L. (2021). Effect of Linear and Nonlinear Pedagogy Physical Education Interventions on Children's Physical Activity: A Cluster Randomized Controlled Trial (SAMPLE-PE). *Children*, *8*(1), 49. https://doi.org/10.3390/children8010049

Dahlgren, G., & Whitehead, M. (1991). Policies and strategies to promote social equity in health. Background document to WHO - Strategy paper for Europe. In *Arbetsrapport* (2007:14; Arbetsrapport). Institute for Futures Studies. https://ideas.repec.org/p/hhs/ifswps/2007_014.html

Daly-Smith, A., Quarmby, T., Archbold, V. S. J., Corrigan, N., Wilson, D., Resaland, G. K., Bartholomew, J. B., Singh, A., Tjomsland, H. E., Sherar, L. B., Chalkley, A., Routen, A. C., Shickle, D., Bingham, D. D., Barber, S. E., van Sluijs, E., Fairclough, S. J., & McKenna, J. (2020). Using a multi-stakeholder experience-based design process to co-develop the Creating Active Schools Framework. *International Journal of Behavioral Nutrition and Physical Activity*, *17*(1), 13. https://doi.org/10.1186/s12966-020-0917-z

de Almeida Mendes, M., da Silva, I. C. M., Ramires, V. V., Reichert, F. F., Martins, R. C., & Tomasi, E. (2018). Calibration of raw accelerometer data to measure physical activity: A systematic review. *Gait & Posture*, *61*, 98–110. https://doi.org/10.1016/j.gaitpost.2017.12.028

De Oliveira, J. A., Rigoli, D., Kane, R., McLaren, S., Goulardins, J. B., Straker, L. M., Dender, A., Rooney, R., & Piek, J. P. (2019). Does 'Animal Fun' improve aiming and catching, and balance skills in young children? *Research in Developmental Disabilities*, *84*, 122–130. https://doi.org/10.1016/j.ridd.2018.07.004

de Waal, E. (2019). Fundamental Movement Skills and Academic Performance of 5- to 6-Year-Old Preschoolers. *Early Childhood Education Journal*, *47*(4), 455–464. https://doi.org/10.1007/s10643-019-00936-6

Denscombe, M. (2008). Communities of Practice: A Research Paradigm for the Mixed Methods Approach. *Journal of Mixed Methods Research*, *2*(3), 270–283. https://doi.org/10.1177/1558689808316807

Department for Education. (2013). *Physical Education Programmes of Study: Key Stages 1 and 2. National Curriculum in England*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/23904 0/PRIMARY_national_curriculum_-_Physical_education.pdf

Department for Education. (2014). *PE and sport premium for primary schools*. GOV.UK. https://www.gov.uk/guidance/pe-and-sport-premium-for-primary-schools

Department for Education. (2017). *Statutory framework for the early years foundation stage Setting the standards for learning, development and care for children from birth to five*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/596629/EYFS_STATUTORY_FRAMEWORK_2017.pdf

Department for Education. (2019). *School sport and activity action plan*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/848082/School_sport_and_activity_action_plan.pdf

Department for Education. (2020a). *Guidance: PE and sport premium for primary schools.* https://www.gov.uk/guidance/pe-and-sport-premium-for-primary-schools#how-to-use-the-pe-and-sport-premium

Department for Education. (2020b). *School teacher workforce*. https://www.ethnicity-facts-figures.service.gov.uk/workforce-and-business/workforce-diversity/school-teacher-workforce/latest#:~:text=This%20data%20shows%20that%3A%201%20in%202018%2C%20around,those%20whose%20ethnicity%20was%20known%29%20More%20items...%20

Department for Education. (2021). *Statutory framework for the early years foundation stage Setting the standards for learning, development and care for children from birth to five*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/974907/EYFS_framework_-_March_2021.pdf

Department for Health and Social Care. (2019a). *Physical activity guidelines: UK Chief Medical Officers' report*. GOV.UK. https://www.gov.uk/government/publications/physical-activity-guidelines-uk-chief-medical-officers-report

Department for Health and Social Care. (2019b). *UK Chief Medical Officers' Physical Activity for early years*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/82988 2/1-physical-activity-for-early-years-birth-to-5.pdf

D'Hondt, E., Deforche, B., De Bourdeaudhuij, I., & Lenoir, M. (2009). Relationship between Motor Skill and Body Mass Index in 5- to 10-Year-Old Children. *Adapted Physical Activity Quarterly*, *26*(1), 21–37. https://doi.org/10.1123/apaq.26.1.21

Dishman, R. K., Washburn, R. A., & Schoeller, D. A. (2001). Measurement of Physical Activity. *Quest*, *53*(3), 295–309. https://doi.org/10.1080/00336297.2001.10491746

Dobell, A. P., Eyre, E. L. J., Tallis, J., Chinapaw, M. J. M., Altenburg, T. M., & Duncan, M. J. (2019). Examining accelerometer validity for estimating physical activity in pre-schoolers during free-living activity. *Scandinavian Journal of Medicine & Science in Sports*, *29*(10), 1618–1628. https://doi.org/10.1111/sms.13496

Dobell, A., Pringle, A., Faghy, M. A., & Roscoe, C. M. P. (2020). Fundamental Movement Skills and Accelerometer-Measured Physical Activity Levels during Early Childhood: A Systematic Review. *Children*, *7*(11), 224. https://doi.org/10.3390/children7110224

Dobell, A., Pringle, A., Faghy, M. A., & Roscoe, C. M. P. (2021). Educators Perspectives on the Value of Physical Education, Physical Activity and Fundamental Movement Skills for Early Years Foundation Stage Children in England. *Children*, *8*(5), Article 5. https://doi.org/10.3390/children8050338

Domville, M. S., Watson, P. M., Richardson, D. J., & Graves, L. E. F. (2019). Educator perspectives on factors influencing children's school-based physical activity. *Health Promotion International*, *34*(5), 931–940. https://doi.org/10.1093/heapro/day041

Donath, L., Faude, O., Hagmann, S., Roth, R., & Zahner, L. (2015). Fundamental movement skills in preschoolers: A randomized controlled trial targeting object control proficiency: Object control training in pre-schoolers. *Child: Care, Health and Development*, *41*(6), 1179–1187. https://doi.org/10.1111/cch.12232

Duff, C., Issartel, J., O' Brien, W., & Belton, S. (2019). Physical Activity and Fundamental Movement Skills of 3- to 5-Year-Old Children in Irish Preschool Services. *Journal of Motor Learning and Development*, *7*(3), 354–373. https://doi.org/10.1123/jmld.2018-0041

Duncan, M. J., Dobell, A., Noon, M., Clark, C. C. T., Roscoe, C. M. P., Faghy, M. A., Stodden, D., Sacko, R., & Eyre, E. L. J. (2020). Calibration and Cross-Validation of Accelerometery for Estimating Movement Skills in Children Aged 8–12 Years. *Sensors*, *20*(10), Article 10. https://doi.org/10.3390/s20102776

Duncan, M. J., Eyre, E. L. J., Cox, V., Roscoe, C. M. P., Faghy, M. A., Tallis, J., & Dobell, A. (2020). Cross-validation of Actigraph derived accelerometer cut-points for assessment of sedentary behaviour and physical activity in children aged 8-11 years. *Acta Paediatrica*, *109*(9), 1825–1830. https://doi.org/10.1111/apa.15189

Duncan, M. J., Foweather, L., Bardid, F., Barnett, A. L., Rudd, J., O'Brien, W., Foulkes, J. D., Roscoe, C., Issartel, J., Stratton, G., & Clark, C. C. T. (2022). Motor Competence Among Children in the United Kingdom and Ireland: An Expert Statement on Behalf of the International Motor Development Research Consortium. *Journal of Motor Learning and Development*, *1*(aop), 1–20. https://doi.org/10.1123/jmld.2021-0047

Duncan, M. J., Hall, C., Eyre, E., Barnett, L. M., & James, R. S. (2021). Pre-schoolers fundamental movement skills predict BMI, physical activity, and sedentary behavior: A longitudinal study. *Scandinavian Journal of Medicine & Science in Sports*, *31*(S1), 8–14. https://doi.org/10.1111/sms.13746

Duncan, M. J., Roscoe, C. M., Noon, M., Clark, C. C., O'Brien, W., & Eyre, E. L. (2019a). Run, jump, throw and catch: How proficient are children attending English schools at the fundamental motor skills identified as key within the school curriculum? *European Physical Education Review*, *26*(4), 814–826.

Duncan, M. J., Roscoe, C. M., Noon, M., Clark, C. C., O'Brien, W., & Eyre, E. L. (2019b). Run, jump, throw and catch: How proficient are children attending English schools at the fundamental motor skills identified as key within the school curriculum? *European Physical Education Review*, *26*(4), 814–826. https://doi.org/10.1177/1356336X19888953

Duncan, M. J., Roscoe, C. M. P., Faghy, M., Tallis, J., & Eyre, E. L. J. (2019). Estimating Physical Activity in Children Aged 8–11 Years Using Accelerometry: Contributions From Fundamental Movement Skills and Different Accelerometer Placements. *Frontiers in Physiology*, *10*. https://doi.org/10.3389/fphys.2019.00242

Dwyer, G. M., Higgs, J., Hardy, L. L., & Baur, L. A. (2008). What do parents and preschool staff tell us about young children's physical activity: A qualitative study. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 66. https://doi.org/10.1186/1479-5868-5-66

Ebbeling, C. B., Pawlak, D. B., & Ludwig, D. S. (2002). Childhood obesity: Public-health crisis, common sense cure. *The Lancet*, *360*(9331), 473–482. https://doi.org/10.1016/S0140-6736(02)09678-2

Eddy, L. H., Bingham, D. D., Crossley, K. L., Shahid, N. F., Ellingham-Khan, M., Otteslev, A., Figueredo, N. S., Mon-Williams, M., & Hill, L. J. B. (2020). The validity and reliability of observational assessment tools available to measure fundamental movement skills in school-age children: A systematic review. *PLOS ONE*, *15*(8), e0237919. https://doi.org/10.1371/journal.pone.0237919

Eddy, L., Hill, L. J. B., Mon-Williams, M., Preston, N., Daly-Smith, A., Medd, G., & Bingham, D. D. (2021). Fundamental Movement Skills and Their Assessment in Primary Schools from the Perspective of Teachers. *Measurement in Physical Education and Exercise Science*, *25*(3), 236–249. https://doi.org/10.1080/1091367X.2021.1874955

Edwardson, C. L., & Gorely, T. (2010). Parental influences on different types and intensities of physical activity in youth: A systematic review. *Psychology of Sport and Exercise*, *11*(6), 522–535. https://doi.org/10.1016/j.psychsport.2010.05.001

Ekelund, U., Luan, J., Sherar, L. B., Esliger, D. W., Griew, P., Cooper, A., & International Children's Accelerometry Database (ICAD) Collaborators, for the. (2012). Moderate to Vigorous Physical Activity and Sedentary Time and Cardiometabolic Risk Factors in Children and Adolescents. *JAMA*, *307*(7), 704–712. https://doi.org/10.1001/jama.2012.156

Eldredge, L. K. B., Markham, C. M., Ruiter, R. A., Fernández, M. E., Kok, G., & Parcel, G. S. (2016). *Planning health promotion programs: An intervention mapping approach* (4th ed.). Jossey-Bass.

Engel, A. C., Broderick, C. R., van Doorn, N., Hardy, L. L., & Parmenter, B. J. (2018). Exploring the Relationship Between Fundamental Motor Skill Interventions and Physical Activity Levels in Children: A Systematic Review and Meta-analysis. *Sports Medicine*, *48*(8), 1845–1857. https://doi.org/10.1007/s40279-018-0923-3

Eshaghi, Z., Jafari, Z., & Jalaie, S. (2015). Static balance function in children with a history of preterm birth. *Medical Journal of the Islamic Republic of Iran*, *29*, 310.

Essiet, I. A., Warner, E., Lander, N. J., Salmon, J., Duncan, M. J., Eyre, E. L. J., & Barnett, L. M. (2022). Exploring Australian teachers' perceptions of physical literacy: A mixed-methods study. *Physical Education and Sport Pedagogy*, *0*(0), 1–20. https://doi.org/10.1080/17408989.2022.2028760

Evenson, K. R., Catellier, D. J., Gill, K., Ondrak, K. S., & McMurray, R. G. (2008). Calibration of two objective measures of physical activity for children. *Journal of Sports Sciences*, *26*(14), 1557–1565. https://doi.org/10.1080/02640410802334196

Eyre, E. L. J., Adeyemi, L. J., Cook, K., Noon, M., Tallis, J., & Duncan, M. (2022). Barriers and Facilitators to Physical Activity and FMS in Children Living in Deprived Areas in the UK: Qualitative Study. *International Journal of Environmental Research and Public Health*, *19*(3), Article 3. https://doi.org/10.3390/ijerph19031717

Eyre, E. L. J., Duncan, M. J., Smith, E. C., & Matyka, K. A. (2013). Objectively measured patterns of physical activity in primary school children in Coventry: The influence of ethnicity. *Diabetic Medicine: A Journal of the British Diabetic Association*, *30*(8), 939–945. https://doi.org/10.1111/dme.12186

Eyre, E. L. J., Walker, L. J., & Duncan, M. J. (2018). Fundamental Movement Skills of Children Living in England: The Role of Ethnicity and Native English Language. *Perceptual and Motor Skills*, *125*(1), 5–20. https://doi.org/10.1177/0031512517745437

Fairclough, S. J., Noonan, R., Rowlands, A. V., Van Hees, V., Knowles, Z., & Boddy, L. M. (2016a). Wear Compliance and Activity in Children Wearing Wrist- and Hip-Mounted Accelerometers. *Medicine and Science in Sports and Exercise*, *48*(2), 245–253. https://doi.org/10.1249/MSS.0000000000000771

Fairclough, S. J., Noonan, R., Rowlands, A. V., Van Hees, V., Knowles, Z., & Boddy, L. M. (2016b). Wear Compliance and Activity in Children Wearing Wrist- and Hip-Mounted Accelerometers. *Medicine & Science in Sports & Exercise*, *48*(2), 245–253. https://doi.org/10.1249/MSS.0000000000000771

Fedewa, A. L., & Ahn, S. (2011). The effects of physical activity and physical fitness on children's achievement and cognitive outcomes: A meta-analysis. *Research Quarterly for Exercise and Sport*, *82*(3), 521–535. https://doi.org/10.1080/02701367.2011.10599785

Figueroa, R., & An, R. (2017). Motor Skill Competence and Physical Activity in Preschoolers: A Review. *Maternal and Child Health Journal*, *21*(1), 136–146. https://doi.org/10.1007/s10995-016-2102-1

Fisher, A., Reilly, J. J., Kelly, L. A., Montgomery, C., Williamson, A., Paton, J. Y., & Grant, S. (2005). Fundamental Movement Skills and Habitual Physical Activity in Young Children: *Medicine & Science in Sports & Exercise*, *37*(4), 684–688. https://doi.org/10.1249/01.MSS.0000159138.48107.7D

Fitts, P., & Posner, M. (1967). *Human Performance*. Brooks/Cole.

Fogelholm, M., Nuutinen, O., Pasanen, M., Myöhänen, E., & Säätelä, T. (1999). Parent–child relationship of physical activity patterns and obesity. *International Journal of Obesity*, *23*(12), 1262–1268. https://doi.org/10.1038/sj.ijo.0801061

Foster, C., & Hillsdon, M. (2004). Changing the environment to promote health-enhancing physical activity. *Journal of Sports Sciences*, *22*(8), 755–769. https://doi.org/10.1080/02640410410001712458

Foulkes, J. D., Knowles, Z., Fairclough, S. J., Stratton, G., O'Dwyer, M., Ridgers, N. D., & Foweather, L. (2015). Fundamental Movement Skills of Preschool Children in Northwest

England. *Perceptual and Motor Skills*, *121*(1), 260–283. https://doi.org/10.2466/10.25.PMS.121c14x0

Foulkes, J. D., Knowles, Z., Fairclough, S. J., Stratton, G., O'Dwyer, M., Ridgers, N. D., & Foweather, L. (2017). Effect of a 6-Week Active Play Intervention on Fundamental Movement Skill Competence of Preschool Children: A Cluster Randomized Controlled Trial. *Perceptual and Motor Skills*, *124*(2), 393–412. https://doi.org/10.1177/0031512516685200

Foweather, L. (2015). Fundamental movement skills in relation to weekday and weekend physical activity in preschool children. *Journal of Science and Medicine in Sport*, 6.

Foweather, L., Crotti, M., Foulkes, J. D., O'Dwyer, M. V., Utesch, T., Knowles, Z. R., Fairclough, S. J., Ridgers, N. D., & Stratton, G. (2021). Foundational Movement Skills and Play Behaviors during Recess among Preschool Children: A Compositional Analysis. *Children*, *8*(7), Article 7. https://doi.org/10.3390/children8070543

Foweather, L., Knowles, Z., Ridgers, N. D., O'Dwyer, M. V., Foulkes, J. D., & Stratton, G. (2015a). Fundamental movement skills in relation to weekday and weekend physical activity in preschool children. *Journal of Science and Medicine in Sport*, *18*(6), 691–696. https://doi.org/10.1016/j.jsams.2014.09.014

Foweather, L., Knowles, Z., Ridgers, N. D., O'Dwyer, M. V., Foulkes, J. D., & Stratton, G. (2015b). Fundamental movement skills in relation to weekday and weekend physical activity in preschool children. *Journal of Science and Medicine in Sport*, *18*(6), 691–696. https://doi.org/10.1016/j.jsams.2014.09.014

Foweather, L., McWhannell, N., Henaghan, J., Lees, A., Stratton, G., & Batterham, A. M. (2008). Effect of a 9-wk. after-school multiskills club on fundamental movement skill proficiency in 8- to 9-yr.-old children: An exploratory trial. *Perceptual and Motor Skills*, *106*(3), 745–754. https://doi.org/10.2466/pms.106.3.745-754

Franjoine, M. R., Gunther, J. S., & Taylor, M. J. (2003). Pediatric Balance Scale: A Modified Version of the Berg Balance Scale for the School-Age Child with Mild to Moderate Motor Impairment. *Pediatric Physical Therapy*, *15*(2), 114–128. https://doi.org/10.1097/01.PEP.0000068117.48023.18

Frey, B. B. (2018). *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation*. SAGE Publications, Inc. https://doi.org/10.4135/9781506326139

Fujinaga, H. (2008). Static standing balance as a component of motor fitness among the 5-year-old children. *International Journal of Fitness*, *4*(2), 67–74.

Gabbard, C. P. (2018). *Life Long Motor Development* (7th ed.). Wolters Kluwer Health.

Gallahue, D. L., & Donnelly, F. C. (2003). *Developmental Physical Education for All Children* (4th ed.). Human Kinetics.

Gallahue, D. L., Ozmun, J. C., & Goodway, J. D. (2011). *Understanding Motor Development: Infants, Children, Adolescents, Adults* (7th ed.). McGraw-Hill.

Gaupp-Berghausen, M., Raser, E., Anaya-Boig, E., Avila-Palencia, I., Nazelle, A. de, Dons, E., Franzen, H., Gerike, R., Götschi, T., Iacorossi, F., Hössinger, R., Nieuwenhuijsen, M., Rojas-Rueda, D., Sanchez, J., Smeds, E., Deforth, M., Standaert, A., Stigell, E., Cole-Hunter, T., & Panis, L. I. (2019). Evaluation of Different Recruitment Methods: Longitudinal, Web-Based, Pan-European Physical Activity Through Sustainable Transport Approaches (PASTA) Project. *Journal of Medical Internet Research*, *21*(5), e11492. https://doi.org/10.2196/11492

Gayle, R., Montoye, H. J., & Philpot, J. (1977). Accuracy of Pedometers for Measuring Distance Walked. *Research Quarterly. American Alliance for Health, Physical Education and Recreation*, *48*(3), 632–636. https://doi.org/10.1080/10671315.1977.10615471

Gidley Larson, J. C., Mostofsky, S. H., Goldberg, M. C., Cutting, L. E., Denckla, M. B., & Mahone, E. M. (2007). Effects of Gender and Age on Motor Exam in Typically Developing Children. *Developmental Neuropsychology*, *32*(1), 543–562. https://doi.org/10.1080/87565640701361013

Glasgow, R. E., Vogt, T. M., & Boles, S. M. (1999). Evaluating the public health impact of health promotion interventions: The RE-AIM framework. *American Journal of Public Health*, *89*(9), 1322–1327. https://doi.org/10.2105/AJPH.89.9.1322

Goldfield, G. S., Harvey, A., Grattan, K., & Adamo, K. B. (2012). Physical Activity Promotion in the Preschool Years: A Critical Period to Intervene. *International Journal of Environmental Research and Public Health*, *9*(4), 1326–1342. https://doi.org/10.3390/ijerph9041326

Goodway, J. D., Ozmun, J. C., & Gallahue, D. L. (2019). *Understanding Motor Development: Infants, Children, Adolescents, Adults; Jones & Bartlett Learning* (8th ed.). Jones and Barlett Learning.

Goodway, J. D., Robinson, L. E., & Crowe, H. (2010). Gender Differences in Fundamental Motor Skill Development in Disadvantaged Preschoolers From Two Geographical Regions. *Research Quarterly for Exercise and Sport*, *81*(1), 17–24. https://doi.org/10.1080/02701367.2010.10599624

Gordon, E. S., Tucker, P., Burke, S. M., & Carron, A. V. (2013). Effectiveness of Physical Activity Interventions for Preschoolers: A Meta-Analysis. *Research Quarterly for Exercise and Sport*, *84*(3), 287–294. https://doi.org/10.1080/02701367.2013.813894

Goss, H. R., Shearer, C., Knowles, Z. R., Boddy, L. M., Durden-Myers, E. J., & Foweather, L. (2021). Stakeholder perceptions of physical literacy assessment in primary school children. *Physical Education and Sport Pedagogy*, 1–16. https://doi.org/10.1080/17408989.2021.1911979

Gough, D., Oliver, S., & Thomas, J. (2017). *Introducing systematic reviews* (2nd ed.). Sage.

GOV.UK. (2020). *School Starting Age*. https://www.gov.uk/schools-admissions/schoolstarting-age

Graham, M., Azevedo, L., Wright, M., & Innerd, A. L. (2021). The Effectiveness of Fundamental Movement Skill Interventions on Moderate to Vigorous Physical Activity Levels in 5- to 11-Year-Old Children: A Systematic Review and Meta-Analysis. *Sports Medicine*. https://doi.org/10.1007/s40279-021-01599-3

Greene, J. C. (2015, August 6). *Preserving Distinctions Within the Multimethod and Mixed Methods Research Merger*. The Oxford Handbook of Multimethod and Mixed Methods Research Inquiry. https://doi.org/10.1093/oxfordhb/9780199933624.013.37

Griffiths, A., Toovey, R., Morgan, P. E., & Spittle, A. J. (2018). Psychometric properties of gross motor assessment tools for children: A systematic review. *BMJ Open*, *8*(10), e021734. https://doi.org/10.1136/bmjopen-2018-021734

Griggs, G. (2010). For sale – primary physical education. £20 per hour or nearest offer. *Education 3-13*, *38*(1), 39–46. https://doi.org/10.1080/03004270903099793

Guba, E., & Lincoln, Y. (1989). *Fourth generation evaluation*. Sage.

Gubbels, J. S., Kremers, S. P. J., van Kann, D. H. H., Stafleu, A., Candel, M. J. J. M., Dagnelie, P. C., Thijs, C., & de Vries, N. K. (2011). Interaction between physical environment, social environment, and child characteristics in determining physical activity at child care. *Health Psychology*, *30*(1), 84–90. https://doi.org/10.1037/a0021586

Guffey, K., Regier, M., Mancinelli, C., & Pergami, P. (2016). Gait parameters associated with balance in healthy 2- to 4-year-old children. *Gait & Posture*, *43*, 165–169. https://doi.org/10.1016/j.gaitpost.2015.09.017

Hagenbuchner, M., Cliff, D. P., Trost, S. G., Van Tuc, N., & Peoples, G. E. (2015). Prediction of activity type in preschool children using machine learning techniques. *Journal of Science and Medicine in Sport*, *18*(4), 426–431. https://doi.org/10.1016/j.jsams.2014.06.003

Hall, C. J. S., Eyre, E. L. J., Oxford, S. W., & Duncan, M. J. (2018). *Relationships between Motor Competence, Physical Activity, and Obesity in British Preschool Aged Children*. *3*(57), 8.

Hall, J., Bingham, D. D., Seims, A., Dogra, S. A., Burkhardt, J., Nobles, J., McKenna, J., Bryant, M., Barber, S. E., & Daly-Smith, A. (2021). A whole system approach to increasing children's physical activity in a multi-ethnic UK city: A process evaluation protocol. *BMC Public Health*, *21*(1), 2296. https://doi.org/10.1186/s12889-021-12255-w

Hardy, L. L., King, L., Farrell, L., Macniven, R., & Howlett, S. (2010). Fundamental movement skills among Australian preschool children. *Journal of Science and Medicine in Sport*, 6.

Hardy, L. L., Reinten-Reynolds, T., Espinel, P., Zask, A., & Okely, A. D. (2012). Prevalence and Correlates of Low Fundamental Movement Skill Competency in Children. *Pediatrics*, *130*(2), e390–e398. https://doi.org/10.1542/peds.2012-0345

Hawkins, S. S., Cole, T. J., & Law, C. (2009). Examining the relationship between maternal employment and health behaviours in 5-year-old British children. *Journal of Epidemiology & Community Health*, *63*(12), 999–1004. https://doi.org/10.1136/jech.2008.084590

Haywood, K. M., & Getchell, N. (2019). *Life Span Motor Development*. Human Kinetics.

Heinrichs, N., Bertram, H., Kuschel, A., & Hahlweg, K. (2005). Parent Recruitment and Retention in a Universal Prevention Program for Child Behavior and Emotional Problems: Barriers to

Research and Program Participation. *Prevention Science*, *6*(4), 275–286. https://doi.org/10.1007/s11121-005-0006-1

Henderson, S. E., & Sudgden, D. A. (1992). *Movement Assessment Battery for Children*. The Psychological Corporation.

Henderson, S. E., Sudgden, D. A., & Barnett, A. L. (2007). *Movement assessment battery for children-2 second edition [Movement ABC-2]*. The Psychological Corporation.

Herlitz, L., MacIntyre, H., Osborn, T., & Bonell, C. (2020). The sustainability of public health interventions in schools: A systematic review. *Implementation Science*, *15*(1), 4. https://doi.org/10.1186/s13012-019-0961-8

Hesketh, K. R., Griffin, S. J., & van Sluijs, E. M. F. (2015). UK Preschool-aged children's physical activity levels in childcare and at home: A cross-sectional exploration. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 123. https://doi.org/10.1186/s12966-015-0286-1

Hesketh, K. R., McMinn, A. M., Ekelund, U., Sharp, S. J., Collings, P. J., Harvey, N. C., Godfrey, K. M., Inskip, H. M., Cooper, C., & van Sluijs, E. M. (2014). Objectively measured physical activity in four-year-old British children: A cross-sectional analysis of activity patterns segmented across the day. *International Journal of Behavioral Nutrition and Physical Activity*, *11*(1), 1. https://doi.org/10.1186/1479-5868-11-1

Hills, A. P., Dengel, D. R., & Lubans, D. R. (2015). Supporting Public Health Priorities: Recommendations for Physical Education and Physical Activity Promotion in Schools. *Progress in Cardiovascular Diseases*, *57*(4), 368–374. https://doi.org/10.1016/j.pcad.2014.09.010

Hinkley, T., Crawford, D., Salmon, J., Okely, A. D., & Hesketh, K. (2008). Preschool Children and Physical Activity. *American Journal of Preventive Medicine*, *34*(5), 435-441.e7. https://doi.org/10.1016/j.amepre.2008.02.001

Hoeboer, J., De Vries, S., Krijger-Hombergen, M., Wormhoudt, R., Drent, A., Krabben, K., & Savelsbergh, G. (2016). Validity of an Athletic Skills Track among 6- to 12-year-old children.

Journal of Sports Sciences, *34*(21), 2095–2105. https://doi.org/10.1080/02640414.2016.1151920

Holfelder, B., & Schott, N. (2014). Relationship of fundamental movement skills and physical activity in children and adolescents: A systematic review. *Psychology of Sport and Exercise*, *15*(4), 382–391. https://doi.org/10.1016/j.psychsport.2014.03.005

Holloway, I. (1997). *Basic concepts for qualitative research*. Blackwell.

Hong, Q. N., Pluye, P., Fàbregues, S., Barlett, G., Boardman, F., Cargo, M., Dagenais, P., Gagnon, M. P., Griffiths, F., Nicolau, B., O'Cathain, A., Rousseau, M.-C., & Vedel, I. (2018). *Mixed Methods Appraisal Tool (MMAT), Version 2018*. McGraw-Hill.

Howells, K., & Meehan, C. (2017). Walking the talk? Teachers' and early years' practitioners' perceptions and confidence in delivering the UK Physical Activity Guidelines within the curriculum for young children. *Early Child Development and Care*, 1–12.

Howie, E. K., & Straker, L. M. (2016). Rates of attrition, non-compliance and missingness in randomized controlled trials of child physical activity interventions using accelerometers: A brief methodological review. *Journal of Science and Medicine in Sport*, *19*(10), 830–836. https://doi.org/10.1016/j.jsams.2015.12.520

Hulteen, R. M., Morgan, P. J., Barnett, L. M., Stodden, D. F., & Lubans, D. R. (2018). Development of Foundational Movement Skills: A Conceptual Model for Physical Activity Across the Lifespan. *Sports Medicine*, *48*(7), 1533–1540. https://doi.org/10.1007/s40279-018-0892-6

Iacobucci, G. (2019). "Some exercise is good, more is better," say medical chiefs in new guidance. *BMJ*, *366*, l5470. https://doi.org/10.1136/bmj.l5470

Iivonen, S., & Sääkslahti, A. K. (2014). Preschool children's fundamental motor skills: A review of significant determinants. *Early Child Development and Care*, *184*(7), 1107–1126. https://doi.org/10.1080/03004430.2013.837897

International Society for Physical Activity and Health. (2020). *ISPAH's Eight Investements That Work for Physical Activity*. https://www.ispah.org/wp-content/uploads/2020/11/English-Eight-Investments-That-Work-FINAL.pdf

Jaakkola, T., Yli-Piipari, S., Huotari, P., Watt, A., & Liukkonen, J. (2016). Fundamental movement skills and physical fitness as predictors of physical activity: A 6-year follow-up study. *Scandinavian Journal of Medicine & Science in Sports*, *26*(1), 74–81. https://doi.org/10.1111/sms.12407

Jago, R., Macdonald-Wallis, C., Solomon-Moore, E., Janice, L. T., Debbie, A. L., & Simon, J. S. (2017). Associations between participation in organised physical activity in the school or community outside school hours and neighbourhood play with child physical activity and sedentary time: A cross-sectional analysis of primary school-aged children from the UK. *BMJ Open*, *7*(9), e017588. https://doi.org/10.1136/bmjopen-2017-017588

Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 40. https://doi.org/10.1186/1479-5868-7-40

Janssen, X., Cliff, D. P., Reilly, J. J., Hinkley, T., Jones, R. A., Batterham, M., Ekelund, U., Brage, S., & Okely, A. D. (2013). Predictive Validity and Classification Accuracy of ActiGraph Energy Expenditure Equations and Cut-Points in Young Children. *PLoS ONE*, *8*(11), e79124. https://doi.org/10.1371/journal.pone.0079124

Jiang, G.-P., Jiao, X.-B., Wu, S.-K., Ji, Z.-Q., Liu, W.-T., Chen, X., & Wang, H.-H. (2018). Balance, Proprioception, and Gross Motor Development of Chinese Children Aged 3 to 6 Years. *Journal of Motor Behavior*, *50*(3), 343–352. https://doi.org/10.1080/00222895.2017.1363694

Johansson, E., Ekelund, U., Nero, H., Marcus, C., & Hagströmer, M. (2015). Calibration and cross-validation of a wrist-worn Actigraph in young preschoolers. *Pediatric Obesity*, *10*(1), 1–6. https://doi.org/10.1111/j.2047-6310.2013.00213.x

Jones, D., Innerd, A., Giles, E. L., & Azevedo, L. B. (2020). Association between fundamental motor skills and physical activity in the early years: A systematic review and meta-analysis. *Journal of Sport and Health Science*, *9*(6), 542–552. https://doi.org/10.1016/j.jshs.2020.03.001

Jones, D., Innerd, A., Giles, E. L., & Azevedo, L. B. (2021). The Association between Physical Activity, Motor Skills and School Readiness in 4–5-Year-Old Children in the Northeast of

England. *International Journal of Environmental Research and Public Health*, *18*(22), Article 22. https://doi.org/10.3390/ijerph182211931

Jones, L., & Green, K. (2017). Who teaches primary physical education? Change and transformation through the eyes of subject leaders. *Sport, Education and Society*, *22*(6), 759–771. https://doi.org/10.1080/13573322.2015.1061987

Jones, R. A., Hinkley, T., Okely, A. D., & Salmon, J. (2013). Tracking physical activity and sedentary behavior in childhood: A systematic review. *American Journal of Preventive Medicine, 44*(6), 651–658. https://doi.org/10.1016/j.amepre.2013.03.001

Jones, R. A., Riethmuller, A., Hesketh, K., Trezise, J., Batterham, M., & Okely, A. D. (2011). Promoting fundamental movement skill development and physical activity in early childhood settings: A cluster randomized controlled trial. *Pediatric Exercise Science, 23*(4), 600–615. https://doi.org/10.1123/pes.23.4.600

Jung, H.-K., Chung, E., & Lee, B.-H. (2017). A comparison of the balance and gait function between children with Down syndrome and typically developing children. *Journal of Physical Therapy Science*, *29*(1), 123–127. https://doi.org/10.1589/jpts.29.123

Kaboub, F. (2008). Positivist paradigm. *Encyclopaedia of Counselling*, *2*(2), 343.

Karas, M., Bai, J., Strączkiewicz, M., Harezlak, J., Glynn, N. W., Harris, T., Zipunnikov, V., Crainiceanu, C., & Urbanek, J. K. (2019). Accelerometry Data in Health Research: Challenges and Opportunities: Review and Examples. *Statistics in Biosciences*, *11*(2), 210–237. https://doi.org/10.1007/s12561-018-9227-2

Kayser, J. W., Cossette, S., & Alderson, M. (2014). Autonomy-supportive intervention: An evolutionary concept analysis. *Journal of Advanced Nursing*, *70*(6), 1254–1266. https://doi.org/10.1111/jan.12292

Kelly, L. A., Reilly, J. J., Fisher, A., Montgomery, C., Williamson, A., McColl, J. H., Paton, J. Y., & Grant, S. (2006). Effect of socioeconomic status on objectively measured physical activity. *Archives of Disease in Childhood*, *91*(1), 35–38. https://doi.org/10.1136/adc.2005.080275

Kelly, P., Kahlmeier, S., Götschi, T., Orsini, N., Richards, J., Roberts, N., Scarborough, P., & Foster, C. (2014). Systematic review and meta-analysis of reduction in all-cause mortality from walking and cycling and shape of dose response relationship. *International Journal of Behavioral Nutrition and Physical Activity*, *11*(1), 132. https://doi.org/10.1186/s12966-014-0132-x

Khanom, A., Evans, B. A., Lynch, R., Marchant, E., Hill, R. A., Morgan, K., Rapport, F., Lyons, R. A., & Brophy, S. (2020). Parent recommendations to support physical activity for families with young children: Results of interviews in deprived and affluent communities in South Wales (United Kingdom). *Health Expectations*, *23*(2), 284–295. https://doi.org/10.1111/hex.13020

King-Dowling, S., Proudfoot, N. A., Cairney, J., & Timmons, B. W. (2020). Motor Competence, Physical Activity, and Fitness across Early Childhood. *Medicine & Science in Sports & Exercise*, *52*(11), 2342–2348. https://doi.org/10.1249/MSS.0000000000002388

Kiphard, E. J., & Schilling, F. (1974). *KörperkoordinationsTest für Kinder*. Weinheim.

Klesges, R. C., Eck, L. H., Hanson, C. L., Haddock, C. K., & Klesges, L. M. (1990). Effects of obesity, social interactions, and physical environment on physical activity in preschoolers. *Health Psychology*, *9*(4), 435–449. https://doi.org/10.1037/0278-6133.9.4.435

Klingberg, B., Schranz, N., Barnett, L. M., Booth, V., & Ferrar, K. (2019). The feasibility of fundamental movement skill assessments for pre-school aged children. *Journal of Sports Sciences*, *37*(4), 378–386. https://doi.org/10.1080/02640414.2018.1504603

Kneale, D., Rojas-García, A., & Thomas, J. (2019). Obstacles and opportunities to using research evidence in local public health decision-making in England. *Health Research Policy and Systems*, *17*(1), 61. https://doi.org/10.1186/s12961-019-0446-x

Kok, G., Gottlieb, N. H., Peters, G.-J. Y., Mullen, P. D., Parcel, G. S., Ruiter, R. A. C., Fernández, M. E., Markham, C., & Bartholomew, L. K. (2016). A taxonomy of behaviour change methods: An Intervention Mapping approach. *Health Psychology Review*, *10*(3), 297–312. https://doi.org/10.1080/17437199.2015.1077155

Konstabel, K., Chopra, S., Ojiambo, R., Muñiz-Pardos, B., & Pitsiladfis, Y. (2019). Accelerometry-based Physical Activity Assessment for Children and Adolescents. In *Instruments for Health Surveys in Children and Adolescents* (pp. 135–173). Springer.

Kriska, A., & Caspersen, C. (1997). *Introduction to a Collection of Physical Activity Questionnaires*. https://doi.org/10.1097/00005768-199706001-00003

Krombholz, H. (2006). Physical Performance in Relation to Age, Sex, Birth Order, Social Class, and Sports Activities of Preschool Children. *Perceptual and Motor Skills*, *102*(2), 477–484. https://doi.org/10.2466/pms.102.2.477-484

Labonté, R., Feather, J., & Hills, M. (1999). A story/dialogue method for health promotion knowledge development and evaluation. *Health Education Research*, *14*, 39–50. https://doi.org/10.1093/her/14.1.39

Lakerveld, J., Woods, C., Hebestreit, A., Brenner, H., Flechtner-Mors, M., Harrington, J. M., Kamphuis, C. B. M., Laxy, M., Luszczynska, A., Mazzocchi, M., Murrin, C., Poelman, M., Steenhuis, I., Roos, G., Steinacker, J. M., Stock, C. C., van Lenthe, F., Zeeb, H., Zukowska, J., & Ahrens, W. (2020). Advancing the evidence base for public policies impacting on dietary behaviour, physical activity and sedentary behaviour in Europe: The Policy Evaluation Network promoting a multidisciplinary approach. *Food Policy*, *96*, 101873. https://doi.org/10.1016/j.foodpol.2020.101873

Lander, N., Eather, N., Morgan, P. J., Salmon, J., & Barnett, L. M. (2017). Characteristics of Teacher Training in School-Based Physical Education Interventions to Improve Fundamental Movement Skills and/or Physical Activity: A Systematic Review. *Sports Medicine*, *47*(1), 135–161. https://doi.org/10.1007/s40279-016-0561-6

Lander, N., Morgan, P. J., Salmon, J., & Barnett, L. M. (2016). Teachers' Perceptions of a Fundamental Movement Skill (FMS) Assessment Battery in a School Setting. *Measurement in Physical Education and Exercise Science*, *20*(1), 50–62. https://doi.org/10.1080/1091367X.2015.1095758

Langford, R., Jago, R., White, J., Moore, L., Papadaki, A., Hollingworth, W., Metcalfe, C., Ward, D., Campbell, R., Wells, S., & Kipping, R. (2019). A physical activity, nutrition and oral health intervention in nursery settings: Process evaluation of the NAP SACC UK feasibility cluster RCT. *BMC Public Health*, *19*(1), 865. https://doi.org/10.1186/s12889-019-7102-9

Latorre Román, P. Á., Mora López, D., Robles Fuentes, A., & García Pinillos, F. (2017). Reference Values of Static Balance in Spanish Preschool Children. *Perceptual and Motor Skills*, *124*(4), 740–753. https://doi.org/10.1177/0031512517708528

Lawless, W., Borlase-Bune, M., & Fleet, M. (2019). The primary PE and sport premium from a staff perspective. *Education 3-13*, *48*(4), 446–454. https://doi.org/10.1080/03004279.2019.1617327

Lawson, C., Eyre, E. L. J., Tallis, J., & Duncan, M. J. (2021a). Fundamental Movement Skill Proficiency Among British Primary School Children: Analysis at a Behavioral Component Level. *Perceptual and Motor Skills*, 003151252199033. https://doi.org/10.1177/0031512521990330

Lawson, C., Eyre, E. L. J., Tallis, J., & Duncan, M. J. (2021b). Fundamental Movement Skill Proficiency Among British Primary School Children: Analysis at a Behavioral Component Level. *Perceptual and Motor Skills*, *128*(2), 625–648. https://doi.org/10.1177/0031512521990330

Lazar, I., & Darlington, R. B. (1982). Lasting effects of early education: A report from the Consortium for Longitudinal Studies. *Monographs of the Society for Research in Child Development*, *47*(2–3), 1–151. https://doi.org/10.2307/1165938

Li, B., Liu, J., & Ying, B. (2022). Physical education interventions improve the fundamental movement skills in kindergarten: A systematic review and meta-analysis. *Food Science and Technology*, *42*, e46721. https://doi.org/10.1590/fst.46721

Li, S., Howard, J. T., Sosa, E. T., Cordova, A., Parra-Medina, D., & Yin, Z. (2020). Calibrating Wrist-Worn Accelerometers for Physical Activity Assessment in Preschoolers: Machine Learning Approaches. *JMIR Formative Research*, *4*(8), e16727. https://doi.org/10.2196/16727

Lima, R. A., Pfeiffer, K., Larsen, L. R., Bugge, A., Moller, N. C., Anderson, L. B., & Stodden, D. F. (2017). Physical Activity and Motor Competence Present a Positive Reciprocal Longitudinal Relationship Across Childhood and Early Adolescence. *Journal of Physical Activity and Health*, *14*(6), 440–447. https://doi.org/10.1123/jpah.2016-0473

Lloyd, R. S., & Oliver, J. L. (2012). The Youth Physical Development Model: A New Approach to Long-Term Athletic Development. *Strength & Conditioning Journal*, *34*(3), 61–72. https://doi.org/10.1519/SSC.0b013e31825760ea

Logan, S. W., Robinson, L. E., Wilson, A. E., & Lucas, W. A. (2012a). Getting the fundamentals of movement: A meta-analysis of the effectiveness of motor skill interventions in children. *Child: Care, Health and Development*, *38*(3), 305–315. https://doi.org/10.1111/j.1365-2214.2011.01307.x

Logan, S. W., Robinson, L. E., Wilson, A. E., & Lucas, W. A. (2012b). Getting the fundamentals of movement: A meta-analysis of the effectiveness of motor skill interventions in children: Effectiveness of motor skill interventions. *Child: Care, Health and Development*, *38*(3), 305–315. https://doi.org/10.1111/j.1365-2214.2011.01307.x

Logan, S. W., Ross, S. M., Chee, K., Stodden, D. F., & Robinson, L. E. (2018). Fundamental motor skills: A systematic review of terminology. *Journal of Sports Sciences*, *36*(7), 781–796. https://doi.org/10.1080/02640414.2017.1340660

Logan, S. W., Webster, E. K., Getchell, N., Pfeiffer, K. A., & Robinson, L. E. (2015). Relationship Between Fundamental Motor Skill Competence and Physical Activity During Childhood and Adolescence: A Systematic Review. *Kinesiology Review*, *4*(4), 416–426. https://doi.org/10.1123/kr.2013-0012

Logan, S., Webster, E., Getchell, N., Pfeiffer, K., & Robinson, L. (2015). Relationship Between Fundamental Motor Skill Competence and Physical Activity During Childhood and Adolescence: A Systematic Review. *Kinesiology Review*, *4*, 416–426. https://doi.org/10.1123/kr.2013-0012

Lonsdale, C., Rosenkranz, R. R., Peralta, L. R., Bennie, A., Fahey, P., & Lubans, D. R. (2013). A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. *Preventive Medicine*, *56*(2), 152–161. https://doi.org/10.1016/j.ypmed.2012.12.004

Loprinzi, P. D., & Cardinal, B. J. (2011). Measuring Children's Physical Activity and Sedentary Behaviors. *Journal of Exercise Science & Fitness*, *9*(1), 15–23. https://doi.org/10.1016/S1728-869X(11)60002-6

Ma, J., Hogan, M. J., Eyre, E. L. J., Lander, N., Barnett, L. M., & Duncan, M. J. (2020). Using Collective Intelligence to identify barriers to implementing and sustaining effective Fundamental Movement Skill interventions: A rationale and application example. *Journal of Sports Sciences*. https://www.tandfonline.com/doi/abs/10.1080/02640414.2020.1841395

Ma, J., Hogan, M. J., Eyre, E. L. J., Lander, N., Barnett, L. M., & Duncan, M. J. (2021). Enhancing the implementation and sustainability of fundamental movement skill interventions in the UK and Ireland: Lessons from collective intelligence engagement with stakeholders. *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 144. https://doi.org/10.1186/s12966-021-01214-8

Malina, R. M. (2004). Motor Development during Infancy and Early Childhood: Overview and Suggested Directions for Research. *International Journal of Sport and Health Science*, *2*, 50–66. https://doi.org/10.5432/ijshs.2.50

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, Maturation, and Physical Activity*. Human Kinetics.

Maltagliati, S., Carraro, A., Escriva-Boulley, G., Bertollo, M., Tessier, D., Colangelo, A., Papaioannou, A. G., Fronso, S. di, Cheval, B., Gobbi, E., & Sarrazin, P. (2021). *Changes in Physical Education Teachers' Motivations Predict the Evolution of Behaviors Promoting Students' Physical Activity During the COVID-19 Lockdown*. SportRxiv. https://doi.org/10.31236/osf.io/h4mw8

Mann, C. M., Ward, D. S., Vaughn, A., Benjamin Neelon, S. E., Long Vidal, L. J., Omar, S., Namenek Brouwer, R. J., & Østbye, T. (2015). Application of the Intervention Mapping protocol to develop Keys, a family child care home intervention to prevent early childhood obesity. *BMC Public Health*, *15*(1), 1227. https://doi.org/10.1186/s12889-015-2573-9

Marin, F. (2012). Ascertaining Study on the Manifestation Level of the Ability to Balance at Children of 4–5 Years Rural Area. *Ovidius" University Annals. Series Physical Education and Sport. Science, Movement and Health (Online)*, *12*(2), 411–416.

McCann, D. A., Knowles, Z. R., Fairclough, S. J., & Graves, L. E. F. (2016). A protocol to encourage accelerometer wear in children and young people. *Qualitative Research in Sport, Exercise and Health*, *8*(4), 319–331. https://doi.org/10.1080/2159676X.2016.1160949

McKenzie, T. L., Sallis, J. F., Broyles, S. L., Zive, M. M., Nader, P. R., Berry, C. C., & Brennan, J. J. (2002). Childhood movement skills: Predictors of physical activity in Anglo American and Mexican American adolescents? *Research Quarterly for Exercise and Sport*, *73*(3), 238–244. https://doi.org/10.1080/02701367.2002.10609017

Meester, A. D., Stodden, D., Brian, A., True, L., Cardon, G., Tallir, I., & Haerens, L. (2016). Associations among Elementary School Children's Actual Motor Competence, Perceived Motor Competence, Physical Activity and BMI: A Cross-Sectional Study. *PLOS ONE*, *11*(10), e0164600. https://doi.org/10.1371/journal.pone.0164600

Mertens, D. (2010). Divergence and Mixed Methods. *Journal of Mixed Methods Research*, *4*, 3–5. https://doi.org/10.1177/1558689809358406

Michie, S., Ashford, S., Sniehotta, F. F., Dombrowski, S. U., Bishop, A., & French, D. P. (2011). A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: The CALO-RE taxonomy. *Psychology & Health*, *26*(11), 1479–1498. https://doi.org/10.1080/08870446.2010.540664

Migueles, J. H., Cadenas-Sanchez, C., Ekelund, U., Delisle Nyström, C., Mora-Gonzalez, J., Löf, M., Labayen, I., Ruiz, J. R., & Ortega, F. B. (2017). Accelerometer Data Collection and Processing Criteria to Assess Physical Activity and Other Outcomes: A Systematic Review and Practical Considerations. *Sports Medicine*, *47*(9), 1821–1845. https://doi.org/10.1007/s40279-017-0716-0

Migueles, J. H., Cadenas-Sanchez, C., Tudor-Locke, C., Löf, M., Esteban-Cornejo, I., Molina-Garcia, P., Mora-Gonzalez, J., Rodriguez-Ayllon, M., Garcia-Marmol, E., Ekelund, U., & Ortega, F. B. (2019). Comparability of published cut-points for the assessment of physical activity:

Implications for data harmonization. *Scandinavian Journal of Medicine & Science in Sports*, *29*(4), 566–574. https://doi.org/10.1111/sms.13356

Ministry of Housing, Communities and Local Government. (2019). *The English Indices of Deprivation 2019 (IoD2019)*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833959/IoD2019_Infographic.pdf

Moghaddaszadeh, A., & Belcastro, A. N. (2021). Guided Active Play Promotes Physical Activity and Improves Fundamental Motor Skills for School-Aged Children. *Journal of Sports Science & Medicine*, *20*(1), 86–93. https://doi.org/10.52082/jssm.2021.86

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Group, T. P. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLOS Medicine, 6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Moore, L. L., Lombardi, D. A., White, M. J., Campbell, J. L., Oliveria, S. A., & Ellison, R. C. (1991). Influence of parents' physical activity levels on activity levels of young children. *The Journal of Pediatrics*, *118*(2), 215–219. https://doi.org/10.1016/S0022-3476(05)80485-8

Mora, S., Cook, N., Buring, J. E., Ridker, P. M., & Lee, I.-M. (2008). *Physical Activity and Reduced Risk of Cardiovascular Events: Potential Mediating Mechanisms*. 15.

Moran, C. A., Carvalho, L. B. C., Prado, L. B. F., & Prado, G. F. (2005). Sleep disorders and starting time to school impair balance in 5-year-old children. *Arquivos de Neuro-Psiquiatria*, *63*(3a), 571–576. https://doi.org/10.1590/S0004-282X2005000400003

Morano, M., Bortoli, L., Ruiz, M. C., Vitali, F., & Robazza, C. (2019). Self-efficacy and enjoyment of physical activity in children: Factorial validity of two pictorial scales. *PeerJ*, *7*, e7402. https://doi.org/10.7717/peerj.7402

Morano, M., Rutigliano, I., Rago, A., Pettoello-Mantovani, M., & Campanozzi, A. (2016). A multicomponent, school-initiated obesity intervention to promote healthy lifestyles in children. *Nutrition (Burbank, Los Angeles County, Calif.)*, *32*(10), 1075–1080. https://doi.org/10.1016/j.nut.2016.03.007

Morgan, D. L. (2007). Paradigms Lost and Pragmatism Regained: Methodological Implications of Combining Qualitative and Quantitative Methods. *Journal of Mixed Methods Research*, 48–76.

Morgan, P. J., Barnett, L. M., Cliff, D. P., Okely, A. D., Scott, H. A., Cohen, K. E., & Lubans, D. R. (2013). Fundamental Movement Skill Interventions in Youth: A Systematic Review and Meta-analysis. *Pediatrics*, *132*(5), e1361–e1383. https://doi.org/10.1542/peds.2013-1167

Morley, D., Till, K., Ogilvie, P., & Turner, G. (2015). Influences of gender and socioeconomic status on the motor proficiency of children in the UK. *Human Movement Science*, *44*, 150–156. https://doi.org/10.1016/j.humov.2015.08.022

Morley, D., Van Rossum, T., Richardson, D., & Foweather, L. (2019). Expert recommendations for the design of a children's movement competence assessment tool for use by primary school teachers. *European Physical Education Review*, *25*(2), 524–543. https://doi.org/10.1177/1356336X17751358

Nagel, T. (1986). *The view from nowhere*. Oxford University Press.

National Institute for Heath and Care Research. (2022). *Payment for Public Involvement in Health and Care Research: A guide for organisations on determining the most appropriate payment approach*. https://www.nihr.ac.uk/documents/payment-for-public-involvement-in-health-and-care-research-a-guide-for-organisations-on-determining-the-most-appropriate-payment-approach/30838

Newell, K. M. (1986). Motor Development in Children: Aspects of Coordination and Control. In *In Constraints on the Development of Coordination*. Martinus Nijhoff.

Nguyen, S., Häcker, A.-L., Henderson, M., Barnett, T., Mathieu, M.-E., Pagani, L., & Bigras, J.-L. (2016). Physical Activity Programs with Post-Intervention Follow-Up in Children: A Comprehensive Review According to Categories of Intervention. *International Journal of Environmental Research and Public Health*, *13*(7), 664. https://doi.org/10.3390/ijerph13070664

NHS Digital. (2020). *National Child Measurement Programme, England 2019/20 School Year*. NHS Digital. https://digital.nhs.uk/data-and-information/publications/statistical/national-child-measurement-programme/2019-20-school-year

NHS Digital. (2021). *National Child Measurement Programme, England 2020/21 School Year*. https://digital.nhs.uk/data-and-information/publications/statistical/national-child-measurement-programme/2020-21-school-year#

NICE. (2009). *Physical activity for children and young people. Public health guideline*. https://www.nice.org.uk/guidance/ph17/resources/physical-activity-for-children-and-young-people-pdf-1996181580229

NICE. (2014). *1 Recommendations | Behaviour change: Individual approaches | Guidance | NICE*. NICE. https://www.nice.org.uk/guidance/ph49/chapter/1-recommendations#recommendation-9-deliver-very-brief-brief-extended-brief-and-high-intensity-behaviour-change

Nilsen, A. K. O., Anderssen, S. A., Johannessen, K., Aadland, K. N., Ylvisaaker, E., Loftesnes, J. M., & Aadland, E. (2020). Bi-directional prospective associations between objectively measured physical activity and fundamental motor skills in children: A two-year follow-up. *International Journal of Behavioral Nutrition and Physical Activity*, *17*(1), 1. https://doi.org/10.1186/s12966-019-0902-6

O’Connor, A., Blewitt, C., Nolan, A., & Skouteris, H. (2018). Using Intervention Mapping for child development and wellbeing programs in early childhood education and care settings. *Evaluation and Program Planning*, *68*, 57–63. https://doi.org/10.1016/j.evalprogplan.2018.02.011

O’Donoghue, G., Kennedy, A., Puggina, A., Aleksovska, K., Buck, C., Burns, C., Cardon, G., Carlin, A., Ciarapica, D., Colotto, M., Condello, G., Coppinger, T., Cortis, C., D’Haese, S., Craemer, M. D., Blasio, A. D., Hansen, S., Iacoviello, L., Issartel, J., … Boccia, S. (2018). Socio-economic determinants of physical activity across the life course: A ‘DEterminants of DIet and Physical ACtivity’ (DEDIPAC) umbrella literature review. *PLOS ONE*, *13*(1), e0190737. https://doi.org/10.1371/journal.pone.0190737

Ofsted. (2019). *The education inspection framework*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/801429/Education_inspection_framework.pdf

Okely, A. D., Ghersi, D., Hesketh, K. D., Santos, R., Loughran, S. P., Cliff, D. P., Shilton, T., Grant, D., Jones, R. A., Stanley, R. M., Sherring, J., Hinkley, T., Trost, S. G., McHugh, C., Eckermann, S., Thorpe, K., Waters, K., Olds, T. S., Mackey, T., … Tremblay, M. S. (2017). A collaborative approach to adopting/adapting guidelines - The Australian 24-Hour Movement Guidelines for the early years (Birth to 5 years): An integration of physical activity, sedentary behavior, and sleep. *BMC Public Health*, *17*(Suppl 5), 869. https://doi.org/10.1186/s12889-017-4867-6

Oliver, M., Schofield, G. M., & Kolt, G. S. (2007a). Physical activity in preschoolers: Understanding prevalence and measurement issues. *Sports Medicine (Auckland, N.Z.)*, *37*(12), 1045–1070. https://doi.org/10.2165/00007256-200737120-00004

Oliver, M., Schofield, G. M., & Kolt, G. S. (2007b). Physical Activity in Preschoolers: Understanding Prevalence and Measurement Issues. *Sports Medicine*, *37*(12), 1045–1070. https://doi.org/10.2165/00007256-200737120-00004

Pacheco, M. M., dos Santos, F. G., Marques, M. T. S. P., Maia, J. A. R., & Tani, G. (2021). Transitional Movement Skill Dependence on Fundamental Movement Skills: Testing Seefeldt's Proficiency Barrier. *Research Quarterly for Exercise and Sport*, *0*(0), 1–10. https://doi.org/10.1080/02701367.2021.1912691

Palmer, K. K., Chinn, K. M., & Robinson, L. E. (2019). The effect of the CHAMP intervention on fundamental motor skills and outdoor physical activity in preschoolers. *Journal of Sport and Health Science*, *8*(2), 98–105. https://doi.org/10.1016/j.jshs.2018.12.003

Pate, R. R., Almeida, M. J., McIver, K. L., Pfeiffer, K. A., & Dowda, M. (2006). Validation and Calibration of an Accelerometer in Preschool Children*. *Obesity*, *14*(11), 2000–2006. https://doi.org/10.1038/oby.2006.234

Pate, R. R., Hillman, C., Janz, K., Katzmarzyk, P. T., Powell, K. E., Torres, A., & Whitt-Glover, M. C. (2019). Physical Activity and Health in Children under 6 Years of Age: A Systematic

Review. *Medicine and Science in Sports and Exercise*, *51*(6), 1282–1291. https://doi.org/10.1249/MSS.0000000000001940

Pate, R. R., McIver, K., Dowda, M., Brown, W. H., & Addy, C. (2008). Directly observed physical activity levels in preschool children. *The Journal of School Health*, *78*(8), 438–444. https://doi.org/10.1111/j.1746-1561.2008.00327.x

Pate, R. R., Mitchell, J. A., Byun, W., & Dowda, M. (2011). Sedentary behaviour in youth. *British Journal of Sports Medicine*, *45*(11), 906–913. https://doi.org/10.1136/bjsports-2011-090192

Pate, R. R., O'Neill, J. R., & Mitchell, J. (2010). Measurement of Physical Activity in Preschool Children: *Medicine & Science in Sports & Exercise*, *42*(3), 508–512. https://doi.org/10.1249/MSS.0b013e3181cea116

Patnode, C. D., Lytle, L. A., Erickson, D. J., Sirard, J. R., Barr-Anderson, D., & Story, M. (2010). The relative influence of demographic, individual, social, and environmental factors on physical activity among boys and girls. *International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 79. https://doi.org/10.1186/1479-5868-7-79

Peach, D., Hoomissen, J. V., & Callender, H. L. (2014). Exploring the ActiLife®filtration algorithm: Converting raw acceleration data to counts. *Physiological Measurement*, *35*(12), 2359–2367. https://doi.org/10.1088/0967-3334/35/12/2359

Peers, C., Issartel, J., Behan, S., O'Connor, N., & Belton, S. (2020). Movement competence: Association with physical self-efficacy and physical activity. *Human Movement Science*, *70*, 102582. https://doi.org/10.1016/j.humov.2020.102582

Penpraze, V., Reilly, J. J., MacLean, C. M., Montgomery, C., Kelly, L. A., Paton, J. Y., Aitchison, T., & Grant, S. (2006). Monitoring of Physical Activity in Young Children: How Much Is Enough? *Pediatric Exercise Science*, *18*(4), 483–491. https://doi.org/10.1123/pes.18.4.483

Piek, J. P., Dawson, L., Smith, L. M., & Gasson, N. (2008). The role of early fine and gross motor development on later motor and cognitive ability. *Human Movement Science*, *27*(5), 668–681. https://doi.org/10.1016/j.humov.2007.11.002

Poitras, V. J., Gray, C. E., Borghese, M. M., Carson, V., Chaput, J.-P., Janssen, I., Katzmarzyk, P. T., Pate, R. R., Gorber, S. C., Kho, M. E., Sampson, M., & Tremblay, M. S. (2016). Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth1. *Applied Physiology, Nutrition, and Metabolism*. https://doi.org/10.1139/apnm-2015-0663

Pringle, A., Kime, N., Lozano-Sufrategui, L., & Zwolinsky, S. (2020). 'Evaluating Interventions' in Hackfort, D. and Schinke, R.J., (eds.). In *The Routledge International Encyclopedia of Sport and Exercise Psychology: Volume 2: Applied and Practical Measures* (Vol. 2). Routledge.

Pronk, N. P., & Faghy, M. A. (2022). Causal systems mapping to promote healthy living for pandemic preparedness: A call to action for global public health. *International Journal of Behavioral Nutrition and Physical Activity*, *19*(1), 13. https://doi.org/10.1186/s12966-022-01255-7

Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the Nutrition Society*, *63*(4), 655–660. https://doi.org/10.1079/PNS2004399

Randall, V., & Clark, H. (2019). *The Primary PE and Sport Premium: APPG Meeting on a Fit and Healthy Childhood*.

Reilly, J. J., Coyle, J., Kelly, L., Burke, G., Grant, S., & Paton, J. Y. (2003). An Objective Method for Measurement of Sedentary Behavior in 3- to 4-Year Olds. *Obesity Research*, *11*(10), 1155–1158. https://doi.org/10.1038/oby.2003.158

Reily, J. J., Hughes, A., Janssen, X., Martin, A., Hesketh, K., Livingstone, S., Hill, C., Kipping, R., Draper, C., Okely, A., & Nimmo, R. (2018). *Expert Working Group Working Paper, Under 5s. UK physical activity guidelines: Draft review and recommendations for the Under 5s* (p. 28). University of Bristol.

Reiss, J., & Sprenger, J. (2020). Scientific Objectivity. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Winter 2020). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/win2020/entries/scientific-objectivity/

Rhodes, R. E., Guerrero, M. D., Vanderloo, L. M., Barbeau, K., Birken, C. S., Chaput, J.-P., Faulkner, G., Janssen, I., Madigan, S., Mâsse, L. C., McHugh, T.-L., Perdew, M., Stone, K., Shelley, J., Spinks, N., Tamminen, K. A., Tomasone, J. R., Ward, H., Welsh, F., & Tremblay, M. S. (2020). Development of a consensus statement on the role of the family in the physical activity, sedentary, and sleep behaviours of children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *17*(1), 74. https://doi.org/10.1186/s12966-020-00973-0

Richardson, P. K., Atwater, S. W., Crowe, T. K., & Deitz, J. C. (1992). Performance of Preschoolers on the Pediatric Clinical Test of Sensory Interaction for Balance. *American Journal of Occupational Therapy*, *46*(9), 793–800. https://doi.org/10.5014/ajot.46.9.793

Robertson, W., Stewart-Brown, S., Wilcock, E., Oldfield, M., & Thorogood, M. (2011). Utility of Accelerometers to Measure Physical Activity in Children Attending an Obesity Treatment Intervention. *Journal of Obesity*, *2011*, 398918. https://doi.org/10.1155/2011/398918

Robinson, L. E., Stodden, D. F., Barnett, L. M., Lopes, V. P., Logan, S. W., Rodrigues, L. P., & D'Hondt, E. (2015). Motor Competence and its Effect on Positive Developmental Trajectories of Health. *Sports Medicine*, *45*(9), 1273–1284. https://doi.org/10.1007/s40279-015-0351-6

Rodriguez-Ayllon, M., Cadenas-Sánchez, C., Estévez-López, F., Muñoz, N. E., Mora-Gonzalez, J., Migueles, J. H., Molina-García, P., Henriksson, H., Mena-Molina, A., Martínez-Vizcaíno, V., Catena, A., Löf, M., Erickson, K. I., Lubans, D. R., Ortega, F. B., & Esteban-Cornejo, I. (2019). Role of Physical Activity and Sedentary Behavior in the Mental Health of Preschoolers, Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Medicine*, *49*(9), 1383–1410. https://doi.org/10.1007/s40279-019-01099-5

Roncesvalles, M. N. C., Woollacott, M. H., & Jensen, J. L. (2001). Development of Lower Extremity Kinetics for Balance Control in Infants and Young Children. *Journal of Motor Behavior*, *33*(2), 180–192. https://doi.org/10.1080/00222890109603149

Roscoe, C. M. P., James, R. S., & Duncan, M. J. (2017a). Calibration of GENEActiv accelerometer wrist cut-points for the assessment of physical activity intensity of preschool aged children. *European Journal of Pediatrics*, *176*(8), 1093–1098. https://doi.org/10.1007/s00431-017-2948-2

Roscoe, C. M. P., James, R. S., & Duncan, M. J. (2017b). Preschool staff and parents' perceptions of preschool children's physical activity and fundamental movement skills from an area of high deprivation: A qualitative study. *Qualitative Research in Sport, Exercise and Health*, *9*(5), 619–635. https://doi.org/10.1080/2159676X.2017.1322630

Roscoe, C. M. P., James, R. S., & Duncan, M. J. (2019a). Accelerometer-based physical activity levels, fundamental movement skills and weight status in British preschool children from a deprived area. *European Journal of Pediatrics*, *178*(7), 1043–1052. https://doi.org/10.1007/s00431-019-03390-z

Roscoe, C. M. P., James, R. S., & Duncan, M. J. (2019b). Accelerometer-Based Physical Activity Levels Differ between Week and Weekend Days in British Preschool Children. *Journal of Functional Morphology and Kinesiology*, *4*(3), 65. https://doi.org/10.3390/jfmk4030065

Rossi, L., Behme, N., & Breuer, C. (2021). Physical Activity of Children and Adolescents during the COVID-19 Pandemic—A Scoping Review. *International Journal of Environmental Research and Public Health*, *18*(21), Article 21. https://doi.org/10.3390/ijerph182111440

Rowlands, A. V., Rennie, K., Kozarski, R., Stanley, R. M., Eston, R. G., Parfitt, G. C., & Olds, T. S. (2014). Children's Physical Activity Assessed with Wrist- and Hip-Worn Accelerometers. *Medicine & Science in Sports & Exercise*, *46*(12), 2308–2316. https://doi.org/10.1249/MSS.0000000000000365

Ryan, G. W., & Bernard, H. R. (2003). Techniques to Identify Themes. *Field Methods*, *15*(1), 85–109. https://doi.org/10.1177/1525822X02239569

Saldaña, J. (2011). *Fundamentals of Qualitative Research*. Oxford University Press.

Sale, J. E. M., Lohfeld, L. H., & Brazil, K. (2002). Revisiting the Quantitative-Qualitative Debate: Implications for Mixed-Methods Research. *Quality and Quantity*, *36*(1), 43–53. https://doi.org/10.1023/A:1014301607592

Sallis, J. F., Conway, T. L., Cain, K. L., Carlson, J. A., Frank, L. D., Kerr, J., Glanz, K., Chapman, J. E., & Saelens, B. E. (2018). Neighborhood built environment and socioeconomic status in relation to physical activity, sedentary behavior, and weight status of adolescents. *Preventive Medicine*, *110*, 47–54. https://doi.org/10.1016/j.ypmed.2018.02.009

Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity of children and adolescents: *Medicine & Science in Sports & Exercise*, 963–975. https://doi.org/10.1097/00005768-200005000-00014

Sallis, J. F., & Saelens, B. E. (2000). Assessment of Physical Activity by Self-Report: Status, Limitations, and Future Directions. *Research Quarterly for Exercise and Sport*, *71*(sup2), 1–14. https://doi.org/10.1080/02701367.2000.11082780

Schmalz, D. L., & Kerstetter, D. L. (2006). Girlie Girls and Manly Men: Chidren's Stigma Consciousness of Gender in Sports and Physical Activities. *Journal of Leisure Research*, *38*(4), 536–557. https://doi.org/10.1080/00222216.2006.11950091

Schmidt, R. A. (1975). A schema theory of discrete motor skill learning. *Psychological Review*, *82*, 225–260. https://doi.org/10.1037/h0076770

Scotland, J. (2012). Exploring the Philosophical Underpinnings of Research: Relating Ontology and Epistemology to the Methodology and Methods of the Scientific, Interpretive, and Critical Research Paradigms. *English Language Teaching*, *5*(9), p9. https://doi.org/10.5539/elt.v5n9p9

Seefeldt, V. (1980). Developmental motor patterns: Implications for elementary school physical education. In *Psychology of motor behavior and sport* (pp. 314–323). Human Kinetics.

SHAPE America. (2016). *Shape of the Nation 2016*. https://www.shapeamerica.org/uploads/pdfs/son/Shape-of-the-Nation-2016_web.pdf

SHAPE America. (2018). *Guidelines for K-12 Online Physical Education*. https://www.shapeamerica.org/uploads/pdfs/2020/guidelines/Online-PE-Guidance-Document.pdf

Sirard, J. R., Trost, S. G., Pfeiffer, K. A., Dowda, M., & Pate, R. R. (2005). Calibration and Evaluation of an Objective Measure of Physical Activity in Preschool Children. *Journal of Physical Activity and Health*, *2*(3), 345–357. https://doi.org/10.1123/jpah.2.3.345

Smuka, I. (2012). Teacher Role Model and Students' Physical Activity. *Polish Journal of Sport and Tourism*, *19*. https://doi.org/10.2478/v10197-012-0027-9

Solomon-Moore, E., Sebire, S. J., Thompson, J. L., Zahra, J., Lawlor, D. A., & Jago, R. (2017). Are parents' motivations to exercise and intention to engage in regular family-based activity associated with both adult and child physical activity? *BMJ Open Sport & Exercise Medicine*, *2*(1), e000137. https://doi.org/10.1136/bmjsem-2016-000137

Sparkes, A. C., & Smith, B. (2013). *Qualitative Research Methods in Sport, Exercise and Health: From Process to Product*. Routledge. https://doi.org/10.4324/9780203852187

Sport England. (2006). *Leaning from the Local Exercise Action Pilots*. Sport England.

Sport England. (2019). *Active Lives Children and Young People Survey Academic Year 2018/19*. https://sportengland-production-files.s3.eu-west-2.amazonaws.com/s3fs-public/2020-01/active-liveschildren-survey-academic-year-18-19.pdf?cVMsdnpBoqROViY61iUjpQY6WcRyhtGs

Sport England. (2021). *Active Lives Children and Young People Survey Academic year 2019/20*. https://sportengland-production-files.s3.eu-west-2.amazonaws.com/s3fs-public/2021-01/Active%20Lives%20Children%20Survey%20Academic%20Year%2019-20%20report.pdf?VersionId=4Ti_0V0m9sYy5HwQjSiJN7Xj.VInpjV6

Sport England. (2022). *Local delivery pilots*. Sport England. https://www.sportengland.org/funds-and-campaigns/local-delivery

Stankovic, M., & Radenkovic, O. (2012). University of Nis, Serbia, Faculty of Sport and Physical Education, PhD student,: Nis, Serbia ^State University of Novi Pazar, Sport and Physical Education, Department of Biomédical Sciences, Novi Pazar, Serbia. *RIK*, *40*(1), 113–116.

Steinbeck, K. S. (2001). The importance of physical activity in the prevention of overweight and obesity in childhood: A review and an opinion. *Obesity Reviews*, *2*(2), 117–130. https://doi.org/10.1046/j.1467-789x.2001.00033.x

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008a). *A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship*. 18.

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008b). A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship. *Quest*, *60*(2), 290–306. https://doi.org/10.1080/00336297.2008.10483582

Stratton, G., Foweather, L., & Hughes, H. (2017). *Dragon Challenge: A National Indicator for Children's Physical Literacy in Wales. Surveillance Report*.

Suton, D., Pfeiffer, K. A., Feltz, D. L., Yee, K. E., Eisenmann, J. C., & Carlson, J. J. (2013). Physical Activity and Self-efficacy in Normal and Over-fat Children. *American Journal of Health Behavior*, *37*(5), 635–640. https://doi.org/10.5993/AJHB.37.5.7

Tan, J. S. Y. (2019). The balance control of young children under different shod conditions in a naturalistic environment. *Gait & Posture*, *68*, 68–71. https://doi.org/10.1016/j.gaitpost.2018.11.005

Tashakkori, A., & Teddlie, C. (2010). Putting the Human Back in '"Human Research Methodology"': The Researcher in Mixed Methods Research. *Journal of Mixed Methods Research*, *4*(4), 271–277. https://doi.org/10.1177/1558689810382532

Taylor, N. J., Sahota, P., Sargent, J., Barber, S., Loach, J., Louch, G., & Wright, J. (2013). Using intervention mapping to develop a culturally appropriate intervention to prevent childhood obesity: The HAPPY (Healthy and Active Parenting Programme for Early Years) study. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 142. https://doi.org/10.1186/1479-5868-10-142

Telama, R., Yang, X., Leskinen, E., Kankaanpää, A., Hirvensalo, M., Tammelin, T., Viikari, J., & Raitakari, O. (2013). Tracking of Physical Activity from Early Childhood through Youth into Adulthood. *Medicine and Science in Sports and Exercise*, *46*. https://doi.org/10.1249/MSS.0000000000000181

The Australian Curriculum. (2020). *Health and Physical Education*. https://www.australiancurriculum.edu.au/f-10-curriculum/health-and-physical-education/

The Department of Health. (2012). *Australian 24-Hour Movement Guidelines for the Early Years (Birth to 5 years): An Integration of Physical Activity, Sedentary Behaviour, and Sleep*. https://www1.health.gov.au/internet/main/publishing.nsf/Content/FCE78513DAC85E08CA257BF0001BAF95/$File/Birthto5years_24hrGuidelines_Brochure.pdf

Thompson, J. L., Jago, R., Brockman, R., Cartwright, K., Page, A. S., & Fox, K. R. (2010). Physically active families - de-bunking the myth? A qualitative study of family participation in physical activity. *Child: Care, Health and Development*, *36*(2), 265–274. https://doi.org/10.1111/j.1365-2214.2009.01051.x

Timmons, B. W., LeBlanc, A. G., Carson, V., Gorber, S. onnor, Dillman, C., Janssen, I., Kho, M. E., Spence, J. C., Stearns, J. A., & Tremblay, M. S. (2012). Systematic review of physical activity and health in the early years (aged 0–4 years). *Applied Physiology, Nutrition, and Metabolism*. https://doi.org/10.1139/h2012-070

Tompsett, C., Sanders, R., Taylor, C., & Cobley, S. (2017). Pedagogical Approaches to and Effects of Fundamental Movement Skill Interventions on Health Outcomes: A Systematic Review. *Sports Medicine*, *47*(9), 1795–1819. https://doi.org/10.1007/s40279-017-0697-z

Tremblay, M. S. (2019). Challenges in global surveillance of physical activity. *The Lancet Child & Adolescent Health*, *4*(1), 2–3. https://doi.org/10.1016/S2352-4642(19)30348-7

Tremblay, M. S., Gray, C. E., Akinroye, K., Harrington, D. M., Katzmarzyk, P. T., Lambert, E. V., Liukkonen, J., Maddison, R., Ocansey, R. T., Onywera, V. O., Prista, A., Reilly, J. J., Martínez, M. del P. R., Duenas, O. L. S., Standage, M., & Tomkinson, G. (2014). Physical Activity of Children: A Global Matrix of Grades Comparing 15 Countries. *Journal of Physical Activity and Health*, *11*(s1), S113–S125. https://doi.org/10.1123/jpah.2014-0177

Trost, S. G., Sirard, J. R., Dowda, M., Pfeiffer, K. A., & Pate, R. R. (2003). Physical activity in overweight and nonoverweight preschool children. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity*, *27*(7), 834–839. https://doi.org/10.1038/sj.ijo.0802311

Tucker, P. (2008). The physical activity levels of preschool-aged children: A systematic review. *Early Childhood Research Quarterly*, 12.

Tucker, P., Irwin, J. D., Sangster Bouck, L. M., He, M., & Pollett, G. (2006). Preventing paediatric obesity; recommendations from a community-based qualitative investigation. *Obesity Reviews*, *7*(3), 251–260. https://doi.org/10.1111/j.1467-789X.2004.00224.x

UK Coaching Learning, T. (2019). *The STEP Model Explained—UK Coaching*. http://www.ukcoaching.org/Resources/Topics/Videos/Subscription/The-STEP-Model-Explained

Ulrich. (2000). *Test of Gross Motor Development, 2nd ed*. PRO-ED.

Ulrich. (2016). *Test of Gross Motor Development, 3nd ed*. PRO-ED.

Ulrich, B. (2007). Motor Development: Core Curricular Concepts. *Quest*, *59*(1), 77–91. https://doi.org/10.1080/00336297.2007.10483538

Utesch, T., Bardid, F., Büsch, D., & Strauss, B. (2019). The Relationship Between Motor Competence and Physical Fitness from Early Childhood to Early Adulthood: A Meta-Analysis. *Sports Medicine*, *49*(4), 541–551. https://doi.org/10.1007/s40279-019-01068-y

Van Capelle, A., Broderick, C. R., van Doorn, N., E.Ward, R., & Parmenter, B. J. (2017). Interventions to improve fundamental motor skills in pre-school aged children: A systematic review and meta-analysis. *Journal of Science and Medicine in Sport*, *20*(7), 658–666. https://doi.org/10.1016/j.jsams.2016.11.008

Van Hees, V. T., Thaler-Kall, K., Wolf, K. H., Brond, J. C., Bonomi, A., Schulze, M., Vigl, M., Morseth, B., Hopstock, L. A., Gorzelniak, L., Schulz, H., Brage, S., & Horsch, A. (2016). Challenges and Opportunities for Harmonizing Research Methodology: Raw Accelerometry. *Methods of Information in Medicine*, *55*(6), 525–532. https://doi.org/10.3414/me15-05-0013

Venetsanou, F., & Kambas, A. (2011). The effects of age and gender on balance skills in preschool children. *Facta Universitatis Physical Education and Sport*, *9*(1), 81–90.

Venetsanou, F., & Kambas, A. (2016). Motor Proficiency in Young Children: A Closer Look at Potential Gender Differences. *SAGE Open*, *6*(1), 2158244015626226. https://doi.org/10.1177/2158244015626226

Verbecque, E., da Costa, P. H. L., Meyns, P., Desloovere, K., Vereeck, L., & Hallemans, A. (2016). Age-related changes in postural sway in preschoolers. *Gait & Posture*, *44*, 116–122. https://doi.org/10.1016/j.gaitpost.2015.11.016

Verbestel, V., Henauw, S. D., Maes, L., Haerens, L., Mårild, S., Eiben, G., Lissner, L., Moreno, L. A., Frauca, N. L., Barba, G., Kovács, É., Konstabel, K., Tornaritis, M., Gallois, K., Hassel, H., &

Bourdeaudhuij, I. D. (2011). Using the intervention mapping protocol to develop a community-based intervention for the prevention of childhood obesity in a multi-centre European project: The IDEFICS intervention. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 82. https://doi.org/10.1186/1479-5868-8-82

Waddington, I. (2000). Sport and health: A sociological perspective. In *Handbook of Sports Studies* (pp. 408–421).

Warburton, D. E. R., & Bredin, S. S. D. (2016). Reflections on Physical Activity and Health: What Should We Recommend? *Canadian Journal of Cardiology*, *32*(4), 495–504. https://doi.org/10.1016/j.cjca.2016.01.024

Warburton, D. E. R., & Bredin, S. S. D. (2017). Health benefits of physical activity: A systematic review of current systematic reviews. *Current Opinion in Cardiology*, *32*(5), 541–556. https://doi.org/10.1097/HCO.0000000000000437

Ward, G., & Scott, D. (2021). Negotiating the Daily Mile Challenge; looking-like a walking break from the classroom. *Sport, Education and Society*, *26*(2), 119–134. https://doi.org/10.1080/13573322.2019.1700106

Wasenius, N. S., Grattan, K. P., Harvey, A. L. J., Naylor, P.-J., Goldfield, G. S., & Adamo, K. B. (2018). The effect of a physical activity intervention on preschoolers' fundamental motor skills—A cluster RCT. *Journal of Science and Medicine in Sport*, *21*(7), 714–719. https://doi.org/10.1016/j.jsams.2017.11.004

Washburn, R., Chin, M. K., & Montoye, H. J. (1980). Accuracy of pedometer in walking and running. *Research Quarterly for Exercise and Sport*, *51*(4), 695–702. https://doi.org/10.1080/02701367.1980.10609330

Webster, E. K., Kracht, C. L., Newton Jr, R. L., Beyl, R. A., & Staiano, A. E. (2020). Intervention to Improve Preschool Children's Fundamental Motor Skills: Protocol for a Parent-Focused, Mobile App–Based Comparative Effectiveness Trial. *JMIR Research Protocols*, *9*(10), e19943. https://doi.org/10.2196/19943

Webster, E. K., Martin, C. K., & Staiano, A. E. (2019). Fundamental motor skills, screen-time, and physical activity in preschoolers. *Journal of Sport and Health Science*, *8*(2), 114–121. https://doi.org/10.1016/j.jshs.2018.11.006

Weisgram, E. S., Fulcher, M., & Dinella, L. M. (2014). Pink gives girls permission: Exploring the roles of explicit gender labels and gender-typed colors on preschool children's toy preferences. *Journal of Applied Developmental Psychology*, *35*(5), 401–409. https://doi.org/10.1016/j.appdev.2014.06.004

WHO. (2003). *Social Determinants of Health: The Solid Facts*. World Health Organization.

Wick, K., Leeger-Aschmann, C. S., Monn, N. D., Radtke, T., Ott, L. V., Rebholz, C. E., Cruz, S., Gerber, N., Schmutz, E. A., Puder, J. J., Munsch, S., Kakebeeke, T. H., Jenni, O. G., Granacher, U., & Kriemler, S. (2017). Interventions to Promote Fundamental Movement Skills in Childcare and Kindergarten: A Systematic Review and Meta-Analysis. *Sports Medicine*, *47*(10), 2045–2068. https://doi.org/10.1007/s40279-017-0723-1

Williams, H. G., Pfeiffer, K. A., Dowda, M., Jeter, C., Jones, S., & Pate, R. R. (2009). A Field-Based Testing Protocol for Assessing Gross Motor Skills in Preschool Children: The Children's Activity and Movement in Preschool Study Motor Skills Protocol. *Measurement in Physical Education and Exercise Science*, *13*(3), 151–165. https://doi.org/10.1080/10913670903048036

Williams, H. G., Pfeiffer, K. A., O'Neill, J. R., Dowda, M., McIver, K. L., Brown, W. H., & Pate, R. R. (2008). Motor Skill Performance and Physical Activity in Preschool Children. *Obesity*, *16*(6), 1421–1426. https://doi.org/10.1038/oby.2008.214

Williams, T. L., & Smith, B. (2020). Qualitative methods. In *The Routledge international encyclopedia of sport and exercise psychology volume one: Theoretical and methodological concepts*. Routledge.

World Health Organisation. (2011). *Information Sheet: Global Recommendations on Physical Activity for Health*. https://www.who.int/dietphysicalactivity/publications/physical-activity-recommendations-5-17years.pdf?ua=1

World Health Organisation. (2019). *Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age. World Health Organization.* https://apps.who.int/iris/handle/10665/311664.

World Health Organisation. (2020). *WHO guidelines on physical activity and sedentary behaviour*. https://www.who.int/publications-detail-redirect/9789240015128

Wu, X. Y., Kirk, S. F. L., Ohinmaa, A., & Veugelers, P. J. (2017). The importance of health behaviours in childhood for the development of internalizing disorders during adolescence. *BMC Psychology*, *5*(1), 38. https://doi.org/10.1186/s40359-017-0208-x

Xiang, P., McBride, R., & Bruene, A. (2003). Relations of Parents' Beliefs to Children's Motivation in an Elementary Physical Education Running Program. *Journal of Teaching in Physical Education*, *22*(4), 410–425. https://doi.org/10.1123/jtpe.22.4.410

Xin, F., Chen, S.-T., Clark, C., Hong, J.-T., Liu, Y., & Cai, Y.-J. (2020a). Relationship between Fundamental Movement Skills and Physical Activity in Preschool-aged Children: A Systematic Review. *International Journal of Environmental Research and Public Health*, *17*(10), Article 10. https://doi.org/10.3390/ijerph17103566

Xin, F., Chen, S.-T., Clark, C., Hong, J.-T., Liu, Y., & Cai, Y.-J. (2020b). Relationship between Fundamental Movement Skills and Physical Activity in Preschool-aged Children: A Systematic Review. *International Journal of Environmental Research and Public Health*, *17*(10). https://doi.org/10.3390/ijerph17103566

Yomoda, K., & Kurita, S. (2021). Influence of social distancing during the COVID-19 pandemic on physical activity in children: A scoping review of the literature. *Journal of Exercise Science & Fitness*, *19*(3), 195–203. https://doi.org/10.1016/j.jesf.2021.04.002

Youth Sport Trust. (2020). *Evidence Paper: The Impact of Covid-19 Restriction on Children and Young People*. https://www.youthsporttrust.org/sites/default/files/resources/documents/Evidence%20paper%20%20The%20impact%20of%20Covid%20restrictions%20on%20children%20and%20young%20people%20-%20Ver%202%20-%20July%202020.pdf

Zeng, N., Ayyub, M., Sun, H., Wen, X., Xiang, P., & Gao, Z. (2017). Effects of Physical Activity on Motor Skills and Cognitive Development in Early Childhood: A Systematic Review. *BioMed Research International*, *2017*, e2760716. https://doi.org/10.1155/2017/2760716

Zeng, N., Johnson, S. L., Boles, R. E., & Bellows, L. L. (2019). Social-ecological correlates of fundamental movement skills in young children. *Journal of Sport and Health Science*, *8*(2), 122–129. https://doi.org/10.1016/j.jshs.2019.01.001

Zumbrunn, T., MacWilliams, B. A., & Johnson, B. A. (2011). Evaluation of a single leg stance balance test in children. *Gait & Posture*, *34*(2), 174–177. https://doi.org/10.1016/j.gaitpost.2011.04.005

Appendices

Appendix 2.1

Table A2.1 PRISMA Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	1-3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	3-4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4, 6-8 figures
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4-5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	4
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	5

Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	9
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	9
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	9
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	12-19 tables
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	9-11
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	20-23
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	23-24
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	24
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	N/A

Appendix 2.2

Table A2.2 MMAT Quality assessment outcomes

Author and year	**Score**
Barnett et al., 2016	7
Cliff et al., 2009	7
Duff et al., 2019	7
Foweather et al., 2015	7
Nilsen et al., 2020	7
Roscoe et al., 2019	7
Webster et al., 2019	7
Eshagi et al., 2015	7
Fujinaga 2008	7
Moran et al., 2005	7
Roman et al., 2017	7
Jones et al., 2011	7
De Oliveira et al., 2019	7
An et al., 2009	6
Jiang et al., 2018	6
Jung et al., 2017	6
Stankovic and Radenkovic 2012	6
Tan et al., 2019	6
Palmer et al., 2018	6
Marin 2012	5
Wasneius et al., 2017	4
Adamovic et al., 2016	5
Amelia et al., 2019	5
Cambier et al., 2001	5
Condon and Cremin 2014	7
Guffey et al., 2016	7
Vanetsanou and Kambas 2011	7
Zumbrunn et al., 2012	6

Appendix 3.1

Table A3.1. School Area and Index of Multiple Deprivation

Location	**IMD**
Leicestershire	31479
North London	4121
Warwickshire	30640
Worcestershire	14043
Coventry	1832
Gloucestershire	26172
South-East London	14786
Coventry	17711
Worcestershire	20632
Somerset	29374

Appendix 3.2

Interview schedule: Name of study: The Value of Physical Education and Activity for Early Years Foundation Stage Children in England

- What does the phrase '**fundamental movement skills**' mean to you as a practitioner?
    - Are there any **particular categories** you would split these skills in to?
    - Do you feel your school provides **adequate opportunity** for children to develop their FMS?

- Do you think physical skills **develop** as a child **matures**, or do you think physical skills should be taught?

- Do you feel PE should hold the **same value** as other academic subjects, especially at EYFS?
    - Do you think PE should be supported by scientific research methods? What do you think the benefits of doing this are?

- Would you feel **confident** delivering a PE intervention to an EYFS class, if training was provided? Why?
    - What would make you more **prepared** for delivery of these?

- Do you believe the **physical activity government guidelines** of 180 minutes per day for children aged 5 years and below are sufficient and achievable? What barrier do you think teachers and schools face to achieving at least 30 mins/day of MVPA for children?
    - Within your **school environment or the environment that you work in** how do you approach achieving these guidelines?
    - Do you think the approach could be **improved?**

- Do you think there are **benefits** to children being physically active?
    - What do you feel children **achieve** from being physically active?

- Do you notice any **key differences** between children who are more physically capable than others?
    - **Physically, socially, academically**?

- With a lack of research around **stability and balance skills** at the ages of 4-5 years old in the UK, how important do you think these skills are? How would you work on these with EYFS students?
    - What sort of tasks do you think balance and stability aid within the school environment and in PE?

Appendix 3.3

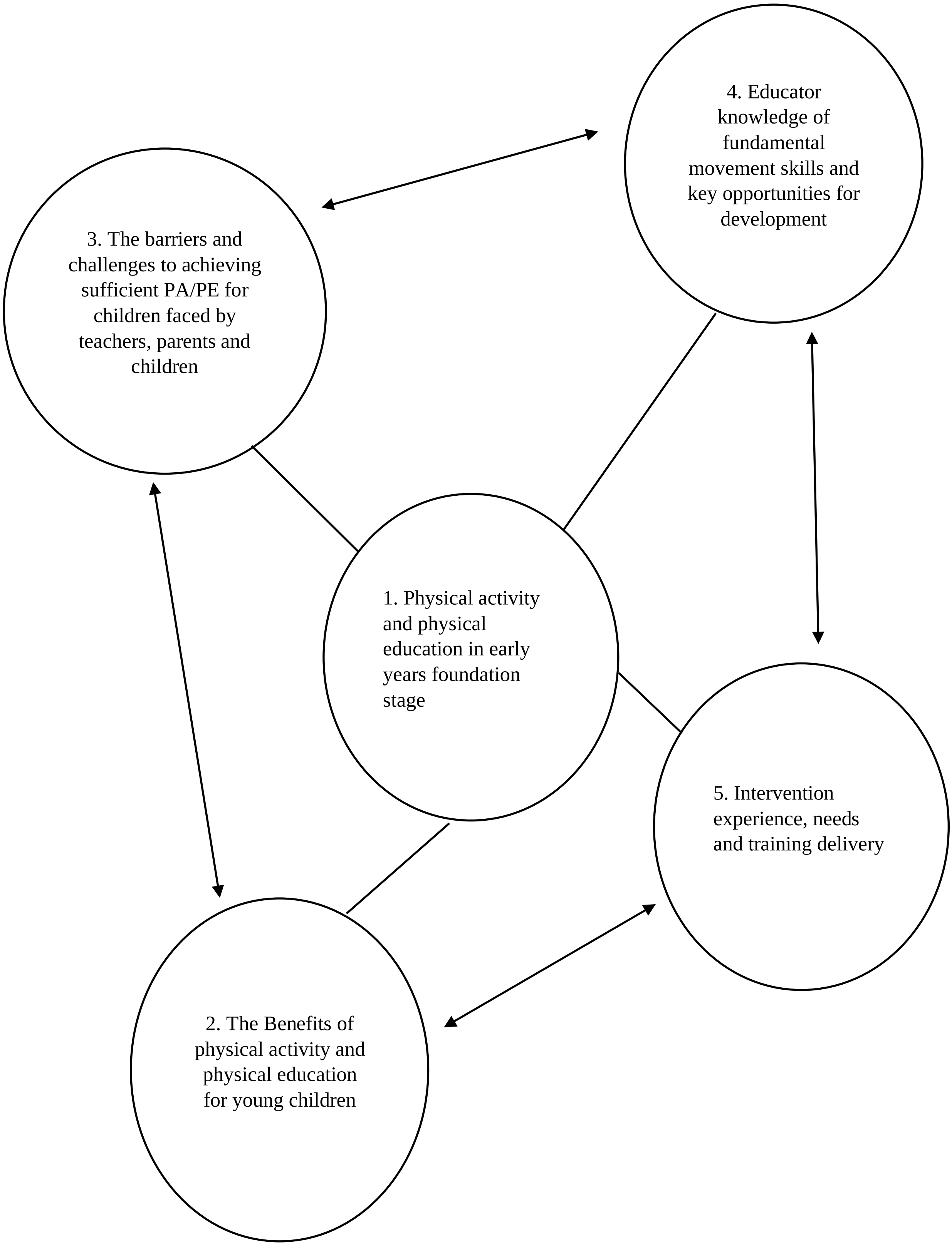


Figure A3.3. Theme map

Appendix 4.1

TGMD-2 Scoring criteria

Run	
1) Brief period where both feet are off the ground	
2) Arms in opposition of legs, elbows bent	
3) Narrow foot placement near or on a straight line (not flat footed)	
4) Non-support leg bent approximately 90 degrees (close to buttocks)	

Gallop	
1) A step forward with the lead foot followed with a step with the trailing foot in a position adjacent to or behind the lead foot	
2) Brief Period where both feet are off the ground	
3) Arms bent and lifted to waist level	
4) Able to lead with right and left foot	

Hop	
1) Foot of non-support leg is bent and carried in the back of the body	
2) Non-support leg swings in pendular fashion to produce force	
3) Arms bent at elbows and swing forward on take off	
4) Able to hop on the right and left foot	

Leap	
1) Take off on one foot and land on the opposite foot	
2) A period where both feet are off the ground (longer than running)	
3) Forward reach with arm opposite the lead foot	

Horizontal Jump	
1) Preparatory movement includes flexion of both knees with arms extended behind the body	
2) Arms extended forcefully forward and upward, reaching full extension above the head	
3) Take off and land on both feet simultaneously	
4) Arms are bought downward during landing	

Slide	
1)Body turned sideways so shoulders are aligned with the line of the floor	
2) A step sideways with the lead foot followed by a slide of the trailing foot to a point next to the lead foot	
3) A minimum of four consecutive step-slide cycles to the right	
4) A minimum of four consecutive step-slide cycles to the left	

Skip	
1) A step forward followed by a hop on the same foot	
2) Arms are flexed and move in opposition to legs to produce force	
3) Completes 4 continuous rhythmic alternating skips.	

Stationary Bounce	
1) Contact ball with one hand at about hip height	
2) Pushes ball with fingers (not a slap)	
3) Ball contacts floor in front of (or to the outside of) foot on the side of the hand being used	

Underhand Roll	
1) Preferred hand swings down and back, reaching behind the trunk while chest faces cones	
2) Strides forward with foot opposite the preferred hand towards the cones	
3) Bends Knees to lower body	
4) Releases ball close to the floor so ball does not bounce more than 4 inches high	

Kick	
1) Rapid continuous approach to the ball	
2) The trunk is inclined backward during the ball contact	
3) Forward swing of the arm opposite the kicking leg	
4) Follow-through by hopping on non-kicking foot	

Overhand Throw	
1) A downward arc of the throwing arm initiates the windup	
2) Rotation of hip and shoulder to a point where the nondominant side faces an imaginary target	
3) Weight is transferred by stepping with the foot opposite the throwing hand	
4) Follow-through beyond ball release diagonally across body toward side opposite throwing arm	

Catch	
1) Preparation Phase where elbows are flexed and hands are in front of the body	
2) Arms extend in preparation for ball contact	
3) Ball is caught and controlled by hands only	
4) Elbows bend to absorb force	

Two-hand Strike	
1) Dominant hand grips the bat above nondominant hand	
2) Nondominant side of body face the tosser (feet parallel)	
3) Hip and spine rotation	
4) Weight is transferred by stepping with front foot	

Appendix 4.2.

Parent questionnaire for child and parent demographics

Data collection form Please complete the form where the information is available and return to your child's class teacher. Thank you	
Participant ID (last two letters of postcode and last two numbers of phone number):	
Child's DOB	
Child's ethnicity	
Child's Sex	
Parental/Guardian highest education level (e.g. GCSE, A-level, Bachelor degree and so on)	
Parent 1	
Parent 2	
Postcode; This is used for purposes related to socioeconomic status	

Appendix 4.3

Online recruitment poster

Appendix 4.4.

Participant instructions and link for online data collection

The FMS Project Instructions

Step 1: Please fill in the form named ‘Participant Data’ (this includes information about your child’s age, height etc.) sent in the same email as these instructions.

Step 2: View the short video (link below) of the different skills your child will need to be filmed performing. It is recommended that you watch this video with your child **ONCE** before asking them to perform the skills.

https://youtu.be/-QMQOTZgFPs

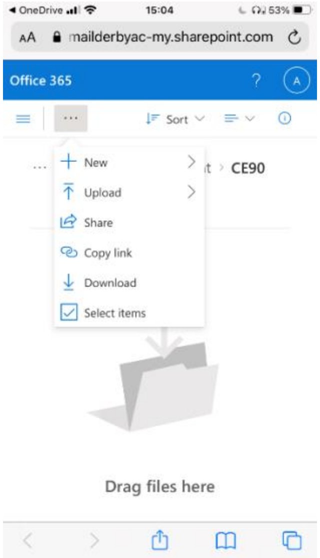
Written skill instructions can be found at the bottom of this document, you my want to print these out.

Step 3: Film an attempt of **each skill twice** (this can be within one video). If you don’t have the equipment to film, just leave this skill out.

For skills with a small ball, these can be replaced socks turned into each other (as shown below)

Step 4: When you have recorded as many videos as possible, please upload these to your onedrive folder. This will have been sent in a direct link email- **‘Alexandra Dobell shared the folder "[PATICPANT ID]" with you’.**

Simply upload the videos by dragging them into the folder, alternatively you can upload them from your phone browser, as show below.



If you have any issues accessing this, please get in touch: a.dobell@derby.ac.uk

Step 5: Once the questionnaire about physical activity levels becomes available a link will be sent to you. Please complete this using your participant ID.

Step 6: Once this is completed your child will receive a personalised certificate and you will be entered into draw to win 1 of 4 £20 Amazon vouchers. Further information to help improve your child's fundamental movement skills will be attached to a debrief email, which can be used as short home PE activities.

Thank you for your interest and participation in this research project!

Alexandra Dobell (Prinicipal Investgator)

PhD Student
School of Human Sciences
College of Life and Natural Sciences

E: a.dobell@derby.ac.uk
University of Derby,
Kedleston Road,
Derby
DE22 1GB

UNIVERSITY OF DERBY

FMS Skill instructions

Skill	Performance description
Run	Ask your child to run as fast as they can in a straight line.
Jump	Ask your child to jump as far forward as they can from a standing start. A standing long jump.
Hop	Ask your child to hop forwards three times on each leg.
Leap	Ask your child to leap over a small object, e.g. a cone. A run up is recommended.
Gallop	Ask your child to gallop forwards in a straight line.
Side-step	Ask your child to side-step in a straight line to the right and then the left. 4 cycles each way.
Skip	Ask your child skip forwards in a straight line.

Skill	Performance description
Overhand Throw	Ask your child to throw a small ball (tennis size) overhand.
Catch	Using a medium size ball, gently throw the ball to your child asking them to catch the ball.
Stationary Bounce	Ask your child to bounce a ball up and down on a hard surface.
Kick	Ask your child to run up and kick a stationary ball.
Underhand roll	Ask your child to roll a small ball along the floor.
Strike	Ask your child to hit a ball with a bat or racket, if possible, make the ball a stationary target, or throw the ball to your child.

Skill	Performance description
Single leg balance	Ask your child to stand on one leg for up to 30 seconds, repeat in the other leg.

Appendix 5.1
Focus group schedules
Write, draw, share and tell- Child focus groups

	STEP 1/2 questions- Establishing the problem, context and setting/programme outcomes
1	• What do you enjoy the most about PE at school?
2	• Show me what you like to do at breaktime or lunchtime? (S5: implementation)
3	• Show me what you learn in PE?
4	• How does doing PE make you feel?
5	• Show me what activities you do at home with mum/day/brother/sister.

	STEP 3 questions- program design/themes
1	• Draw your favourite television character/brand/toy/story book

2	• Tell me about your favourite sport that you do, or you watch (in-person, on the television, you do with friends/parents do)
3	• **Show children** a picture of many superheroes and discuss which one is their favourite and why?
4	• What do you do when you are outdoors?

	STEP 4/5- program production and implementation
1	• Tell me about your favourite lesson at school
2	• What is your favourite kind of reward a school?

Focus group 1 Parents (FG1P)

STEP 1 questions-

1	• What factors/determinants do you believe effect a child's physical development abilities? ○ Think as broadly as you can here- socioecological, can you also be self-critical?
2	• Do you know what the term fundamental movement skill means?
3	• How does your child's school environment facilitate opportunity for physical activity?
4a	• Please discuss how you keep your children active at home and outside of school? ○ And what helps you to do this, e.g. clubs, outdoor spaces, equipment /resources
4b	• Does your child do any specific sports? If so, what are these? ○ How do these opportunities contribute to your child's overall physical development?
5a	• What are the barriers for PA and healthier lifestyles for children, including PE provision at school?
5b	• If you struggle to keep your child physically active, why do you think this is? ○ Your work, facilities to do so, space at home, your knowledge, support, ideas?

6	• If I was to use the term self-efficacy, what would this mean to you?
7	• Do you feel well supported/know where to look for help with PA at home and meeting the government guidelines? o Do your children's school help/hinder your efforts with this?

STEP 3 questions

	THEMES/ ROLE MODELS
1	• What themes/characters/cartoons engage your children?
2	• Do you think existing familiarity or novelty is important to engage young children?
3	• Would you prefer to be active with your child or for them to attend different settings with coaches?
	SCOPE
4	• Would you want to be involved with an intervention your child was doing at school, or rather it all happened at the school setting? Why?

5	• If your child was to take part in an intervention, how would you like to see progress measured and reported?
	COMPONENTS
6	• Name any resources that you think would help your child to engage in more PA. o Do you think technology would be a useful approach to increasing children's activities?
7	• What engages your children to learn or take part? Type of activity, technology etc?

STEP 4- Key Messages of the programme

1	• What kind of message do you believe helps to capture people's attention to make a change in their health-related behaviours or environments? (Parents and children)

STEP 5- Implementation

1	• Other than increasing children's PA/physical skills what other outcomes do you feel are essential to improve through the program implementation and sustainability? E.g. the structure in place for interventions to happen in your setting- ease of adoption of the program.
2	• What would make the program outcomes valuable to you as a parent? o What would you perceive as a manageable and achievable objective for a child?

STEP 6- Evaluation

1	• What do you think would be best to evaluate/measure the changes of a program or intervention that is introduced within a school? ○ Student reports, relaying information to parents?
2	• What elements do you think should be reported and evaluated to have policy level impact? E.g. PA levels, happiness of the children, how the program was successful or unsuccessful, parents perceptions of the use of the program- noticing changes in their children.
3	• How do you think ‘real world’ success can be measured? ○ What would be an outcome that you want to see come from this program for it to continue it within your child’s school?

Focus group 1 Researchers (FG1R)

STEP 1 questions- Establishing the problem, context and setting

1	• According to your own experience, knowledge and thoughts surrounding the existing literature, what do you believe are the largest and most significant barrier to early years PA opportunities in England?
2	• Regarding self-efficacy and perceived motor competence, do you think this is important to focus on in the early years considering its relationship in middle to late childhood?
3	• What approaches do you believe have been unsuccessful in increasing PA and FMS competency in children? o Why? Do you think these approaches could be improved?
4	• What factors do you think make schools a successful or unsuccessful setting for intervention?
5	• Where does the biggest change need to come from? o Environment, policy etc?
6	• What would you consider the biggest personal and environmental determinants for PA and FMS performance are for young children?

STEP 3- program design

	THEMES/ ROLE MODELS
1	• Have you found themes/characters/cartoons engage children when working with them? If so, what are these/ ones you have previously used?
2	• If a program was to have an overall theme, what do you believe would best engage young children? Research related?
3	• Do you think existing characters/familiarity is important to engage young children?
	SCOPE
6	• How best do you think interventions fit into education settings? For example, 15 minutes/day or 1 hour/week, encouraging home-based tasks?
7	• What measurements do you think are most important to measure during interventions so that children and implementers are able to see progress?
8	• What kind of environments do you think work best for a program? o Outdoors, in the classroom, larger spaces, equipment?

9	• What methods do you find work best for increasing both awareness and knowledge of stakeholders, facilitators, and end users?
	COMPONENTS
1	• When designing a multicomponent intervention, what is the maximum number of components you would suggest using/have successfully used previously?

STEP 4- Key Messages of the programme

1	• What kind of message do you believe helps to capture people's attention to make a change in their behaviours or environments?

STEP 5- Implementation

1	• From your own perspective and the research you have done, what do you believe are the three main reasons interventions are not always successful in sustainability?
2	• What do you think important elements of implementation are? o Communication techniques, resources needed, training delivered?
3	• Once implemented into a school, what would helps to maintain and sustain the use of a program and possible longevity/adoption? o E.g. regular contact, a website/app,

STEP 6- Evaluation

1	• What do you think would be best to evaluate/measure the changes of a program or intervention that is introduced within your setting? ○ Student reports, relaying information to parents, measuring outcomes for researchers.
2	• What elements do you think should be reported and evaluated? E.g. PA levels, happiness of the children, how the program was successful or unsuccessful, parents perceptions of the use of the program- noticing changes in their children.
3	• How do you think ‘real world’ success can be measured?

Appendix 5.2

Feedback Sheet (parents and researchers)

Feedback sheet

On the table below please rate the *individual* outcomes in **order of importance from 1-7** for young children when participating in physical activity (1=most important, 7=least important).

Outcomes	**Importance**
Enjoyment	
Communication	
Developing resilience	
Improving Fitness levels	
Improving Academic achievement	
Increasing Physical capability/ movement skill mastery	
Increasing Self-efficacy/ confidence in ability	

On the table below please rate the *environmental* factors in **order of importance from 1-8** for young children when participating in physical activity (1=most important, 8=least important).

Factor	**Importance**
Indoor Space	
Facilities/equipment	
Outdoor space	
Role model	
Encouragement	
Training of facilitators (teachers/coaches)	
Cost	
Time dedicated to physical activity	

PLEASE CONTNUE TO THE NEXT PAGE

PERFORMANCE OBJECTIVES:

Please state whether you agree, slightly agree, neither agree or disagree, slightly disagree, or disagree with the following statements as achievable performance outcome for young children/school settings.

1) **Increase amount of time children spend doing physical activity in school by 10% across a week**
   By:
   - Giving more opportunity to practice fundamental movement skills in school
   - School actively encouraging active transport
   - Teachers receiving training and resources to improve planning and confidence to deliver PA

☐ Agree

☐Slightly agree

☐Neither agree or disagree

☐Slightly disagree

☐Disagree

2) **Increase the amount of structed fundamental movement skill (FMS) practice a child partakes in each week**
   By:
   - Using a framework and resource of games provided to teachers to introduce children to activities that could be used in their free play opportunities
   - Teachers allocating time for FMS practice, as they would with reading/writing practice
   - Children setting goals with their teacher/parent

☐ Agree

☐Slightly agree

☐Neither agree or disagree

☐Slightly disagree

☐Disagree

3) Increase child's physical self-efficacy* in their fundamental movement skills and taking part in physical activity

*self-efficacy is an individual's belief in their capacity to execute behaviours necessary to produce a specific performance.

By:

- Creating a record of child's FMS and physical activity achievements
- Encouraging children to initiate own games and play with peers
- Providing different physical environments/challenges for practice and play

☐ Agree

☐Slightly agree

☐Neither agree or disagree

☐Slightly disagree

☐Disagree

If you any further comments about the above, including ideas/thoughts, please provide them below (extend box as needed)

Please type here:

THANK YOU FOR COMPLETING THIS FORM.

Please return to a.dobell@derby.ac.uk

Appendix 5.3

The Framework Booklet

A Guide to Improving Fundamental Movement Skills in your EYFS

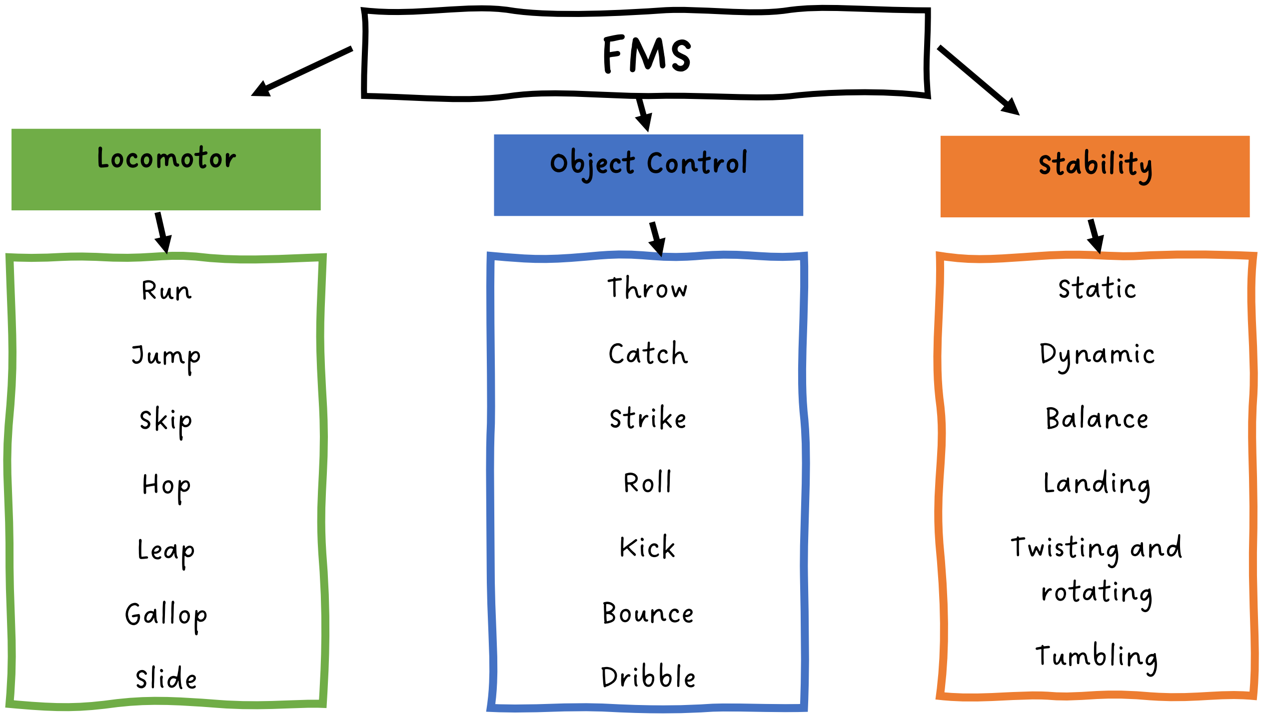
THE FMS SCHOOL PROJECT

Contents

Section 1

What are FMS?

Fundamental movement skills (FMS) are the building blocks to taking part in physical activity and sport. It is important that children develop them from the early years to enable competency in these skills and the ability to perform sport specific skills and lifelong physical activity. FMS is split into three sub-categories: locomotion, object control and stability.

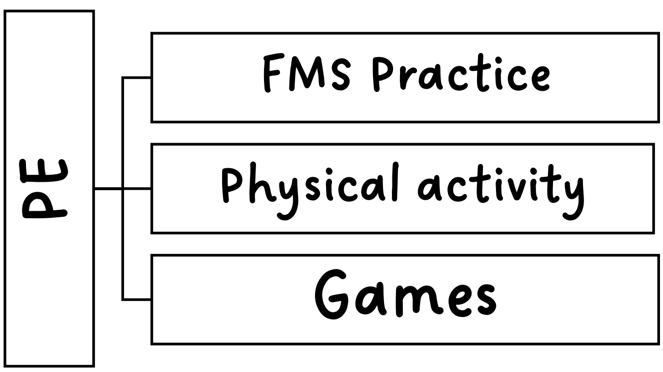


Initially, children should develop these skills independently before progressing to combining FMS together, which best represents sport specific skills.

Physical activity, PE, and FMS

Physical activity is important to children's health throughout their childhood, and into adult life. Physical activity can improve adiposity, psychosocial health, cardiometabolic health indicators, and motor development. It can also help to reduce cardiovascular risk, improve health-related fitness, maintain a healthy weight, and increase bone density and strength. Importantly, it can also improve academic attainment!

Physical education (PE) should give children a chance to be physically active while developing FMS and other key social and personal skills at the EYFS. PE can be structured, giving the children multiple movement opportunities, with a greater level of instruction. PE can also be less structured, providing movement environments for children to practice their own skills, with the supervision of teachers.



Evidence shows that FMS development can aid children academically in their classroom activities, in addition to the benefits seen in PE, physical activity and play opportunities. FMS practice opportunities are vital to children gaining competency, these practice opportunities can be implemented into the classroom setting and activities, and not just within PE (covered in section 4).

Section 2

Planning for FMS

As mentioned, ***structured and unstructured*** practice of FMS can take place in the school environment. However, to achieve success in improving children's skills, practice should be implemented on a regular basis and therefore be planned into children's days.

Planning does not need to take a long time, and the outcome should be to identifying which skills will be practiced and developed within sessions and to ensure a balance of provision is achieved for all domains of skills.

A good example is to focus on a particular skill each week or to change skill focus each day but repeat over a 4 week period. An example of a week of skill provision planning is shown on the next page, followed by a blank template for your use.

Day	Skill	Session/Activity
Monday	Running	Whole PE session
Tuesday	Catching	Morning activity
Wednesday	Skipping	Afternoon activity
Thursday	Throwing	PE session
Friday	Dynamic balance	Classroom activity

Day	Skill	Session/Activity

The **FRAMEWORK** provided in section 3 of this guide provides you with a whole range of activities to implement in your class in ***practical sessions,*** supported by ***in-classroom activities*** in section 4 to enhance children's ***knowledge and enjoyment*** of FMS.

During practice there are two key elements which are: ***quality and repetition***. These will be discussed further in the following section.

Quality and repetition

To develop competency in their FMS, children need a ***repeated*** number of opportunities to practice them in the ***same and differing*** environments

- Similar and familiar environments for practice should be provided at the start of tuition and practice.
- Introducing different environments should be provided when a child is close to or has mastery of a skill.

Practice opportunities should be of high quality which requires you, as facilitators, to have good knowledge to recognise good competency of FMS. To achieve this require you to understand ***the 3-4 critical elements of each skill***. This also gives you 3-4 areas of skill to be worked upon in sessions The key elements of 7 locomotor and 6 object control skills are included on the next page:

Locomotor

Run	
1) Brief period where both feet are off the ground	
2) Arms in opposition of legs, elbows bent	
3) Narrow foot placement near or on a straight line (not flat footed)	
4) Non-support leg bent approximately 90 degrees (close to buttocks)	

Gallop	
1) A step forward with the lead foot followed with a step with the trailing foot in a position adjacent to or behind the lead foot	
2) Brief Period where both feet are off the ground	
3) Arms bent and lifted to waist level	
4) Able to lead with right and left foot	

Hop	
1) Foot of non-support leg is bent and carried in the back of the body	
2) Non-support leg swings in pendular fashion to produce force	
3) Arms bent at elbows and swing forward on take off	
4) Able to hop on the right and left foot	

Leap	
1) Take off on one foot and land on the opposite foot	
2) A period where both feet are off the ground (longer than running)	
3) Forward reach with arm opposite the lead foot	

Horizontal Jump	
1) Preparatory movement includes flexion of both knees with arms extended behind the body	
2) Arms extended forcefully forward and upward, reaching full extension above the head	
3) Take off and land on both feet simultaneously	
4) Arms are bought downward during landing	

Slide	
1)Body turned sideways so shoulders are aligned with the line of the floor	
2) A step sideways with the lead foot followed by a slide of the trailing foot to a point next to the lead foot	
3) A minimum of four consecutive step-slide cycles to the right	
4) A minimum of four consecutive step-slide cycles to the left	

Skip	
1) A step forward followed by a hop on the same foot	
2) Arms are flexed and move in opposition to legs to produce force	
3) Completes 4 continuous rhythmic alternating skips.	

Object Control

Stationary Bounce	
1) Contact ball with one hand at about hip height	
2) Pushes ball with fingers (not a slap)	
3) Ball contacts floor in front of (or to the outside of) foot on the side of the hand being used	

Underhand Roll	
1) Preferred hand swings down and back, reaching behind the trunk while chest faces cones	
2) Strides forward with foot opposite the preferred hand towards the cones	
3) Bends Knees to lower body	
4) Releases ball close to the floor so ball does not bounce more than 4 inches high	

Kick	
1) Rapid continuous approach to the ball	
2) The trunk is inclined backward during the ball contact	
3) Forward swing of the arm opposite the kicking leg	
4) Follow-through by hopping on non-kicking foot	

Overhand Throw	
1) A downward arc of the throwing arm initiates the windup	
2) Rotation of hip and shoulder to a point where the nondominant side faces an imaginary target	
3) Weight is transferred by stepping with the foot opposite the throwing hand	
4) Follow-through beyond ball release diagonally across body toward side opposite throwing arm	

Catch	
1) Preparation Phase where elbows are flexed and hands are in front of the body	
2) Arms extend in preparation for ball contact	
3) Ball is caught and controlled by hands only	
4) Elbows bend to absorb force	

Two-hand Strike	
1) Dominant hand grips the bat above nondominant hand	
2) Nondominant side of body face the tosser (feet parallel)	
3) Hip and spine rotation	
4) Weight is transferred by stepping with front foot	

Having knowledge of these skills and elements will enable you to provide ***high quality feedback*** to your children and develop your own strategies for improving their skills. These skill elements can be noted when you are planning a session.

Cue words can also be used- which is a key way to enhance knowledge. Cue words can relate to the skill elements provided above or to an activity can be linked to an analogy. For example, ‘can you leap like spiderman’, Spiderman can then become a memorable cue word.

The Step Model

Adaptation of activities is likely needed for children in your class. Physical skills of the youngest children are likely to be less developed than of the older children, however improvements can be made for both groups of children.

Using the ***STEP model*** is a simple but effective way to adapt activities:

S-space: can the shape of the space be changed, can it more from indoors to outdoors or a larger space?
T-task: how can children score points withing a game, can some children have different rules?
E-equipment: can equipment be added or taken away to the activity, can equipment of different sizes be used?
P-people: can some children have different roles within a game or activity, can the number in a group increase or decrease?

Another essential element to providing high quality experiences will come from the ***child's enjoyment***. With this in mind, the activities suggested in the FRAMEWORK follow play and game-based strategies, as well as elements of exploration.

therefore, practice should be ***game and play based***.

A good way to enhance enjoyment is to ask for children's ***formative feedback***, this will help you to identify what they did and didn't enjoy about the sessions. It may also help to give you an insight into the children's confidence in skills. Formative feedback is covered in section 3 of this guide.

To summarise:

- Plan weekly > plan individual sessions/ activities
- Repeat opportunities
- Allow high quality practice and feedback
    - Critical elements
    - Cue words
- The STEP adaptive model
- Enjoyment > formative feedback

Section 3

FRAMEWORK for Practical Sessions

The section provides you with a collection of over 40 activities to use with your class of EYFS of children. The 3 domains of FMS are presented with their typical skills, and there is also a 'combination' activities section. Finally, a section for ideas to use as formative feedback are given. This can be used as individual reflection, feedback on their thoughts about the tasks and activities, or as peer-to-peer feedback. Activities can be used as standalone or as a collection to plan a whole skill session:

1) Choose a skill domain by clicking on the boxes below
2) Choose a skill or skills to practice
3) Pick from a list of activities/games
4) Create your session plan (template/example included)

Locomotor	Object Control	Stability	Combination	Formative feedback techniques

Locomotor						
Skipping	Running	Jumping	Hopping	Leaping	Galloping	Side stepping
Skip to the music	Fishes and Sharks	Frogs and Lily pads	Bunny rabbits	Superheroes	Horses and Unicorns	Under the sea
	Captains command	Can you Jump…?	Hopscotch	Horses and Unicorns	Under the sea	Grab the tail

Object Control					
Throwing	Kicking	Catching	Striking	Bouncing	Rolling
Target throw- buckets & hoops	Wall kick	Balloon throw and catch	Balloon bat and ball	Drop-catch	Roll and run
All throw	Dribbling	High to low	Rounders	Hoop-bounce	Goalkeeper

Stability and Coordination					
Static balance	Dynamic balance	Twisting and turning	Dodging	Landing	Coordination
Flamingos	The balance beam challenge	Obstacle course	Fishes and sharks	Can you jump…?	Rub tummy/pat head
Musical statues	Bean bag balance	Move through the hoop		Obstacle course	Body parts on the ground

Combination					
Equipment discovery	My cone, your cone	Monkeys	Bean game	Sport based activities	Obstacle course

Formative feedback techniques					
Traffic lights	Smiley faces	2 stars and a wish	1-10 scale	Medals	Positive sandwich

Fishes and Sharks ▪ Chose two sharks from the group of children, the rest of the children are fish. ▪ They must run from one side of the playing area to the other without getting tagged (eaten) by the sharks. If a fish is eaten, they become a shark and the fishes try to cross the area again. ▪ This game can create a winner by the last fish left S- make the space bigger or smaller T- fishes can become crabs and must sidestep, or seahorses and must gallop E- add cones into the space as rocks/seaweed that the children must dodge around P- start with more or less sharks	**Time:** 1 round of game = 5 minutes **Outcomes:** Children practice running and develop dodging Learning about winning **Equipment:** cones **Cue words/critical elements:** Running: feet to bottom, on your toes, swing your arms, fast!

<u>Fogs and lily pads</u> ▪ Ask the children to show you how a frog would jump- the children should use their imagination to do this. You can also ask the children what noise a frog might make. ▪ Set out spots across the playing area as 'lily pads', ask the children to travel as frogs between the lily pads **S-** ask children what shape the pond is, get them to think about shapes, make the pond bigger so they must jump further **T-** Children could become pond skaters and move across the pond on all fours **E-** When a child reaches a lily pad, they must perform a balance/ lily pad could be hoops **P-** one big pond or lots of smaller ponds, working in pairs	**Time:** 5 minutes **Outcomes:** Children practice how to jump. Thinking about their journey across the pond **Equipment:** soft rubber spots/cones **Cue words/critical elements:** Jumping: Bending knees, arms behind body and above head
<u>Bunny Rabbits</u> ▪ Children must start in pairs standing within a hoop, this is their den. Place orange cone/bean bags around the playing space, these are carrots. ▪ Children must hop one at a time from each pair to collect carrots from the playing space, before returning to the den, they may only collect one carrot at a time. ▪ The pair with highest number of carrots at the end of the game wins. **S-** **T-** Once children become proficient hopping on one leg, ask them to swap to the other **E-** If using cones AND beanbags, these can total different points **P-** Introduce one person as a fox who can capture bunny rabbits for 10 seconds. The fox must tip-toe around the space	**Time:** 5-10 minutes **Outcomes:** Practice hopping skills and progress to using both legs **Equipment:** Hoops, cones/ beanbags **Cue words/critical elements:** Bent arms, resting foot behind working leg, leg pendulum swing
<u>Under the sea</u> ▪ Begin with a short discussion of what animals we might find in the sea. Highlight if any child mentions a crab. Demonstrate how a crab might move (use hands etc.) ▪ Using lines within a playing space or a space marker by cones, ask the children to sidestep around a box shape. Blow a whistle telling the children to start side stepping the other way.	**Time:** 10 minutes **Outcomes:** Practice side stepping or various other locomotor skills.

<table>
<tr><td>

- Create a relay race for the children, where they must only move like a crab, remind them to encourage one another

S- Change the lines so they are zigzags or a circle for example
T- This task can be change to any animal the children mention and can come up with a motion for (this does not have to be a set locomotor skill), for example a seahorse (galloping)
E- incorporate a sandpit into a relay by hiding items that children must find and return to their team during the race
P- Once more advance, children could be different creatures under the sea. Like in fish and sharks, a child/children could become predators for other children to avoid (mark them out with bibs)
</td><td>
Communication with one another

Equipment: cones/lines, sandpit, hidden items, bibs

Cue words/critical elements: sidestep: Always facing sideways, feet apart then together.
</td></tr>
<tr><td>

<u>**Can you jump….?**</u>

- A simple recall style game. Ask the children is they can jump like a…. Kangaroo, frog, grasshopper.
- Ask the children, can you jump… As high as possible, as far as possible, for as long as possible
- Can you jump… with a skipping rope?

S- use the space in a uniform way, from one end to another, or around a circle to avoid children bumping into each other
T- Place out objects and ask the children how many jumps they think they need to get to the object, complete as a group/class
E- When jumping as far as possible, use markers for who can jump the furthers, could be incorporated in maths.
P- Children turn the skipping rope for the other children.
</td><td>
Time: 5 minutes (warm up)

Outcomes:
Practice jumping

Equipment: none

Cue words/critical elements: Jumping: Bending knees, arms behind body and above head, taking off and landing on two feet
</td></tr>
<tr><td>

<u>**Superheroes**</u>

- Ask children to be their favourite superhero- popular choices are superman/woman, spider man and wonder woman.
- Begin by getting the children to run around and when you should 'superhero' they must make their best superhero pose.
- Next, create spaces where children must leap over objects to carry on travelling with the playing space
</td><td>
Time: 10-15 minutes

Outcomes: Practicing leaping over objects, running

Equipment: Cones, larger objects as leaping progresses, teddy bears/toys
</td></tr>
</table>

S- Create safe spaces, where superheroes can rest for ten seconds. If your space has a climbing frame, children may use this to practice climbing skills. **T-** Using toys/teddy bears etc. ask the superheroes to save them and take them back to a safe space, have a time limit to make this a game. **E-** As children gain proficiency, create bigger obstacles for them to leap over, increasing the height or length of the object. **P-** Create 'baddies' who can chase the superheroes but cannot leap over the obstacles.	**Cue words/critical elements:** Take off and land on opposite feet, reach out hand for balance, avoid jumping, use run up
Horses and Unicorns ▪ Set the scene of being galloping horses/unicorns. Horses/unicorns must collect 3 items (carrots/mints- green/orange cones). ▪ 2nd stage: progress by galloping 3 right leg, 3 left leg. ▪ 3rd stage: Leaping over jumps- cones (red/blue) ▪ 4th stage: combine all three elements	**Time:** 10-15 minutes **Outcomes:** Practicing galloping and leaping, counting skills **Equipment:** Cones **Cue words/critical elements:** Galloping: One step forward trail leg follow, arms bend by side
Captains command ▪ Ask children to stand in the middle of the playing space. Mark out the ship by using: To their right: starboard, to the left: port, in front of them: bow and behind: stern. ▪ Ask the children to run to starboard, port, bow or stern. **S-** Progress by playing outdoors and having a bigger space to run within **T-** Other actions you can shout are climbing the rigging, tilt the deck (squat down), captains coming (stand and salute) and scrub the deck, knee, and scrub the deck. **E-** Use a bench children can climb and balance on at starboard and/or port. **P-** Ask one of the children to become captain and shout the commands.	**Time:** 10-15 minutes **Outcomes:** Practicing running skills and change of direction and other foundational skills **Equipment:** Paper with names of locations **Cue words/critical elements:** Running: feet to bottom, on your toes, swing your arms, fast!
Grab the tail ▪ Children work in pairs, and have a bib tucked into their shorts. ▪ They one must be trying to get the bib and the other avoiding their bib being taken.	**Time:** 5-10 minutes

▪ They must only sidestep and try and reach and grab the bib. **S-** make the space the children can work in bigger or smaller, remember they can only move sideways **T-** Children have two bibs tucked in and both must be taken. Time the children to see who can do it the fastest **E- N/A** **P-** remember to remind the children to switch roles of grabber and avoider. Children can also join up with another pair and work against each other as pairs.	**Outcomes:** Practicing side stepping **Equipment:** bibs **Cue words/critical elements:** Always facing sideways, feet apart then together.
Hopscotch ▪ Mark out on the playground with chalk or foam numbers inside, a hopscotch for the children to follow. If using chalk, more than one can be set up **S-** Start with very short course and make them longer, make the boxes the children have to land in bigger or smaller. **T-** Make the hopscotches marked out progressively harder for the children to complete **E-** use hoops to mark out the course, this means children must hop over the edge of the hoop to complete each section. **P-** Can a pair of children complete a hopscotch in synchronisation?	**Time:** 5-10 minutes **Outcomes:** Practicing hopping and counting **Equipment:** Chalk, foam number squares **Cue words/critical elements:** Bent arms, resting foot behind working leg, leg pendulum swing
Skip to the music ▪ Play music and ask the children to skip around the room/playing area to the beat ▪ When the music stops the children must freeze wherever they are **S-** Children must skip around in a circle/square/triangle/rectangle, all facing the same way **T-** Relate it to a song learnt in music **E-** More advance children might be able to use a skipping rope at the same time. **P-** Ask the children to request a song to play to skip to	**Time:** 5-10 minutes **Outcomes:** Practicing skipping **Equipment:** Music **Cue words/critical elements:** Step-hop, arms bent and swinging.

<u>Balloon Throw and Catch</u> ▪ To begin to develop a child throwing and catching skills ask them to throw a balloon up and down to themselves- the balloon gives them enough time to position themselves to catch it confidently with both hands. ▪ Children can then work in pairs and throw balloon to each other. **S-** when in pairs children move further apart as they get more proficient **T-** Ask children to count how many times they can throw and catch the balloon without dropping it **E-** when children feel confident, they could move to a large soft ball and repeat the process **P-** children can progress to work in teams, they can shout each other name when they throw the balloon to that person	**Time:** 5-10 minutes (good warm up) **Outcomes:** Improve catching confidence and competency. **Equipment:** balloons, ball for progression **Cue words/critical elements:** push the balloon from the body, two hands to catch, arms out, then bend into body
<u>Balloon Bat and ball</u> ▪ Similar to balloon throw and catch, use balloons as you would balls with a racket/bat of choice (tennis, badminton, rounders cricket). Repeat the steps of individual practice before working pairs and groups. ▪ This activity can also be bought into the classroom by children creating their own rackets using items like wooden spoons and paper plates, use creativity here. **S-** Use targets within the space for children to hit the balloons into **T-** Progress this task into a game by asking the children to see if they can complete a rally between themselves, as good opportunity to practice counting. **E-**Use different variations of rackets and bats: badminton, tennis, rounders, cricket (ensure these are of appropriate size for the children). **P-** if one child is struggling with throwing, ask them to practice throwing towards another child's racket, so they can practice their striking skills.	**Time:** 10-20 mins (dependant on progression) **Outcomes:** improve striking skills **Equipment:** balloons, utensils, paper plates and stick, rackets **Cue words/critical elements:** step and swing, dominant hand grip, twist the body
<u>Target throw</u>	**Time:** 15-30 (depends on task and progression chosen)

▪ Set up 3-5 hoops that get further and further from a starting position. Using bean bags, ask the children to throw into each hoop. Children can use an under or over arm throw. ▪ Start with bean bags and hoops, progress with buckets and then to soft balls, and then to standing on one leg. **S-** Instead of placing the targets in a straight line, they could be placed in a circle/square or any desired shape or pattern around the starting position **T-** this can be made into a race once the children are competent at it **E-** Use different sized hoops to challenge the children's accuracy **P-** Children could work in pairs for this task. Using one bean bag only, one child throws, while the other must hop to the hoop and return the bean bag (or use another locomotor skill)	**Outcomes:** Improve throwing skills and accuracy. Locomotor skills can be practice in people adaptation **Equipment:** Beans bags, balls, hoops, buckets. **Cue words/critical elements:** swing back to forwards, step with opposite foot to throwing arm
<u>Roll and run</u> ▪ Children standing in a circle all with a ball each ▪ Roll into the middle, run into the middle, and chose another ball, return to the edge of the circle and repeat **S-** space could be a different shape or increased in size so that children must run further. **T-**when the children roll the ball ask them to skip, side-step or gallop after the ball to change the practice of their locomotor skills. **E-** children could have different sized balls to roll into the middle of the circle. **P-** to make this game more competitive some children might not start with a ball but should try and return to the edge of the circle with a ball. This then repeats for the child without a ball	**Time:** 10 minutes **Outcomes:** practice underhand rolling and several locomotor skills **Equipment:** balls of different sizes **Cue words/critical elements:** step forwards, bend knees, ball along the ground
<u>Goalkeeper</u> ▪ Set up a goal marked out by some cones for children working in pairs. ▪ Using only an underhand roll, one child must try and roll the ball past their 'goalkeeper' opponent to score a point, the goalkeeper must try and stop the ball, only with their hands **S-** Create a small or bigger goal if one child of the pair is struggling **T-** this can also be adapted for bouncing a ball, bounce the ball towards the goalkeeper and aim to bounce pass past them	**Time:** 10-15 minutes **Outcomes:** Improve underhand rolling, speed, power, and accuracy **Equipment:** balls (big to small) and cones

E- start with larger soft balls and progress to smaller balls as the children improve their skills **P-** this can also be done in groups or threes; a pair must roll the ball between them down the playing space before trying to score past the goalkeeper	**Cue words/critical elements:** step forwards, bend knees, ball along the ground
Drop catch ▪ To begin developing basic bouncing skills, children should drop a ball and then catch it ▪ Start with the children on their knees, dropping then catch the ball as is bounces back ▪ Once they are competent, progress to kneeling on one knee ▪ Again, progress to standing up **S-** children will only need a small space, a hard surface floor **T-** Once a child and can drop and catch, begin the process again, but with a bounce in the middle **E-** different sized balls should be used, not too large, so that children can proficiently catch them **P-** children can work in pairs and 'drop'/throw the ball between them and the other catches, like a bounce pass	**Time:** 10 minutes **Outcomes:** Improve ball control **Equipment:** bouncy balls **Cue words/critical elements:** push the ball down with two hands and catch with both hands, tap the ball to bounce
Hoop Bounce ▪ Similar to target throw, children must aim to bounce a ball in a hoop, within a set distance in front of them ▪ Another child will stand on the other side to retrieve the ball and bounce it back to their partner **S-** move the pairs further and further apart as they become more proficient **T-** ask a child to stand in a large hoop and to practice their stationary bounce, the ball must not leave the hoop (helps to stay close to the body) **E-** progress to using smaller balls like tennis balls so that accuracy must be improved **P-**as a bigger group, place a hoop in the middle of a circle and pass between each other by bouncing the ball into the hoop	**Time:** 10-15 minutes Outcomes: improve bouncing and accuracy skills. Equipment: **Cue words/critical elements:** push the ball down with two hands and catch with both hands, tap the ball to bounce with one hand
High to low ▪ All children start by standing up, and throwing a ball between themselves in a circle	**Time:** 10 minutes (depends on size of group)

▪ If a child does not catch the ball, the must drop to one knee ▪ If they catch the ball, they may return to two feet is they drop again they must kneel ▪ If they drop the ball for a final time when kneeling, they are out **S-** use smaller group/circles if children are struggling to throw far enough **T-** this can also be down with rolling the ball, where children can end by sitting on the floor too. **E-** start with a larger ball and progress to smaller balls over time **P-** children who are out can decide if the next throw is under or overarm (take turns)	**Outcomes:** practice throwing and catching skills, communication skills **Equipment:** ball **Cue words/critical elements:** two arms out in front, stretch, pull ball into body
<u>**Dribbling**</u> ▪ Step up 4-5 cones, well spread from one another. ▪ Ask a child to dribble a ball through the cones ▪ Their partner must hop/side-step/jump beside them while the complete the task ▪ Swap at the end of the cones and return, complete as many times as possible in 5 minutes **S-** place the cones closer together to increase the difficulty **T-** have a goal at the end of the cones to kick the ball through **E-** place the cones closer together to increase the difficulty **P-** if children are struggling to dribble, pass between each of the cones to their partner	Time: **Outcomes:** improve dribbling and kick skills, **Equipment:** balls and cones **Cue words/critical elements:** use the instep of the foot, keep body close to ball when dribbling foot follows through the with the ball, slight lean back (kick at end)
<u>**Wall Kick**</u> ▪ Using larger balls, and ask children to kick a ball against a wall and then control it with their feet ▪ Begin with no run up ▪ Add in a run up, as this will add difficulty to controlling the ball ▪ This activity could also be 'wall throw' where the kick is changed for a throw **S-** children increase the distance from them and the wall to increase the challenge of controlling the ball **T-** progress by getting children to pass the ball between each other	**Time:** 10-15 mins **Outcomes:** practicing kick and ball control **Equipment:** balls and a wall **Cue words/critical elements:** use the instep of the foot,

E- if doing wall catch, different sized ball can be used to increase the difficulty P- children kick the ball against the ball and another child must control it, and then return the ball	foot follows through the with the ball, slight lean back
Rounders ▪ Play a traditional game of rounders but begin with a racket rather than a bat to give the children a larger surface area. ▪ One child must bowl the ball to the batter, then the child must run around the playing space, past each base. ▪ Each base will have a child on, who can get the batter out ▪ Other children should stand around the playing space to catch, run to and throw the ball to the bowler/bases S- use more or fewer bases than four to give enough children a role/chance of staying in the game T- begin with just bowlers and batters practicing with one another E- progress to a bat when you feel it is sufficient (cricket or rounders, ensure it is the correct size for the children) P- ensure all children have a go at least three roles (batter, bowler, fielder, base)	**Time:** whole session **Outcomes:** practice striking skills, underarm and overarm throwing skills, catching, and running **Equipment:** rackets, bats, cones for bases **Cue words/critical elements:** step and swing, dominant hand grip, twist the body
All Throw ▪ A simple call and repeat game. Introduce different types of throwing: underarm, overarm, chest passes, overhead throwing, bounce passes, one arm and two arm throws. ▪ Have the children stand in a line, call out a type of throw/pass and the children must perform this action ▪ They must then run after their ball collect it can come back to the start S- If you have an outdoor space, see how far the children can throw the balls (may help set goals) T- When proficient to do so, as the children to work in pairs and throw to each other E- use smaller balls for over and underarm throwing P- when in pairs one child can call out the action and be the ball collector while the other performs the throw	**Time:** 5-10 min warm up **Outcomes:** develop a variety of throwing skills **Equipment:** balls of various sizes **Cue words/critical elements:** dependant on throw chosen

<u>**Flamingos (part of animal movements)**</u> ▪ Ask the children to stand like flamingos, once they have been shown an image. They can have a cone on their head to indicate good balancing. ▪ Combine this task by asking children to move like other animals, e.g., a cheetah may run very fast or a jumping kangaroo ▪ This task could be combined with a lesson (biology/geography) when exploring different animals/ birds **S-** n/a **T-** see how long children can hold this balance for, ask the children to count at the same time **E-** can children perform the task on a platform/elevated position? **P-** split children into groups, ask them to choose a type of animal, and demonstrate it to the class who must guess what animal they are	Time: 10-15 mins dependant on animals Outcomes: practice static balance (flamingos), dynamic balance as other animals Equipment: cones
<u>**The balance beam challenge**</u> ▪ Begin with a bench for the children to walk along, ask them to successfully get from one end to the other ▪ Place items such as balls/toys along the length of the balance beam, ask the children to collect these as the walk along the beam **S-** Go outdoors and try to find some natural balance beams in the school environment **T-** This can progress into a race for the children **E-** if available, use a beam that is narrower than a bench, or beam that has a more uneven surfaces or turns within it **P-** if children are struggling at the start other children can be a support and hold their hand from the floor	**Time:** 5-10 minutes **Outcomes:** improve dynamic walking/ running balance **Equipment:** bench/balance beam
<u>**Musical statues**</u> ▪ Use a traditional game of musical statues to test children's balance. ▪ Play music and ask the children to dance or perform a specific locomotor skill around a space. When the music is paused the children must freeze in that position **S-** increase or decrease the size of the space to work on children's spatial awareness or give a larger space for locomotor practice **T-** instead of having to stop and be still on two feet ask children to hold a balance on one leg	**Time:** For as long as many songs as the children want/need **Outcomes:** improve static balance skills and awareness (listening)

E- n/a **P-** children get to choose their favourite songs to dance to, this will help them to have ownership of the task/game	**Equipment:** music playing device
<u>Bean Bag balance</u> ▪ Give each child a bean bag and ask them to place it on their head ▪ Begin by walking around the playing area. Then ask the children to count at the same time as balancing the bean bag on their head **S-** ask the children to walk around a square, a circle shape or weave a roue through each other **T-** change the method of travel, can the children crawl or run? **E-** the bean bag can be changed to a cone as a 'hat' **P-** can the children do it while they hold hands? Working in pairs or groups?	**Time**: 10-15 minutes **Outcomes:** Improve and practice stability and posture **Equipment:** bean bags and cones
<u>Obstacle course</u> ▪ Set up an obstacle course with several balancing challenges within it, include twisting and turn, e.g., a pencil roll ▪ This could include beam walking, jumping off platforms/boxes, climbing up equipment and so on. It can also include other activities that focus on locomotor and object control skills **S-** if children are working in groups, give them a specific part of the school ground or hall where there might be spaces they can be imaginative with **T-** get the children to create their own obstacle course using the equipment available **E-** restrict the equipment children can use to improve their creative thinking **P-** make it a relay between the children, they work in one big team and try to beat their previous time or smaller groups	**Time:** 30 minutes **Outcomes:** work on improving a number of balancing skills. **Equipment:** an array of equipment, beams, boxes, hoops, balls, cones, rackets/bats (the whole PE cupboard)
<u>Rub tummy/pat head</u> ▪ A simple game to get children to think about their coordination skills ▪ Ask the children to rub their tummy and pat their head at the same time ▪ Swap these roles over **S-** n/a	**Time:** 5 minute warm up **Outcomes:** practice simple coordination

T- If the children are really struggling with the task, ask them to rub or tap both their tummy and head at the same time **E-** n/a **P-** one child oversees the commands for the rest of the group	**Equipment:** n/a
<u>Move through the hoop</u> ▪ Start with a hoop that is big enough for all the children to fit through ▪ The children should stand in a circle holding hands, they must pass the hoop up or over each one of them in the full circle **S-** start as a whole class task in one big group, decrease into smaller groups **T-**challenge the children to do it faster than they did it the previous time **E-** use a bigger hoop to start with, as the children get more proficient the size of the hoop can be decreased **P-** mix the children up and get them to work next to a child they usually don't work with, to help them improve their teamwork	**Time:** 5-10 mins **Outcomes:** Children establish how to coordinate their body through the hoop Work on their communication skills with each other. **Equipment:** a hoop
<u>Body parts on the ground</u> ▪ The teacher calls out a number of body parts on the floor from 1 (e.g., 1 foot, your bottom) to 5 (e.g. both hands, feet and your head) and so on **S-** **T-** exclude a body part from being on the ground at any point. E.g., right foot or little fingers **E-** n/a **P-** One child is at the front of the group and the rest of the group must copy that child's actions	**Time:** 5-10 minutes (good cool down) **Outcomes:** practice more complex coordination and balance **Equipment:** n/a

<u>**Equipment Discovery**</u> ▪ Within the playing area set up a selection of equipment for the children to use, including hoops, woggles, balls (3 different sizes), rackets. ▪ Ask the children to use and play with the equipment however they like e.g., they could make up games or build different structures for example. ▪ Observe how the children use a variety of equipment, how they move e.g., actions like squatting down, the grip they use to hold equipment. **S-** use both indoor and outdoor settings **T-** set tasks such as making an obstacle course and others in the class completing it **E-** each time this task is used with the children introduce a new piece of equipment or remove a previous piece so that children become more imaginative **P-** children can work individually, in pairs, small groups, or as a whole class.	**Time:** 15-20 minutes **Outcomes:** practice both locomotion and object control skills using the equipment. To come up with their own game(s). **Equipment:** hoops, woggles, balls (3 different sizes), rackets
<u>**My cone, your cone**</u> ▪ Split the group into two teams (bib one team up) ▪ 30-45 cones spread around the space (half upside down, half right way up) ▪ One team turn cones upside down and other team right way up ▪ Start with running, blow whistle and change to hopping, skipping, jumping, galloping **S-** make the space smaller or larger, so that the children must run further or focus more on their coordination in smaller spaces **T-** teams must collect a specific colour of cone and begin to build a cone tower, the quickest team to do so wins the game **E-** use fewer or more cones depending on how long you want the children to spend on the task **P-** can split into more groups e.g., 3 or 4 if children can understand	**Time:** 5-10 minutes **Outcomes:** practice a variety of locomotor skills and bending and twisting **Equipment:** cones and bibs
<u>**Monkeys**</u> ▪ If your school has a climbing frame this is a great activity and start by pairing children up. ▪ While one child must climb up and down the frame, the other child must move like a monkey from one side of the room to the other (e.g., squatted down, with hand/knuckles on the floor)	**Time:** 10-20 minutes **Outcomes:** practice climbing, coordination,

▪ Once these tasks have been completed, they must swap over **S-** if this can be completed outside using a different kind of climbing equipment, use this **T-** make this a floor-based game where all children are monkeys. One set of monkeys must collect equipment and bring it back to the 'home', but if they are tagged the must drop the equipment and go back to the start. **E-** the monkey on the floor may have to collect an item (bean bag/cone) and bring it back **P-** tagging monkeys	balance, and locomotor skills. **Equipment:** cones/bean bags, climbing frame
<u>**The bean game**</u> ▪ Using as many types of beans as possible that you can think of ask/shout to the children to be: ▪ Baked beans (curl up into a ball), runner beans (run around), broad beans (stretch as wide as they can), string beans (stretch as long as they can), jumping beans (jump around the space), magic beans (choose their own bean action). **S-** can they all be broad beans curled up together or broad or string beans in a line **T-** if they are asked to be runner or jump beans you can ask them to run a certain number of times (e.g., 3 times up and down the hall) or jump ten times **E-** bean bags can also be used in this game **P-** a child get to choose the types of beans the rest of the group become	**Time:** 5-10 minutes **Outcomes:** practice reaction skills and coordination to move into different shapes. Improve locomotor skills **Equipment:** n/a
<u>**Sport based activities**</u> ▪ Use any simple to understand games or other games/sports used in PE such as football, tag rugby, dance, tennis, badminton. ▪ Within these sessions any activities can be used as warm up or cool down to begin to practice and warm up those skills ▪ Football: kicking balls (passing/dribbling), twisting, and turning, running ▪ Tag rugby: running, bending, stretching, jumping ▪ Dance: balance, jumping, leaping, galloping ▪ Tennis/badminton: striking a ball/shuttle cock, throwing for serves ▪ Get the children to pick from a selection of sports and included in the decisions for the session	**Time:** from 10 mins to whole session Outcomes: ensure that the sport allows a number of skills to be practiced and improved. **Equipment:** whatever is needed for the chosen activity

Traffic lights Use a green, orange/amber, and red cone to represent different coloured traffic lights. Children can then use these colours to reflect how they feel about a skill or activity, e.g., GREEN- I'm good to go and feel confident with this skill/activity AMBER- I'm nearly ready to do this on my own, but I need a little bit more help RED- I'm not confident in this skill yet and need more help and guidance.	
Smiley faces Using a sad, okay, and happy face to represent how children feel about a task/activity/skill. Happy: I really enjoyed this activity Okay: this activity was okay, but not that good Sad: I did not enjoy this activity	
2 stars and a wish Children are asked to come up with 2 things they were good at in the activity, or things that they enjoyed about the activity, and then a wish for improvement in their performance or a wish to what they would change about the activity.	
1-10 scale Use a 1 to 10 scale to represent how the children feel about an activity. This could be the confidence, their enjoyment. The children could 'rate' specific parts of the activity.	
Medals Similar to the traffic lights or smiley faces, children can give themselves or their peers a gold, silver or bronze medal for their performance. Or a gold, silver, or bronze medal for the activity they have done. This can be a good peer assessment tool to provide positive feedback as all medals are achievements, which helps with positive reinforcement.	
Positive sandwich Similar to 2 stars and a wish the children chose two positive parts of a task/skill/activity and sandwich these between a negative or an area for improvement. For example: 1) I was able to run fast in the game 2) I need to work on my turning skills 3) We worked well as a team today.	

Plan Practical Session here

Time:	Aim(s):		Equipment:
Activities:	1.	Skills focus	1.
	2.		2.
	3.		3.
	4.		4.
Formative feedback:			

Example session:

<table>
<tr>
<td>Time:
35 mins</td>
<td>Aim(s):
1) Practice and begin to develop at least 3 skills (jump, coordination)
2) Discover new pieces of equipment, think of ways to use these objects.
3) Develop our teamwork and listening skills</td>
<td colspan="2">Equipment:
Cones, hoops, woggles, balls, rackets, bibs</td>
</tr>
<tr>
<td rowspan="2">Activities:</td>
<td>1. <u>Fogs and lily pads</u>
▪ Ask the children to show you how a frog would jump- the children should use their imagination to do this. You can also ask the children what noise a frog might make.
▪ Set out spots across the playing area as 'lily pads', ask the children to travel as frogs between the lily pads
▪ Include demonstration of jumping to give the children a visual guide

S- ask children what shape the pond is, get them to think about shapes, make the pond bigger so they must jump further
T- Children could become pond skaters and move across the pond on all fours
E- When a child reaches a lily pad, they must perform a balance/ lily pad could be hoops
P- one big pond or lots of smaller ponds, working in pairs</td>
<td rowspan="2">Skills focus</td>
<td>1. Jumping and locomotor skills</td>
</tr>
<tr>
<td>2. <u>Equipment Discovery</u>
▪ Within the playing area set up a selection of equipment for the children to use, including hoops, woggles, balls (3 different sizes), rackets.
▪ Ask the children to use and play with the equipment however they like e.g., they could make up games or build different structures for example.</td>
<td>2. Combination and discovery skills</td>
</tr>
</table>

	▪ Observe how the children use a variety of equipment, how they move e.g., actions like squatting down, the grip they use to hold equipment. S- use both indoor and outdoor settings, pretend children are in different natural environments. T- set tasks such as making an obstacle course and others in the class completing it E- each time this task is used with the children introduce a new piece of equipment or remove a previous piece so that children become more imaginative P- children can work individually, in pairs, small groups, or as a whole class.		
	3. <u>**Move through the hoop**</u> ▪ Start with a hoop that is big enough for all the children to fit through ▪ The children should stand in a circle holding hands, they must pass the hoop up or over each one of them in the full circle S- start as a whole class task in one big group, decrease into smaller groups T-challenge the children to do it faster than they did it the previous time E- use a bigger hoop to start with, as the children get more proficient the size of the hoop can be decreased P- mix the children up and get them to work next to a child they usually don't work with, to help them improve their teamwork		3. Coordination and communication skills
	4.		4.
Formative feedback:	a) recover start of the session by becoming frogs again b) big, middle, or small smiley		

Section 4

FRAMEWORK for other curriculum areas

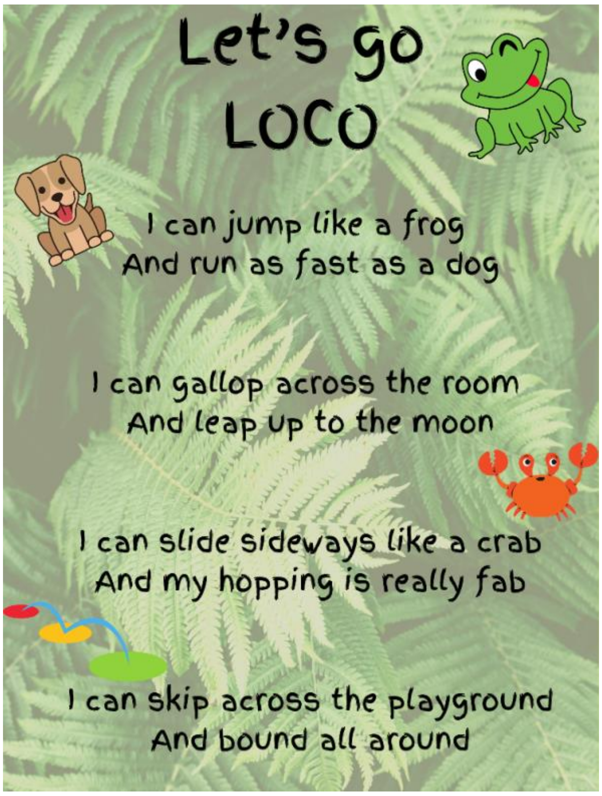
To raise awareness of FMS practice and activities in your school and improve the knowledge and confidence of the children within your class, it can be beneficial to try and implement FMS themed activities outside the PE environment. This section introduces some ideas and activities to engage children in FMS education- this is designed to help improve their knowledge about FMS skills and how they can be used outside of PE. This section should be built upon by incorporating your traditional classroom activities with FMS.

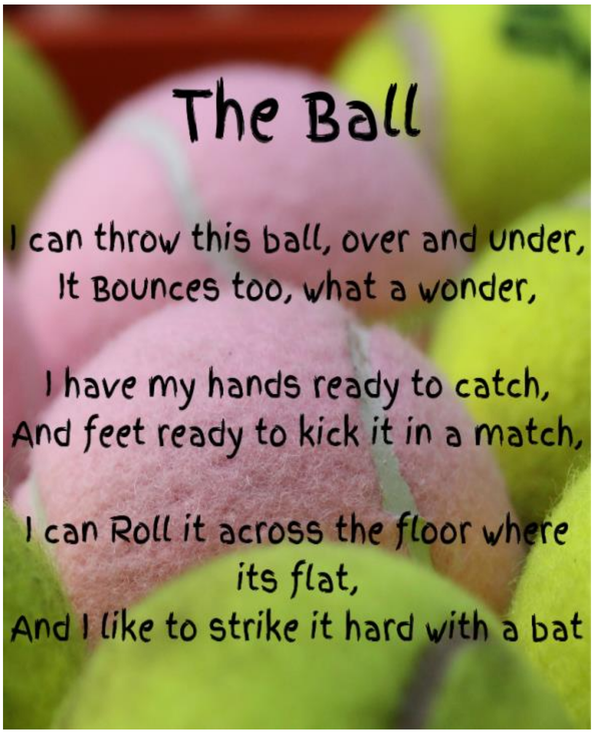
The following sections provides ideas to be used in English and literacy, maths, art, and science-based subjects/lessons. Resources for the recommendations are provided at the end of the booklet.

Classroom activities/materials

English and Literacy

Poems





Learning the alphabet

Associate a letter of the alphabet to a fundamental movement skill, an action/descriptive word related to moving (e.g. quickly), or how a child might assess themselves. Use the table below, or create your own.

Amazing	Bouncing	Catching	Dancing
Elegant leaping	Fast running	Galloping	Hopping
I am great!	Jumping	Kicking	Leaping
Marching	N	Overhand throw	Passing- balls
Quick	Rolling	Striking	Throwing
Underhand roll	Vertical jump	Walking	X
Y	Zig-zag running		

Maths

Calculations

Assign a skill a number, it may be that the more advanced skills for your children have a higher number. You may practice maths with the children and ask them to do the action of whatever the answer is, or even the whole equation. The table below can be used, or your own created.

For example, 3-2=1, the children would run. OR they would have to jump, catch an object and run.

1=run	4=throw	7=slide	10=roll
2=catch	5=hop	8=strike	11=leap
3=jump	6=bounce	9=gallop	12=kick

Art

Jumping for height

A fun activity for children to do, while practicing their vertical jumping skills. Children paint their hand before jumping as high as they can and making a handprint, could make pretty classroom artwork!

Science

What animal am I?

When learning about other animal species you may ask children to move and act in ways the animals do. This can be linked to many of the locomotor activities in section 3.

Resources

1=	4=	7=	10=
2=	5=	8=	11=
3=	6=	9=	12=

A	B	C	D
E	F	G	H
I	J	K	L
M	N	O	P
Q	R	S	T
U	V	W	X
Y	Z		

Section 5

Goal setting

Helping children to set their own goals can improve their engagement with activities, motivation to take part and inspire their imagination. Young children should be guided to set appropriate but meaningful goals and should be involved in the goal setting process. Physical goals should be outcome based. Process goals could be focussed towards elements such as communication and team-work.

- These goals should be used as part of the assessment process (e.g., written into school reports).
- Goals should follow the SMART acronym.
    - **S**pecific- to the child and their current ability
    - **M**easurable- can be measured easily in the environment- useful for assessment too.
    - **A**ctionable- by using the framework, a child can work towards this goal.
    - **R**ealistic- is not too far out of reach or complex
    - **T**ime-bound- can be achieved within a school term/half-term
- They don't need to be very formal or complex goals and should also be fun for children to achieve, inspiring each child individually and as a group/class.

Example goals:

<u>**Goal set**</u> **Skill**: Improve throwing **Measure:** Number of times to throw into a bucket in 1 minute **Time frame**: by the end of term (10 weeks)
<u>**Goal set**</u> **Skill**: Communication **Measure:** Be able to work in a group of three to complete an obstacle course **Time frame**: by the end of half term (5 weeks)

Assessing improvements

It is hoped that by planning and using sessions within this FRAMEWORK and from your own development delivering FMS focussed sessions and activities, that physical improvements will be made by the children in your class.

There are several ways you may want to measure the children's physical progress. This might be against one of their physical or skill goals they set, be a product assessment (number of times completing a skill) or through a more thorough process assessment (how the skill is completed). If you want to assess several skills, an easy way to do this might be an obstacle course, or a circuit-based activity session. Examples of these three methods are provided below:

Goals set: can they meet their goals they have set?
Product/outcome: Can the run a certain distance in a certain time, or throw a certain distance, or catch 5 times in row. These are easy to report and measure.
Process/performance of a skill: does a child show they can perform a skill better, e.g. not running flat footed, swinging their arms when they jump, stepping forward when throwing a ball. Must be observed a number of times.

Other assessments of the programme and improvements in the children, might be about what they feel they achieved the most from the programme. This can be done by using the accompanying card sort activity (separate document). Suggested outcomes for the children have been used, and there are also blank spaces for the children to suggest their own answers, providing them with some autonomy.

Resources

Goal set Skill: Measure: Time frame:
Goal set Skill: Measure: Time frame:
Goal set Skill: Measure: Time frame:
Goal set Skill: Measure: Time frame:
Goal set Skill: Measure: Time frame:

Section 6

Homework

To bring further FMS into the house environment, homework tasks can be set for children. First and foremost, these opportunities must provide fun and target in a way using as minimal equipment as possible. If children have the means to document their home activity, e.g. a camera, this can be used, but other methods such as writing and drawing can also be used and may help consolidate learning further. Simple physical homework tasks may include:

Animal journey Give children a list of animals for each day of the week: zebra, kangaroo, fish, frog, crab, monkey etc. Ask the child to move as much as they can like that animal each day at home. The following day at school introduce the next animal.
Sock balls Fold socks into each other to create a ball shape, a children can then safely use this soft ball in the home to practice their ball throwing and rolling skills. Ask parents to practice with the child, and set task such as, how many time can the sock ball be thrown between the child and parent before it is dropped.
The bean game Using the parent materials to explain the bean game used in section 4 of the framework, ask them to do it with their child at home. Ask the child

to write down which their favourite bean is and draw themselves as the bean.
Rub tummy/pat head As above use parent materials and section 4 of the framework to get the parent to practice this activity with their child at home at least once a day. Get children to practice in class each day to consolidate.
Home obstacle course Similar to the school obstacle course but at home, ask children to use what they can find in their house to make an obstacle course. Ask them to write down what they used in their course and show and tell at school

Engaging with parents

Parents can be hard to engage with around their child's health and education. A lot of parents '*want what's best'* for their child, but *'won't do anything that upsets'* them.

Provided with this booklet are parent information packs, that we recommend sending out to parents each term of the school year. Each pack introduces them to a new domain of FMS (locomotion, object control, stability) that their child will be being taught about in their EYFS year at school.

There are further ways to engage with the parent audience. This includes:

- Providing/writing their child's goals within their written reports home
- Combining academic and physical skills homework, to show value is at the same level
- Inviting parents into the school to take part in skills sessions or mornings. Like asking parents to come to a sports day, but encouraging their involvement WITH their child- this can then be replicated in the home environment. Here, your valuable knowledge can be used to explain the importance of developing their child's FMS and ways to encourage this at home.
- Create parent groups for parents to share their ideas with each other about how to engage with their child's FMS. Or for children to meet up out of school to do activities to promote their FMS.

Appendix 5.4

Training the teacher's plan

3x1 hour sessions

All participants would be provided with the **information and framework document** to help guide through the sessions

The **first** training session slides are provided in the next appendix.

Session 1 aims:

1) Introduce physical activity and health for children

2) Discuss what FMS is and relate to PA and health- use demo video of FMS skills (https://youtu.be/fyaogozrDuo) plus additional information on balance and coordination
    a. Open a discussion around knowing about FMS and their own FMS skills

3) Survey of the children key needs and their environment- what is available to the children already- 1st step
    a. Then begin to plan how they can help the children in their own environments

4) Highlight need for quality and repetition in delivery- use of cue words/questions, critical elements and STEP model to develop tasks for children - no need for perfection just practice opportunities

Session 2 aims:

1) Introduction to how to use the framework effectively and how to plan practical using it
    a. Discuss how to allocate time and plan time efficiently

2) Using the teacher's own ideas, knowledge, and self-efficacy development, and gathering formative feedback from children

3) Not sport based, play and game based
    a. Use example activity and address any question around how to use them in plans

4) The framework being brought into the classroom/combining with other subject areas- engaging the less active children
    a. Development time to suggest their own activities

Session 3 aims:

1) Projected overall delivery of programme- time scale, appropriate dose, goal setting

2) Intervention focus: outcome measurement and evaluating change (card sorts)

3) Positive role modelling and changing social norms with parents - creating 'homework'
    a. Discuss problems with engaging with parents about the intervention delivery

4) Creating high autonomy of children and staff
    a. High encouragement to make the programme 'their own'- as a class and as a practitioner

Training Session 1

1

Outline of session 1

1) Physical activity and health for children
2) Introduction to Fundamental Movement Skills
3) Survey of the children's key needs and their environment
4) Quality and repetition in FMS delivery
   - STEP to develop tasks
   - Cue words and critical elements

2

Physical activity and health for children

Benefits of Physical activity:

- **Physical health:** building cardiovascular and muscular fitness (health related fitness), healthy weight status, better neuromuscular coordination, improves cardiovascular health, lowers diabetes risk
- **Mental health: develops** confidence, competency, reduces anxiety, reducing possibility of depression
- **Social development:** better communication, improved leadership, working with other children and adults
- **Academic achievement and school readiness:** several aspects of academic achievement: mathematics-related skills, and reading

3

Under 5s physical activity guidelines

Guidelines from the UK government recommend that children under 5 years of age should aim to be active for **180 minutes per day**, with **60 minutes** of this being at **moderate to vigorous** levels of activity

Examples of moderate to vigorous activity include:

Cycling, running, climbing, jumping, combination of these activities in games/activities

Main aim: to reduce significant amounts of sedentary time*

*(it is recognised some sedentary time is important for other areas of development- fine motor skills and cognitive ability)

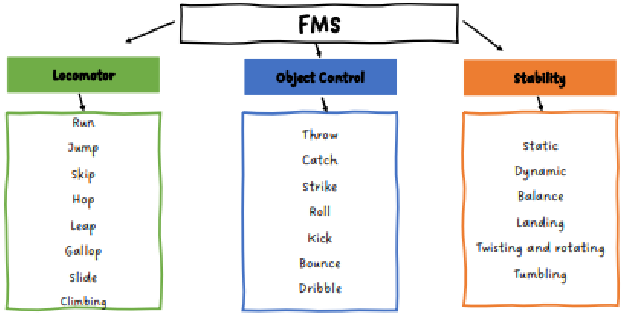
4

What is FMS?

https://youtu.be/fyaogozrDuo

5

Fundamental Movement skills



Children have the ability to master these skills by the age of 6-7 years old- this relies on adequate **practice and tuition**

6

Why are FMS important?

- Increase physical activity participation, competency, and confidence
- Ability to participate in more activities= less possible social isolation
- Aid the development of positive health and self-management behaviours, including participating in regular physical activity

7

What do you already do **well** in your school for children's FMS development?

Also Discuss:

- How good would you say your own FMS are?
- What could you do better as a teacher and as a whole school?
- Do you help children recognise and develop their own FMS?

8

Survey of the children's key needs and their environment

Key needs of children	Environment
e.g. large spaces to play and perform physical activity in	Currently only have access to a small outdoor area

9

Survey of the children's key needs and their environment- the changes

Key needs of children	Environment change needed
e.g. large spaces to play and perform physical activity in	Organise times with school/local authority on a weekly basis to use large open spaces

10

Quality and **repetition**- two key words

- To develop competency in their FMS children need a **repeated number** of opportunities to practice them in the same and differing environments
- Practice should be of **high quality** which requires you as facilitators to have good knowledge to recognise good competency
- High quality will also come from **enjoyment** therefore practice should be game and play based for young children

11

Cue words and questions

- Cue words and questions will help children to recognise key elements/actions of a skill and will help you to improve the quality of their movements

- Cue words and questions can relate to other themes such a animals or superheroes to help children remain engaged

12

Cue words/questions- examples

- **Leaping**- 'can you leap like spiderman?'
- **Jumping**- 'swing your arms up like a monkey'
- **Gallop**- 'gallop like a horse/pony'
- **Throwing**- 'wind up your throwing arm'
- **Slide/side-step** 'feet apart, feet together'
- **Kicking**- 'eyes on the ball'
- **Bounce**- 'tap not slap'
- **Underhand roll-** 'bowl it like a bowling ball'

13

Critical Elements

- Critical elements are **part of a skill** that a key to it's mastery
- The process of the performance of a skill can include **3-4** critical elements (see framework booklet)
- When looking at the criteria/critical elements of a skill think about how these could be broken down into **instructions or worked on individually**

14

Critical Elements- example

A skill may be able to be broken down in to multiple different activities or ques/questions for the children to work on a specific criteria:

Lets look at the skill criteria for the run:

- ***Criteria***: non-support leg bent approximately 90 degrees (close to buttocks) = *'can you kick your bottom with your heel?'*
- ***Criteria***: foot placement near or on line (not flat footed)= *Begin with the children tip-toeing around, this could be a game of sleeping lions. Then progress in speed; this helps children to progress with a less flat footed run*
- ***Criteria***: Brief period where both feet are off the ground= *This criterion is most easy to achieve when a child is running at speed- can you play a game where there is an element of 'danger' for example: sharks and fishes, this may increase their reaction to run fast*

15

Critical Elements

- Having knowledge of these skills and elements will enable you to provide **high quality feedback** to your children and develop your own strategies for improving their skills.
- We recommend that these skill elements can be noted when you are planning a session

16

Adaptation of activities

- ***Adaptation*** of activities is likely needed for children in your class
- Physical skills of the youngest children are likely to be less developed 13 than of the older children, however improvements can be made for both groups of children
- Using the **STEP model** is a simple but effective way to adapt activities

17

STEP

- **SPACE:** what can we change about a space?
- **TASK:** what variables of the task can be modified or adapted?
- **EQUIPMENT:** what can be changed about equipment?
- **PEOPLE**: what variables can be changed via people?

18

STEP- example

With a traditional game of throw and catch

- **SPACE:** children stand further apart, groups in circles
- **TASK:** children must throw underarm only
- **EQUIPMENT:** smaller or bigger balls
- **PEOPLE**: from pairs up to larger groups

19

Appendix 5.5

Teacher card sort

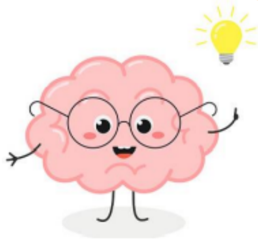
Children's Enjoyment

Participation

Ease of delivery in your setting

Increase in motor competence

Your own increase in knowledge of FMS and PA



Ability to use new ideas outside of structured sessions

Ethical Approval

Chapter 3

Decision - Ethics ETH1920-2939: Alexandra Dobell

UD University of Derby <ethicsdigitisation@derby.ac.uk>
To: Alexandra Dobell

Dear Alexandra

ETH1920-2939

Thank you for submitting your application to the College of Life and Natural Sciences Research Ethics Committee, which has now been reviewed and considered.

The outcome of your application is:

approved.

Feedback on your application is available here.

If any changes to the study described in the application are necessary, you must notify the Committee and may be required to make a resubmission of the application.

On behalf of the Committee, we wish you the best of luck with your study.

Yours sincerely

Steph Wright

Chapter 4

Decision - Ethics ETH1920-1139: Alexandra Dobell

UD University of Derby <pgrstudentoffice@derby.ac.uk>
To: Alexandra Dobell

Dear Alexandra

ETH1920-1139

Thank you for submitting your application to the College of Life and Natural Sciences Research Ethics Committee, which has now been reviewed and considered.

The outcome of your application is:

approved.

If any changes to the study described in the application are necessary, you must notify the Committee and may be required to make a resubmission of the application.

Please note that ethical approval for this application is valid for 5 years

On behalf of the Committee, we wish you the best of luck with your study.

Yours sincerely

Lee Rylands

Chapter 4- online study

Decision - Ethics ETH2021-1243: Alexandra Dobell

UD University of Derby <ethicsdigitisation@derby.ac.uk>
To: Alexandra Dobell

Dear Alexandra

ETH2021-1243

Thank you for submitting your application to the College of Science and Engineering Research Ethics Committee, which has now been reviewed and considered.

The outcome of your application is:

approved.

If any changes to the study described in the application are necessary, you must notify the Committee and may be required to make a resubmission of the application.

Please note that ethical approval for this application is valid for ...

On behalf of the Committee, we wish you the best of luck with your study.

Yours sincerely

Charlotte Dakin

Chapter 5

UD University of Derby <uodresearchsystem@derby.ac.uk>
To: Alexandra Dobell

Mon 16/08/2021 13:12

University of Derby

Dear Alexandra

ETH2021-3572

Thank you for submitting your application to the College of Science and Engineering Research Ethics Committee, which has now been reviewed and considered.

The outcome of your application is:

approved.

If any changes to the study described in the application are necessary, you must notify the Committee and may be required to make a resubmission of the application.