An evaluation of the fundamental movement skill proficiency of children with intellectual disabilities participating in the Special Olympics Young Athletes programme

Hayley Kavanagh BSc.

Supervised by Dr. Johann Issartel, Dr. Mika Manninen, Dr. Sarah Meegan

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School of Health and Human Performance

Dublin City University

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Authors Declaration

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

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They say it takes a village to raise a child…while I can't attest to that right now, I can confirm that **it takes a village to complete a PhD!** There have been many, many people over the last number of years who have contributed in their own way to this project and who without, I would not be here today.

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List of Abbreviations

AIC = Akaike's information criterion

BIC = Bayesian information criterion

BID = Borderline intellectual; disability

BOT-2 = Bruininks Oserestky Test of Motor Proficiency, 2nd edition

CI = Confidence interval

CwID = Children with intellectual disabilities

DCU = Dublin City University

DCUREC = Dublin City University Research Ethics Committee

DS = Down syndrome

FMS = Fundamental movement skills

ID = Intellectual disability/ disabilities

IQ = Intellectual quotient

M = Mean

MC = Motor competence

MID = Mild intellectual disability

MNM = Mastery/Near Mastery

MVPA = Moderate to vigorous intensity physical activity

N = Number

NGB = National Governing Body

PA = Physical activity

PC = Perceived competence

PE = Physical education

PMSC = Pictorial movement skill competence

POMP = Percent of the maximum possible

PRISMA =Preferred Reporting Items for Systematic Reviews and Meta-analyses

RTA = Reflexive thematic analysis

SD = Standard deviation

SO = Special Olympics

SOI = Special Olympics Ireland

SSS = Sports specific skills

TD = Typically developing

TDC = Typically developing children

TMS = Transitional movement skills

TGMD = Test of Gross Motor Development

YA programme = Young Athletes programme

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Abstract

PhD Title: An evaluation of the fundamental movement skill proficiency of children with intellectual disabilities participating in the Special Olympics Young Athletes programme

Author: Hayley Kavanagh

Fundamental movement skills (FMS) are known as the building blocks required for participating in sport and physical activity. These skills encompass three categories of movement including locomotor, ball and balance skills. Children with ID (CwID) must be provided with opportunities to learn, practice and reinforce these skills. Throughout the literature, CwID exhibit lower motor skill proficiency levels compared to typically developing children (TDC). Phase one of this project involved completing a meta-analysis of studies comparing the FMS of CwID to TDC (n = 3525, age 4-12 years) in order to quantitatively obtain a macroscopic picture of the FMS proficiency of CwID in comparison with TDC. Phase two consisted of carrying out a nationwide assessment of a broad range of FMS amongst CwID (n = 100) and coaches' perceptions of CwID proficiency levels participating in the Special Olympics Young Athletes (YA) programme. The main results highlight that CwID demonstrate low levels of FMS mastery (0-60.4%) TDC scored significantly higher in all FMS subsets compared to CwID ($p < .001$). Weak to moderate associations (0.20-0.59) were found on an individual skill level between CwID actual motor competence (MC) and coaches' perceptions of children's skill level. The final phase explored the experiences of coaches (n = 8) involved in delivering the YA programme, including their perceptions of the barriers and facilitators to implementing the programme. Overall, findings highlight sub optimal levels of FMS proficiency amongst CwID participating in the YA programme and the need for tailored FMS interventions targeting CwID specific weakness in FMS. Additionally, the results presented highlight a knowledge gap that exists in coach education. Training is required for YA coaches to 1) help them identify and correct weaknesses in FMS proficiency levels and 2) support them tailoring training programmes for CwID.

Chapter 1: Introduction to Thesis

1.1 Publications

Published:

Kavanagh, H., Manninen, M., and Issartel, J. (2023) Comparing the fundamental movement skill proficiency of children with intellectual disabilities and typically developing children: a systematic review and meta-analysis. *Journal of Intellectual Disability Research*, https://doi-org.dcu.idm.oclc.org/10.1111/jir.13012.

Kavanagh, Hayley, Manninen, Mika, Meegan, Sarah, & Issartel. Johann. (2023). Assessing the Fundamental Movement Skills of Children With Intellectual Disabilities in the Special Olympics Young Athletes Program. *Adapted Physical Activity Quarterly*. Advance online publication. https://doi.org/10.1123/apaq.2022-0201.

Kavanagh, H., Issartel, J., Meegan, S., and Manninen, M. (2023) Exploring the motor skill proficiency barrier among children with intellectual disabilities: analysis at a behavioural component level. *PLOS One.* https://doi.org/10.1371/journal.pone.0288413.

Under Review:

Kavanagh, H., Issartel, J., Meegan, S., and Manninen, M. (2023) Can Special Olympics coaches accurately report on the motor competence of children with intellectual disabilities? *Journal of Applied Research in Intellectual Disabilities.* (Submitted 22nd July 2023)

Kavanagh, H., Healy, S., Manninen, M., Issartel, J., and Meegan, S. (2023) Coaching from the Heart: Experiences of Coaches delivering the Special Olympics Young Athletes programme. *Journal of Intellectual Disabilities.* (Submitted 15th June 2023)

Oral Presentations:

Trends in Motor Skill Proficiency levels amongst children with intellectual disabilities aged 4-12 years - systematic review and meta-analysis.
European Congress of Adapted Physical Activity - June 2022, Coimbra, Portugal

'SO Fun' - Importance of developing children's FMS as a Coach.
Special Olympics All Island Coaching Conference - September 2022, UCD, Dublin, Ireland

A Systematic Review and Meta-analysis of the motor skill proficiency of children with intellectual disabilities and typically developing children aged 4-12 years.
All-Ireland Postgraduate Conference in Sport Science, Physical Activity and Physical Education - September 2022, DCU, Dublin, Ireland

'*SO Fun*' - Evaluation of the Special Olympics Ireland, Young Athletes programme
Berlin World Summer Games - International Lecture Series - May 2023, Online to a global audience

Special Olympics Young Athletes programme: fundamental movement skills proficiency and coaches perspective – *7th International ICOACH Kids Conference – September 2023, Arnhem, Netherlands*

Coaching children with intellectual disabilities in the Young Athletes programme – *Special Olympics International Coach Webinar Series – October 2023, Online to a global audience*

1.2 Introduction

Throughout my undergraduate studies, I developed a love and passion for adapted physical activity (APA). This love led me to volunteering and working with people with intellectual disabilities (ID) in the area of sport and physical activity. My professional roles included Adapted Physical Activity Coordinator for an ID service provider delivering sports programmes to over four hundred over service users and Health and Wellbeing Coordinator for Special Olympics Ireland (SOI). Additionally, I volunteered with SOI as a Young Athletes (YA) head coach. As part of my voluntary role, I delivered the YA programme to children with ID aged 4-12 years. The YA programme is the first step of an athlete's journey with SOI, it is a sport and play programme that is designed to introduce the fundamental movement skills (FMS). The YA programme offers children with ID an opportunity to get involved in sport and physical activity (PA) from a young age. PA is defined as "any bodily movement produced by the skeletal muscles that results in a substantial increase over resting expenditure" (Caspersen, Powell and Christenson, 1985; Piggin, 2020). The World Health Organisation (WHO) recommends that all children participate in 60 minutes of moderate to vigorous intensity PA per day (Bull et al., 2020), however globally children are failing to meet these guidelines. Research shows that children with ID are even less active then their typically developing peers (Wouters et al., 2019).

Physical inactivity is a known high-risk factor for early cause mortality (WHO, 2023). Furthermore, physical inactivity is associated with developing a number of non-communicable diseases (NCDs) including high blood pressure, diabetes and obesity (WHO, 2023). People with ID are at an increased risk of developing these NCDs from a younger age (Krahn and Fox, 2014), which can only be exacerbated by high levels of physical inactivity. It is recognised that people with ID are five times more likely to have diabetes, twice as likely to have cardiovascular disease and asthma, three times more likely to have arthritis and on average die sixteen years earlier than the general population (Reichard et al., 2011; Recihard and Stolzle, 2011). It is important to note that these NCDs are not directly linked to the individuals having an ID diagnosis but stem from a number of other factors including poor nutrition, lack of opportunities to engage in PA, inadequate attention by carers and healthcare providers, limited access to health education and healthcare assessments (Krahn and Fox, 2014). Research demonstrates that those who are at risk of NCDs in childhood are far more likely to develop poor health outcomes during adulthood (Banks, 2016; Whitney, 2022; Wang et al., 2023). On the contrary, taking part in PA is linked to a host of positive health outcomes for people with ID including improved physical fitness and mobility, increased strength, better quality of life, improved balance and psychological well-being (Bartlo and Klein, 2011; Pestana et al., 2018). In order to break down the health disparities that exist for people with ID and in light of the many benefits of PA participation, it is crucial that every effort is made to provide children with ID opportunities to engage in physical activity. In order to do this effectively, we must investigate the barriers and facilitators that children with ID face to engaging in PA to ultimately improve the health outcomes and healthy life years in the ID population.

One of the main barriers to PA participation faced by children with ID as described in recent systematic reviews (Sutherland et al., 2021; Yu et al., 2022), is the low FMS proficiency levels exhibited by this group. Higher levels of FMS proficiency have been associated with increased PA participation amongst children with ID (Stodden et al., 2008; Wouters et al., 2019; Sutherland et al., 2021). FMS are the 'building blocks' required to perform more complex movements that are needed to participate in sport and PA (Behan et al., 2019). FMS encompasses three domains including locomotor skills (e.g., running, skipping), ball skills (e.g., throwing, kicking) and balance skills (e.g., dynamic, static). It is known that children have the potential to master these skills by the time they reach six years of age (Gallahue and Ozmun, 2006), however more commonly it is expected that all children should master these foundational skills by ten years of age (Hardy et al., 2010). Despite this, globally children with and without ID exhibit deficiencies in their FMS proficiency levels (Kavanagh et al., 2023). Findings from Behan et al. (2019) demonstrated that amongst primary school aged children in Ireland deficiencies in FMS proficiency were high with just over half achieving mastery/near mastery in locomotor skills (52.8%) and ball skills (54.8%). The highest proficiency levels were found for balance skills with 60.6% of children reaching mastery/near mastery levels (Behan et al., 2019).

While people might assume that FMS develop naturally, this is not the case as children need to be provided with opportunities to learn, practice and reinforce these vital skills (Clark, 2005; Barnett et al., 2016). As children develop and perfect their FMS at a mastery level, they then have the ability to link these skills together to produce sports specific skills (Seefeldt, 1986; Robinson et al., 2015; dos Santos et al., 2021). If children fail to master the FMS, they are less likely to participate in sport and PA for life (Stodden et al., 2013). If children cannot catch, kick, run, hop, throw etc., they will have less opportunities to engage in PA as they get older as they will not have the prerequisite FMS proficiency level required to be active (Stodden et al., 2008). Therefore, it is imperative that researchers and practitioners address the low FMS proficiency levels demonstrated in children with ID through more effective motor skill interventions as it could have a long-term impact on their PA participation.

A recognised facilitator to increasing PA participation amongst children with ID are sports coaches and expert APA instructors (Alesi and Pepi, 2017). These key personnel play an integral role in encouraging children with ID to begin playing sport and taking part in PA, as well as motivating them to stay active throughout their life (Farrell et al., 2004; Alesi and Pepi, 2017). Additionally, coaches and expert APA instructors play a gatekeeper role in developing the FMS proficiency of children with ID and as such should be adequately trained to assess children's motor competence (Liong et al., 2015). Coaches who are appropriately trained in motor competence assessments can develop tailored FMS interventions to target specific weaknesses across the FMS, addressing the low FMS proficiency levels amongst children with ID (Liong et al., 2015). Encouraging coaches to regularly assess the FMS of children with ID who attend their sports sessions will promote positive improvements in children's motor competence, enable coaches to track each individual's progress over time, as well as highlight to parents which particular skills need to be practised at home (Bolger et al., 2018).

Within the literature there are still mixed opinions on the best practice FMS intervention characteristics (e.g. minutes of instruction time, instructional approaches) for children with ID (Logan et al., 2012). A systematic review by Maïano et al. (2019) found that balance improvements were seen in children and adolescents with ID when they participated in targeted intervention programmes including general motor skill programmes, physical therapy programmes, balance and strength exercises, specific sport techniques and vestibular sensorimotor exercises which were delivered by professionals. These interventions were found to be most effective when they were delivered for at least a 6-week period with participants attending 3 sessions per week with a duration of 30-60 minutes (Maïano et al., 2019). Due to the limited number of studies included in the review, the effects of motor skill interventions targeting locomotor and ball skills in children with ID remain unclear (Maïano et al., 2019). Further research examining a variety of intervention protocols targeted at all ID categories, is required to determine the gold standard guidelines for delivering evidence-based FMS interventions to improve FMS proficiency levels of children with ID.

This thesis aims to gain an accurate picture of the FMS proficiency levels amongst children with ID aged 4-12 years who are participating in the SOI YA programme. This is the first time since the programme was rolled out in 2016 that a baseline of children's FMS proficiency levels has been established. Additionally, coaches' experiences of delivering the programme on the ground as well as their perceptions of barriers and facilitators to its implementation were also explored. Investigating the coaches' ability to assess the motor competence of children with ID who attend their sports session is an important indicator to SOI and SO internationally of where the knowledge gap exists for coaches and highlights the need for improved coach education.

1.3 Philosophical Position

I believe that it is important to acknowledge my own experiences and philosophical positioning when considering the research methods, findings and interpretations of this PhD. Philosophical perspectives, as described by Moon and Blackman (2014) are a network of generalised views of the world that are shaped by ontology (the study of being) and epistemology (the theory of knowledge) which forms beliefs and drives actions. Throughout my undergraduate degree (BSc Sports Science and Health) and time spent volunteering with Special Olympics, I developed a positivist approach to my theoretical and practical knowledge acquisition. As I continued my personal and professional growth and development during my PhD journey, alongside gaining hands-on experience working directly with children and adults with ID, my philosophical position has further developed. Therefore, it is important to note that the following interpretations made throughout this thesis are influenced by my own experiences and understandings. I view myself as a pragmatic researcher and throughout my PhD my main aim was to generate knowledge that is practically meaningful to both researchers and practitioners working with people with ID. Giacobbi et al. (2005, p.19) describes a pragmatic research philosophy as one that "emphasises practical solutions to applied research questions". Pragmatism maintains that researchers draw on their own 'real world' experiences in the research process (Kaushik and Walsh, 2019). This rang true in my case as I leant on my own experiences of being a coach, a tutor and working directly in the intellectual disability field for the last four years throughout my research journey. I feel that my positioning as both an academic and practitioner who is familiar with Special Olympics, the children involved in the study, their parents and coaches, enabled me to bring innovative and novel insights into study approaches and data collected (Bryant, 2009). For a thesis to be coherent, researchers should illustrate that the approach they have selected is suitable to answer their research question while aligning with their philosophical position (Poucher et al., 2019). Taking this into consideration, the approaches laid out in this thesis are built on a strong foundation of well-established, validated and robust methodologies. In my opinion, research should generate meaningful impact that has practical implications and building on previous empirical findings, in my view, is the best way to do this.

1.4 Aims and objectives of the study

Primary Research Aims:

1. To objectively quantify the differences in motor skill proficiency levels between children with intellectual disabilities and typically developing children (Chapter 3).

2. To assess and compare the FMS proficiency of a large sample of children with ID and typically developing children aged between 5-12 years in Ireland (Chapter 4).

3. To examine FMS at the behavioural component level of performance amongst children with ID (Chapter 5).

4. To investigate the relationship between the PA levels and motor competence of children with ID (Chapter 6).

5. To compare coaches' perceptions of the motor competence of children with ID to children's actual motor competence (Chapter 6).

6. To explore coaches' experience of the overall quality of the YA programme, their narratives of programme delivery, as well as any perceived barriers and facilitators to its implementation (Chapter 7).

Secondary Objectives:

1. To investigate the age and gender differences on FMS proficiency for both groups (Chapter 4 and 5).

2. To evaluate the mastery/near mastery percentages in FMS for both children with ID and typically developing children (Chapter 4).

3. To identify weaknesses within performance and commonality of these weaknesses across skills (Chapter 5).

4. To evaluate whether coach gender and coaching experience influence coaches perceptions of children's motor competence (Chapter 6).

1.5 Research questions and hypotheses

1. What are the differences in FMS proficiency levels between typically developing children and children with intellectual disabilities?

> *Hypothesis*: Typically developing children will demonstrate higher levels of fundamental movement skill proficiency compared to children with intellectual disabilities**.**

2. What are the FMS proficiency levels of children with ID participating in the Young Athletes programme?

> *Hypothesis:* Children with intellectual disabilities participating in the Young Athletes programme will demonstrate low fundamental movement skill proficiency.

3. Are children with ID in the Young Athletes programme achieving mastery in any fundamental movement skills?

> *Hypothesis:* Children with intellectual disabilities in the Young Athletes programme will achieve mastery in some of the fundamental movement skills**.**

4. Do children with ID display any gender discrepancies in fundamental movement skill proficiency?

Hypothesis: Males demonstrate significantly greater levels of object control proficiency while females will demonstrate significantly greater levels of locomotor proficiency.

5. Is there a correlation between behavioural components of different fundamental movement skills?

Hypothesis: Strong correlations exist between behavioural components of different fundamental movement skills.

6. Can coaches accurately report on motor competence levels of children with intellectual disabilities who participate in the Young Athletes programme?

Hypothesis: Coaches can accurately report on motor competence levels of children with intellectual disabilities.

7. Do coaches experience challenges while delivering the Young Athletes programme?

Hypothesis: Coaches experience some challenges while delivering the programme.

1.6 Thesis Structure

Chapter 1: Introduction to Thesis

This chapter gives a broad overview of the thesis, including the aims and objectives of the study.

Chapter 2: Literature Review

This chapter gives a critical evaluation of the previous literature in areas such as:
the classification of ID, Special Olympics Movement, fundamental movement skills of children with ID and the role of the coach. This chapter gives a comprehensive up to date review, highlighting gaps in the literature.

Chapter 3: Comparing the fundamental movement skill proficiency of children with intellectual disabilities and typically developing children: a systematic review and meta-analysis

This chapter provides an in-depth systematic review and meta-analysis on the global differences seen in fundamental movement skill proficiencies between children with intellectual disabilities and typically developing children. It also examines potential variations in the outcomes standardised mean differences (SMD's) between different studies. This chapter has been published in the Journal of Intellectual Disability Research.

Kavanagh, H., Manninen, M., and Issartel, J. (2023) Comparing the fundamental movement skill proficiency of children with intellectual disabilities and typically developing children: a systematic review and meta-analysis. *Journal of Intellectual Disability Research*, https://doi-org.dcu.idm.oclc.org/10.1111/jir.13012.

Chapter 4: Assessing the fundamental movement skills of children with intellectual disabilities within the Special Olympics Young Athletes programme

This chapter investigates the differences in fundamental movement skill proficiency between a group of Irish children with intellectual disabilities and typically developing children aged 5-12 years. It also investigates the role of age and gender on FMS proficiency between these groups and evaluates the mastery/near mastery of FMS for both groups. This chapter has been published in the Journal of Adapted Physical Activity.

Kavanagh, Hayley, Manninen, Mika, Meegan, Sarah, & Issartel. Johann. (2023). Assessing the Fundamental Movement Skills of Children With Intellectual Disabilities in the Special Olympics Young Athletes Program. *Adapted Physical Activity Quarterly*. Advance online publication. https://doi.org/10.1123/apaq.2022-0201.

Chapter 5: Exploring the motor skill proficiency barrier among children with intellectual disabilities: analysis at a behavioural component level

This chapter examines FMS at the behavioural component level of performance amongst children with intellectual disabilities. It identifies weaknesses within performances and commonality of these weaknesses across skills. Finally, it investigates the role of gender and age on FMS proficiency for children with intellectual disabilities. This chapter has been published in PLOS ONE.

Kavanagh, H., Issartel, J., Meegan, S., and Manninen, M. (2023) Exploring the motor skill proficiency barrier among children with intellectual disabilities: analysis at a behavioural component level. *PLOS One.* https://doi.org/10.1371/journal.pone.0288413.

Chapter 6: Can Special Olympics Coaches accurately report on the motor competence of children with intellectual disabilities?

This chapter assesses the ability of coaches to report on the motor competence of children with intellectual disabilities. The relationship between physical activity participation and motor competence is examined. Finally, coach gender and years of experience are evaluated to determine if they influence coaches perceptions of children's motor competence. This chapter is under review in the Journal of Applied Research in Intellectual Disabilities.

Kavanagh, H., Issartel, J., Meegan, S., and Manninen, M. (2023) Can Special Olympics coaches accurately report on the motor competence of children with intellectual disabilities? *Journal of Applied Research in Intellectual Disabilities.* (Submitted 22nd July 2023, Under Review)

Chapter 7: Coaching from the Heart: Experiences of Coaches delivering the Special Olympics Ireland Young Athletes programme

This chapter explores coaches' experience of the overall quality of the YA programme, their narratives of programme delivery, as well as any perceived barriers and facilitators to its implementation. This chapter is under review in the Journal of Intellectual Disabilities.

Kavanagh, H., Healy, S., Manninen, M., Issartel, J., and Meegan, S. (2023) Coaching from the Heart: Experiences of Coaches delivering the Special Olympics Young Athletes programme. *Journal of Intellectual Disabilities.* (Submitted 15th June 2023, Under Review)

Chapter 8: Discussion, conclusions and future direction of the 'SO *Fun*' project

This chapter provides an overview of the thesis, presenting the main findings, strength and limitations of the study, directions for future research, and potential options to progress the 'SO *Fun*' project.

1.7 Definition of Terms

Children: A child is any human being under eighteen years of age. Children is the plural noun for child. (Lansdown and Vaghri, 2022)

Intellectual Disability: An intellectual disability is defined in the DSM-5 as “neurodevelopmental disorders that begin in childhood and are characterised by intellectual difficulties as well as difficulties in conceptual, social and practical areas of living” (Boat and Wu, 2015) An intellectual disability originates before the age of 22 years.

Typically developing child: A child is considered to be typically developing when they are achieving the ‘developmental milestones’, which are a set of goals that children are expected to reach as they mature. The developmental milestones are grouped into 5 areas including: gross motor skills, fine motor skills, language, social-emotional, cognitive and behavioural (Misirliyan, Boehning and Shah, 2023).

Fundamental Movement Skills (FMS): FMS are defined as the ‘gross motor skills that involve the large force producing muscles of the trunk, arms and legs’ (Clark, 1994, p245). They are recognised as the building blocks of movement that develop during childhood. There are three domains of FMS including locomotor (e.g. hopping, skipping), ball skills (e.g. throwing and catching) and balance skills (e.g. static vs. dynamic balance) (Gallahue and Ozmun, 2006).

Motor skill proficiency / Motor competence: The global definition of ‘Motor Skill Proficiency’ represents a range of terminologies (eg. motor competence, motor skill performance, motor ability, motor coordination, fundamental movement skills). All of these variations describe goal-directed human movement (Robinson et al., 2015; Logan et al., 2018; Laukkanen et al., 2020). Motor skill proficiency / motor competence refers to the quality of an individual's movement coordination and how well they perform different movement skills (Robinson et al., 2015; Kavanagh et al., 2019).

Locomotor subtest: In the context of FMS, the locomotor subtest contains motor skills that demonstrate fluid, coordinated movements as the child's body moves through space. Examples include running, hopping, skipping (Ulrich, 2013).

Ball skills subtest: Also known as 'object control subtest', contains motor skills that centre around a child's ability to control and manipulate objects. Examples include kicking, striking, throwing (Ulrich, 2013).

Balance: Balance is deemed to be one of the categories of FMS and is considered one of the 'most basic skills within the FMS family' (Gallahue, Ozmun and Goodway, 2012). It is defined as a person's ability to maintain a stationary position throughout the movement. The ability to maintain a static balance on one foot is an important skill involved in many sports including gymnastics, diving, dance and team sports (NSW Department of Education and Training, 2000).

Mastery/Near Mastery: A participant is deemed to have achieved mastery of a FMS when they perform all components of a skill correctly. A participant is deemed to have achieved near mastery of a FMS when they perform all but one component of the skill correctly (van Beurden et al., 2002).

Behavioural components: In the context of FMS, behavioural components are also known as performance criteria within skills (Ulrich, 2013). A participant demonstrates mature movement skill patterns when they are achieving good proficiency in the performance criteria associated with that skill (O'Brien et al., 2015).

Motor skill proficiency barrier: Seefeldt's model of childhood motor development indicates that children who demonstrate low FMS proficiency levels will experience difficulties learning transitional movement skills and therefore sports specific skills. Children will be hindered by a hypothetical 'glass ceiling' known as the proficiency barrier (Seefeldt, 1986).

Proxy report: A method of capturing data when an individual is unable to self-report eg. a parent or coach on behalf of a child (Roydhouse et al., 2022).

Perceived motor competence: A person's awareness of their ability to perform gross and fine motor skills (Rudisill, Maher and Meaney, 1993).

Adapted Pictorial Movement Skill Competence (PMSC) scale: The original PMSC scale is composed of 12 pictographic tasks corresponding to the FMS assessed using TGMD-2 and is used by children to rate their perceived motor competence. The scale has been transformed into a written version with each FMS name and supported with a matching image to be used by parents, teachers and coaches to proxy report on children's FMS (Estevan et al., 2018).

Special Olympics: World's largest sports organisation for adults and children with intellectual disabilities, providing year round sports competition and training in a number of Olympic-style sports (SpecialOlympics.org, 2018).

Physical Activity: Physical activity is defined as any bodily movement that is produced by the skeletal muscles and requires energy expenditure that is an increase over the resting rate (Casperson et al., 1985). The World Health Organisation recommends that children participate in 60 minutes of moderate to vigorous intensity physical activity per day (Bull et al., 2020).

Reliability: Reliability describes whether a particular procedure, test or tool will produce similar results when used in a different environment, assuming everything else remains the same (Roberts and Priest, 2006).

Validity: Validity describes the concept of the extent to which an instrument measures what we believe that it's supposed to be measuring (Roberts and Priest, 2006).

1.8 Delimitations

This study is delimited to primary school children aged 4 – 12 years of age with and without intellectual disabilities and Special Olympics coaches delivering the Young Athletes programme.

This study used the TGMD-3 and the BOT-2 short form balance subtest to assess FMS.

This study used an adapted version of the PMSC scale to determine coaches' perceptions of the motor competence of children with intellectual disabilities.

Reflexive thematic analysis was used as a tool to analyse and develop the themes from the coaches focus groups.

Chapter 2: Literature Review

2.1 Intellectual Disability

Defining Intellectual Disability (Classifications)

To define and classify the condition of an ID, there are two systems which are commonly used, 1) the American Association on Intellectual and Developmental Disabilities (AAIDD) and 2) Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5), which is published by the American Psychiatric Association (Boat et al., 2015). The level or severity of ID is determined in both of these systems by the degree of support required for an individual to achieve optimal personal functioning (Boat et al., 2015). The AAIDD classification system was the first of the systems to be developed in 1876 (AAIDD, 2023). Throughout the PhD and thesis chapters, both classifications of ID are referred to as a result of different peer reviewed journal reviewers, researchers and disability organisations (e.g. SO) expressing a personal preference to use one classification system over another. SO International utilises the AAIDD classification system to define ID. It is important to note that while there are other classification systems defining ID such as the International Statistical Classification of Diseases and Related Health Problems (ICD) and the International Classification of Functioning, Disability and Health (ICF), for the purpose of this research the AAIDD and DSM-5 definitions will be used and are outlined below.

The AAIDD defines ID as a condition "characterised by significant limitations in both intellectual functioning and adaptive behaviour, which originates before the age of 22 years" (Shcalock, Luckasson and Tassé, 2021, p.439). This definition changed in 2021 and was published in the 12th edition of the AAIDD manual; previous definitions said the condition originated before the age of 18 (Schalock et al., 2010). Adaptive behaviour comprises three categories including conceptual skills (language, literacy, money and time concepts), social skills (interpersonal skills, self-esteem, problem solving, social responsibility) and practical skills (activities of daily living, travel, safety, occupational skills). The AAIDD manual insists on five assumptions essential to applying the definition of ID as follows (Schalock, Luckasson and Tassé, 2021):

1. Limitations in an individual's functioning need to be considered within the context of their community environment, age, peers and culture.
2. Cultural and linguistic diversity are considered as part of valid assessment, in addition to differences in communication, behavioural, motor and sensory factors.
3. An individual's strengths must also be taken into consideration.
4. The purpose of identifying the limitations is to develop and implement appropriate supports for the individual.
5. If the appropriate and individualised supports are provided and maintained for an individual with an ID, their life functioning will improve.

The DSM-5 defines ID as "neurodevelopmental disorders that begins in childhood and are characterised by intellectual difficulties as well as difficulties in conceptual, social, and practical areas of living" (American Psychiatric Association, 2013). This definition is underpinned by three criteria ((American Psychiatric Association, 2013; Boat et al., 2015):

1. Limitations in intellectual functioning which include reasoning, problem solving, judgement, academic learning, abstract thinking, planning and learning from experience, must be confirmed through a clinical evaluation and individual IQ testing (APA, 2013, p.33).
2. Limitations in adaptive functioning that significantly impact an individual conforming to developmental and sociocultural standards for their independence and their capability to meet their social responsibilities.
3. Limitations have an early onset during the childhood period.

There are four categories of ID for both classification systems, as described in Table 2.1 Categorising or classifying the levels of ID is an optional organising system that takes place post diagnosis (Schalock, Luckasson and Tassé, 2021). An explicit framework and systematic process is used to split the group of individuals with ID into smaller subgroups based on set criteria (Boat et al., 2015; Schalock, Luckasson and Tassé, 2021). The main purpose to the subgroup categories are to a) describe the level of support needs, b) identify the severity of limitations in intellectual functioning and c) the extent of limitations in adaptive skills (Boat et al., 2015; Schalock, Luckasson and Tassé, 2021).

Many causes of ID are often unknown, most commonly the aetiology of ID stems from two factors, environmental and genetic (Lee et al., 2023). Genetic causes such as chromosomal abnormalities, single gene mutations or copy number variation may lead to ID (Lee et al., 2023). Down Syndrome (DS), also known as Trisomy 21) is the most common chromosomal abnormality cause of ID (Boat et al., 2015; Lee et al., 2023). Other examples of genetic causes of ID include Fragile X syndrome and phenylketonuria (PKU). Fragile X syndrome is the most common genetic cause of ID (Lee et al., 2023). Environmental factors may also cause ID, including exposure to toxic substances (e.g. maternal alcohol consumption, pre or postnatal lead exposure), deficiencies in nutrition (e.g. prenatal iodine deficiency), traumatic brain injury (e.g. deprived of oxygen during birth), childhood brian infections (e.g. meningitis, measles, whooping cough), maternal infections (e.g. rubella) (Boat et al., 2015; Lee et al., 2023). Foetal alcohol syndrome is the most commonly known environmental cause of ID (Lee et al., 2023).

The prevalence of ID is 2% globally (McBride et al., 2021), equating to as many as 200 million people. Males are more likely to be diagnosed with ID than females with the prevalence of ID 0.78 percent in boys and 0.63 percent in girls (Boyle et al., 2011; Boat et al., 2015). Socioeconomic status plays a role with poverty being named as a consistent risk factor for ID (Boat et al., 2015). Race and ethnicity may also be a factor in receiving an ID diagnosis with white non-hispanic children 1.5 times as likely and black non-hispanic children 2 times as likely to receive an ID diagnosis in the United States (Boat et al., 2015; Van Naarden Braun et al., 2015). These higher rates of ID diagnosis as a result of racial and ethnic differences are likely due to poverty and differences in language (Boat et al., 2015).

Table 2.1 System Comparison of the Classifications of Intellectual Disability

Category of ID	% Cases *	DSM-5 Criteria based on IQ	DSM-5 Criteria based on daily skills	AAIDD Criteria based on level of supports
Mild	85%	IQ range 50-69	Can live independently with minimum levels of support.	Intermittent support needed during transitions or periods of uncertainty.
Moderate	10%	IQ range 36-49	Independent living may be achieved with moderate levels of support, e.g. group homes.	Limited support needed in daily situations.
Severe	3.5 - 4%	IQ range 20-35	Requires daily assistance with self-care activities and safety supervision.	Extensive support needed for daily activities.
Profound	1 – 1.5%	IQ < 20	Requires 24-hour care.	Pervasive support needed for every aspect of daily routines.

*Indication of % cases globally – Boat et al., 2015; Lee et al., 2023.

2.2 Special Olympics Movement

What is Special Olympics?

SO is the world's largest sports organisation for children and adults with ID, founded by Eunice Kennedy Shriver in 1968. The mission of SO "is to provide year-round sports training and athletic competition in a variety of Olympic-type sports for children and adults with intellectual disabilities, giving them continuing opportunities to develop physical fitness, demonstrate courage, experience joy and participate in a sharing of gifts, skills and friendship with their families, other Special Olympics athletes and the community" (Special Olympics, 2018). By participating in SO, athletes reap a number of benefits extending beyond the sports field including increasing physical fitness, developing friendships, fostering a sense of community, experiencing joy, building courage and confidence. According to the Special Olympics Reach Report (2021), over three million athletes with ID are reached through the SO programming with over three hundred thousand coaches delivering the sports training sessions. SO are a non-profit organisation and receive funding from local governments, fundraising, donations, grants and statutory authorities.

The SO movement started when Eunice Kennedy Shriver hosted a summer camp in her back garden for her sister Rosemary and other people with ID in the early 1960's. After this the movement began to rapidly develop and expand with the first SO International Summer Games held in Chicago in 1968 officially launching the organisation (Special Olympics, 2018). According to Myśliwiec and Damentko (2015), the SO movement was granted permission to use the word 'Olympics' to demonstrate their work in 1971. At this time, the organisation was allowed to utilise the ceremony of the Olympic Games including the lighting of the Olympic torch (Janusiewicz-Kuder et al., 1999; Myśliwiec and Damentko, 2015).

Since the conception of SO, the organisation has grown year on year and continues to grow across its seven regions, Africa, Asia Pacific, East Asia, Europe/Eurasia, Latin America, Middle East/North Africa and North America, made up of 193 countries. Along with year-round sports training, the competition schedule operates on a four year cycle, similar to that of the Olympics and Paralympics. SO athletes have the opportunity to compete in both summer and winter sports. The SO competition cycle culminates with countries hosting a National Games once every three years and the World Summer Games are held once every four years of the cycle. Most recently, the World Summer Games were held in Berlin in 2023 with the World Winter Games due to be held in Turin in Italy in 2025. A total of 37 individual and team sports are offered by the SO organisation, 28 summer sports, 8 winter sports and the Motor Activities Training Programme (MATP) (Special Olympics, 2023). The MATP is designed for people with more severe to profound ID and who are unable to compete in the other 36 sports on offer. In addition to the sports programmes, other programmes are delivered through the organisation including Healthy Athletes, Athlete Leadership and Young Athletes.

The SO Movement in Ireland - 'Share the feeling'

Anecdotal evidence would suggest that SOI is recognised for being a leader of the SO movement and for demonstrating best practice guidelines across their sport, competition and health programmes. SOI was first formed in 1978 and has grown considerably over the last forty five years (Special Olympics Ireland, 2019). SOI made history in 2003 by being the first SO programme to host a World Summer Games outside of the USA, with the event taking place in Dublin, accommodating 5,500 athletes competing from around the world (Special Olympics Ireland, 2019; Carlin, 2019). Today, SOI provides year round training, sport and competition programmes for people with ID beginning at age four, with no upper age limit (Special Olympics Ireland, 2019). Currently, SOI reaches over 8,000 athletes with ID who participate in fifteen different sports across the island of Ireland (Special Olympics Ireland, 2019).

The SO movement encourages athletes to develop skills that extend beyond the sports field and this aim is achieved through the non-sport offerings provided by SOI including the 1) Athlete Leadership and 2) Health and Wellbeing programmes (Special Olympics Ireland, 2019). Through the Athlete Leadership programme, athletes learn skills which empower them to be advocates for themselves and other people with ID, as well as acting as a Leader for SO and within their communities (Special Olympics Ireland, 2019). Training is provided to athletes who undertake this programme enabling them to build confidence and self-esteem. This programme provides athletes with a voice so they can speak out about the positive changes SO brings to the lives of individuals, families and communities (Special Olympics Ireland, 2019). There are four keyways in which athletes can get involved in the programme including; taking on an ambassador role, becoming an athlete-volunteer, taking on a committee role or completing challenges as part of the awards scheme (Special Olympics Ireland, 2019).

The Health and Wellbeing programme aims to develop and strengthen the health skills of athletes, empowering them to make the healthy choice the easy choice, to benefit their health both on and off the sports field (Special Olympics, 2022). People with ID are at an increased risk of developing NCDs including high blood pressure, obesity, diabetes and cardiovascular disease from a younger age (Krahn and Fox, 2014). It is recognised that people with ID are five times more likely to have diabetes, twice as likely to have cardiovascular disease and asthma, three times more likely to have arthritis and on average die sixteen years earlier than the general population (Reichard et al., 2011; Recihard and Stolzle, 2011). It is important to note that these NCDs are not as a result of an individual having an ID diagnosis but arise as a result of a number of other factors including lack of opportunities to participate in PA, poor nutrition, limited access to health education and quality healthcare (Krahn and Fox, 2014). The SOI Health and Wellbeing programme is offered across three strands and aims to help end the health disparities faced by people with ID: *1) Health Education* - provides accessible health information to encourage athletes to pursue healthy lifestyles through increased PA, proper nutrition and hydration, mental health and wellbeing. Currently there are three health education programmes available to athletes, a) Health Promotion programme, b) Stronger Minds, Happier Lives, both of which are available to those over 16 years of age and c) Health@Play designed for athletes aged 4-15 years (Special Olympics, 2022). *2) Healthy Athletes* - is a free health screening programme delivered by trained healthcare professional volunteers and students across six disciplines: Opening Eyes (vision), FUNFitness (physiotherapy), Healthy Hearing (audiology), Fit Feet (podiatry), Health Promotion (nutrition and healthy lifestyle), Special Smiles (dentistry) (Holder, 2015). *3) Healthy Communities* - is a recognition programme run by SO International which works to improve the health of people with ID by increasing access to quality healthcare and prevention programming (Special Olympics, 2020). The ultimate goal of Healthy Communities is to ensure people with ID can lead healthy lives within their own local communities through encouraging communities to adopt more inclusive practices (Special Olympics, 2020).

Young Athletes Programme (YA)

YA is a motor skills programme which was first introduced to the SO movement by Special Olympics New Jersey in 2004 (Favazza et al., 2013). The programme was developed in consultation with the University of Medicine and Dentistry of New Jersey in order to tackle the motor challenges experienced by children with ID under eight years of age through a range of motor play activities (Favazza et al., 2013). The YA programme aims to develop the FMS of children with ID across the three categories of skills including locomotor skills (e.g. running, skipping, hopping), ball skills (e.g. catching, throwing, kicking) and stability skills (e.g. static, dynamic balance) (Favazza et al., 2013). The YA programme enabled SO to fill a gap in their programming and provide an opportunity to children with ID under eight years of age to participate in SO for the first time (Favazza et al., 2014). Typically, in the United State, this programme is offered to children with ID who are between the ages of 2-7 years (Young Athletes Research, 2019). In contrast to this, SOI introduced the YA programme in 2016 and offers the programme to children with ID aged between 4-12 years (Special Olympics Ireland, 2019). The YA programme is vital to target the motor skill deficiencies exhibited by children with ID from a young age (Favazza et al., 2014; Kavanagh et al., 2023). These proficiency deficiencies will be further discussed later in this literature review chapter.

Coaches, volunteers, teachers and parents can follow the 'YA Activity Guide' designed by SO which is available on their website, to help them implement the YA sessions. The Guide recommends following a set structure for each session consisting of a warm up, individual skill development section, group games/activities and a cool down. A benefit of the YA programme is that it can be delivered in a variety of settings including the community, school and at home (Favazza et al., 2014; Special Olympics Ireland, 2019). The YA models of delivery may vary between different SO programmes and what they can offer their athletes. A comparison of the models available in the United States and Ireland are described in Table 2.2 with data from Favazza et al. (2014) YA Globalisation Report and the Special Olympics Ireland website.

The first key difference between the YA models of delivery begins with coach education. A self-guided online e-learning course called ‘Special Olympics Young Athletes Coach Course’ is available on the SO International learning portal. This course is used by volunteers and coaches in the United States to provide them with the qualifications to deliver the YA programme. Volunteers and coaches within SOI undertake the Sport Ireland accredited course called ‘Coaching Children Workshops’, which is delivered over Zoom and in person by a trained tutor. These workshops aim to provide coaches with a “basic understanding of children’s sport and PA and best ways to optimise children’s enjoyment, participation and positive outcomes” (Sport Ireland, 2023). Chapter 7 of this thesis details the experiences of coaches delivering the YA programme and highlights the coaches’ recommendations to enhance the sustainability of programme delivery. Additionally, chapter 8 highlights the next steps for this project which includes redeveloping the coach education materials and framework for YA coaches in order to provide coaches with the skills to assess children’s FMS and identify weaknesses.

Another difference between the models of delivery is the frequency of the session delivery also varies at the programme level in the United States and Ireland (see Table 2.2). For Ireland this is a potential limitation as typically, children with ID are only participating in one session per week of the YA programme at the community level or in the school setting. The YA intervention as tested and described by Favazza et al., (2013) consisted of 24 motor skill lessons, delivered three times a week (30 minutes) for eight weeks and found that children with ID aged 2-7 years demonstrated motor development gains of 7-9 months compared to the average gains of 3-5 months of the control group. Additionally, an ‘at home’ component was included in this intervention involving parents and families of the young athletes. Prior to undertaking this PhD, SOI had not assessed the baseline FMS proficiency levels of children with ID who participate in the YA programme and to date, no intervention with pre and post testing has been implemented. Future recommendations for the project as described in chapter 8 identifies the need for an intervention to determine whether the programme is improving the FMS of children with ID aged 4-12 years. Furthermore, materials and resources should be developed to encourage parents and families to continue implementing the YA programme in the home setting, in order to improve weaknesses in FMS.

Table 2.2 Young Athletes Models of Delivery: Comparison between United States and Ireland

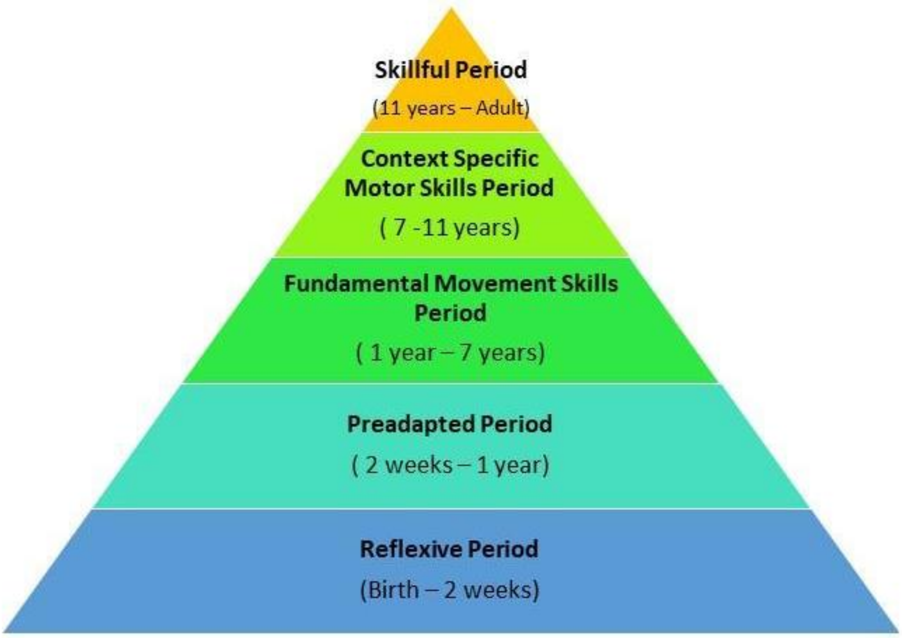
	United States			Ireland		
	Where	**How Often**	**Led By**	**Where**	**How Often**	**Led By**
YA Demonstration	Public event with Audience e.g. World Games, National Games	1 day	SO Staff Volunteers Parents	Public event with Audience e.g. World Games, National Games	1 day	SO Staff Volunteers Parents YA Tutors
YA Come and Try				Hosted in local communities to provide an opportunity for children and parents to experience programme and see if they would like to participate	1 day	SO Staff Volunteers YA Tutors
Community Model	Community setting	1-2 days per week	Teachers Parents Siblings SO Staff	Local community SO clubs. Suitable venues inc. sports hall, Astro pitch	1 day per week	Volunteers
School Model	School	3 days a week for 8 weeks	Teachers Parents	School	1-2 days per week, included as part of PE class*	Teachers SNA's
Family Model	Home or Neighbourhood	Varies: Parents decide	Parents Siblings	Home or Neighbourhood Option available but not currently reinforced or highlighted enough	Varies: Parents decide Not currently tracking this information	Parents Siblings

Volunteers = Coaches and general volunteers, - = Not currently offered, *** =** Irish primary school curriculum PE consists of 60 minutes per week, often broken into two 30 minute sessions, SNA = Special Needs Assistant

Theory underpinning the content of the YA programme

The motor development model underpinning the content of YA programme is Clark's Mountain of Motor Development (Clark, 1994) as described by Favazza et al. (2013, 2014). The authors describe the Mountain of Motor Development as having a dynamic approach that is consistent with Lerner's stage approach to motor development (Lerner, 1976). Clark's approach recognises that individual differences in children will exist throughout the motor development journey (Favazza et al., 2013), this may have been important for the researchers as children with ID are known to experience motor skill deficits. Clark's (1994) metaphor of learning to climb a mountain aligning with motor skill development across the lifespan, describes the stages of motor development (see Figure 2.1). Similarly, the many other models of childhood motor development such as Seefeldt's Motor Skill Proficiency Barrier (1986), Clark and Metcalfe's Mountain of Motor Development (2002) and Gallahue's Hourglass Model of Motor Development (1998), all explain the importance of gaining an adequate proficiency level in FMS and highlight this as critical to lifelong participation in sport and PA (Seefeldt, 1986; Clark, 2005; Gallahue, Ozmun and Goodway, 2012). These models describe the acquisition and development of movement skills in a hierarchical structure (Seefeldt, 1986; Clark, 2005; Gallahue, Ozmun and Goodway, 2012), in which repetitive exposure and practice of FMS directly influences performance and progression over time (dos Santos et al., 2022).

Figure 2.1 Clark's Mountain of Motor Development



The first period of the Mountain of Motor Development is the Reflexive period which includes the final three weeks of an infant's prenatal development and the initial weeks following the birth (Clark and Metcalfe, 2002). This is a critical period to ensure survival as well as cognitive and motor development (Clark and Metcalfe, 2002). It is recognised that an infant's reflexes help the infant begin to navigate interactions with the world around them, however these reflexes may cause problems if infants remain in this phase for too long (Salehi et al, 2017). In typically developing infants these reflexes are gradually and automatically phased out during their first year of life. However, in children who experience developmental delays, e.g. children with ID, these reflexes can persist thus slowing the typical rate of development (Salehi et a., 2017).

The second stage is known as the Preadapted period, referring to the ability of an individual to begin to control their reflexes and the emergence of voluntary movements (Clark and Metcalfe, 2002). Movements in this period progress from the ability to maintain control of our head and neck, to developing the ability to sit, stand and eventually walk independently once we gain control of the rest of our body parts (Salehi et al., 2017).

The third period describes the acquisition of FMS (Clark and Metcalfe, 2002) which are known as the ‘building blocks’ for participation in sport and PA, i.e., more complex movements (Behan et al., 2019). FMS encompass three categories of movements including locomotor skills (running, skipping, hopping), ball skills (throwing, catching, kicking) and balance skills (static, dynamic) (Behan et al., 2019). The literature depicts that TDC have the potential to master these vital skills between the ages of 6-10 years (Gallahue and Ozmun, 2006; Hardy et al., 2010). A number of factors may influence an individual's ability to develop their FMS including the number of opportunities to practice and reinforce the skills, amount of instruction and encouragement provided (Salehi et al., 2017). This period is the key focus for the YA programme. Through the programme, SO want to provide children with ID the opportunity to practice, learn and reinforce the acquisition of FMS. Current literature demonstrates that TDC significantly outperform children with ID with Kavanagh et al. (2023a) finding a large standardised mean difference (g = 1.24) in overall FMS proficiency between the two groups.

The fourth period of the mountain of motor development is called the Context specific motor skills period. It is within this period that children develop the ability to utilise the FMS learned in the previous period and refine, combine and progress these skills for use in situations where there is increased demand e.g., sports, PA and activities of daily living (Clark and Metcalfe, 2002).

The fifth period is known as the Skilful period. It is prior to entering this period that an individual obtains mastery levels of the FMS (Clark and Metcalfe, 2002), however experience and practice are required to achieve this. This period is influenced by whether an individual has developed a broad base of movement skills in the previous periods, which would enable them to reach higher levels of skill development now (Clark and Metcalfe, 2002). To be able to attain this high level of skill, it takes years of dedication and focus on developing this proficiency (Salehi et al., 2017). Individuals who have achieved this high level of proficiency can now perform the movements without focusing on the skill itself but rather on strategies or adaptations to further enhance the movement within certain settings (Salehi et al., 2017).

Clark and Metcalfe (2002) describe how apt the mountain of motor development metaphor is to emulate the cumulative process of motor learning which takes time, in which an individual must meet different criterion along their motor journey and how the process is influenced by an individual's ability and their environment. Finally, the peak of the mountain represents an individual achieving the ultimate goal, mastering the motor skills and being able to perform them to the most accurate level (Clark and Metcalfe, 2022). To summarise, each period on the mountain of motor development contributes to the skill acquisition necessary for an individual to move onto the next period (Salehi et al., 2017). The amount of time an individual spends at each period is individualised as it is influenced by a number of factors including cognitive ability, strength, movement speed, amount of exposure to reinforcing the skills and quality of instruction provided to them (Salehi et al., 2017).

Chapters 3, 4 and 5 in this thesis describe in further detail the FMS proficiency levels of children with ID in relation to Clark's Mountain of Motor Development, particularly how their performance compares to TDC of the same age. Additionally, chapter 5 provides details at the behavioural component level of FMS in order to highlight to coaches and PE teachers where the weaknesses in skill performance exist for this population.

Benefits from and motivations for participating in SO

Research has found that people with ID who participate in SO experience less stress, an increased quality of life and higher self-esteem then those with ID who do not participate in the SO programmes (Crawford, Burns and Fernie, 2015). These findings are further supported by Weiss et al. (2003) who found amongst SO athletes that being involved in more sports and competitions was associated with higher levels of self-esteem. Having higher levels of self-esteem is an important factor contributing to an individual's overall wellbeing and motivation to be physically active (Baumeister et al., 2003; Zamani Sani et al., 2016). Harada et al. (2008a) reports that 70% of SO coaches from China indicated "great" improvements in athletes' self-esteem. Similarly, 90% of athletes from SO programmes in South America report significant improvements in their own self-esteem and self confidence since they began participating in the programme (Harada et al., 2008b).

In addition to psychosocial benefits, people with ID gain a number of health related benefits through participation in the SO programme. Investigations by Sweeney et al. (2016) in a large-scale health impact evaluation study found that people with ID participating within SOI, rate their own health significantly better compared to people with ID who do not participate in the programme. Family members of the participants' proxy reported higher health related quality of life experienced by athletes compared to non athletes. Finally, athletes (n = 119) from SOI demonstrated a significantly higher overall health profile score (2.18 ± 0.81) compared to non athletes (1.64 ± 0.70). The health profile score consists of BMI, blood pressure reading, distance walked in submaximal fitness test and meeting ≥ 30 mins MVPA daily (Sweeney et al., 2016; Walsh et al., 2018). Physical fitness levels of SO athletes are higher compared to non athletes with ID, demonstrating lower BMI, increased flexibility, higher scores in hand grip strength and faster one mile walking scores (Rintala et al., 2016). Similarly, accelerometer data collected from athletes in SOI demonstrated an accumulation of 52.6 ± 34.3 minutes of moderate to vigorous physical activity per day compared to 45.3 ± 29.7 minutes for non SOI athletes, indicating that SOI athletes are more physically active compared to those who do not participate in the programme (Walsh et al., 2018).

Moreover, athletes who participate in the SO fitness models were found to decrease their body weight with a mean overall weight loss of 0.67 kg (95% CI: 0.9, 0.5), lower their systolic blood pressure (SBP) by 8.60 mm Hg (95% CI: 12.0, 5.2) and diastolic blood pressure (DBP) by 5.63 mm Hg (95% CI: 11.0, 2.9) from their baseline levels of SBP 118.3 mm Hg and DBP of 95.2 mm Hg (Rubenstein et al., 2020). The duration of time between baseline and follow up measurements was on average 56 days (Rubenstein et al., 2020).

The motivations of people with ID and the reasons for their continued participation in SO has been thoroughly explored across many programmes including Ireland, the United States, South America and China (Siperstein et al., 2005; Harada et al., 2008a, Harada et al., 2008b). Similar findings arose across the countries, despite cultural differences with athletes' motives for participating including having fun, winning competitions, to make new friends, to be healthy (Siperstein et al., 2005; Harada et al., 2008a, Harada et al., 2008b). These findings complement those found by Farrell et al. (2004) who explored the motivations of SO athletes from Canada for joining and participating in SO. Athletes cited motivations as building friendships, to have fun, develop new skills and feel included (Farrell et al., 2004). Furthermore, research emerging from the Europe/Eurasia region indicated social inclusion was a big motivator for young people with ID, as SO enabled them to connect with the wider community through a shared love of sport with the Unified Sports programmes (Dowling et al., 2010). As demonstrated by the literature, participating in sport enables people with ID to thrive as a valued member of society and have a sense of identity (Darcy and Dowse, 2013; Hudson et al., 2018). Sports clubs are the ideal environment to build friendships, enjoy the company of others and meet new people, all of which enhances a sense of belonging for people with ID (Darcy and Dowse, 2013). Being part of a sports club in their local community enables people with ID to define themselves as “athletes” and “team mates” rather than solely identifying as a person with an ID (Hudson et al., 2018). Through SO, people with ID can experience a shared identity with their fellow athletes and having a role on their sports team or within their sports club where they feel valued has a positive consequence encouraging sport and PA participation for people with ID.

Impact of SO on Families and Caregivers

The benefit from participation in SO is not only for the athletes but also their families and caregivers. Recent studies have begun to investigate the involvement of parents and caregivers in SO and the role SO has on their lives (Kersh and Siperstein, 2012; Sweeney et al., 2016; Bowers et al., 2016; Pickett et al., 2022). Often caregivers of people with ID express increased feelings of social isolation and loneliness related to the responsibilities of caregiving (Chiu et al., 2013; Pickett et al., 2022). Caregivers report that their involvement in SO helps to alleviate these feelings of social isolation (Pickett et al., 2022) by providing them with a support network and social outlet (Sweeney et al., 2016). Kersh and Siperstein (2012) described how caregivers identified SO as a source of social support for themselves and their families, enabling them to build connections extending beyond their family circle. SO helps to improve the mental health and wellbeing of families and caregivers (Pickett et al., 2022) by providing them with increased social support as previously outlined which reduces stress and social isolation (Tsai et al., 2003). Shiba et al. (2016) identified the vital need of social connectedness in maintaining the health of caregivers. Many parents highlighted that SO was their primary means of interacting with other people who shared a similar lived experience (Kersh and Siperstein 2012; Sweeney et al., 2016; Pickett et al., 2022). Parents frequently placed high value on being able to speak with other parents whose children may be experiencing similar challenges and knowing that they understand their situation (Kersh and Siperstein, 2012). Additionally, these support networks were an invaluable tool for parents to discuss and share information on school and community services available for their children (Kersh and Siperstein, 2012). Therefore, SO is recognised as a “powerful engine of connection” (Kersh and Siperstein, 2012, p. 26) for families of SO athletes, reducing social isolation, providing a space to socialise and build connections.

Families shared the increased sense of pride they felt for their family members who participated in SO and being able to watch their athletes succeed and accomplish great things through sport (Kersh and Siperstein, 2012; Sweeney et al., 2016). Parents noted how impressed they were with their children exceeding their expectations with their athletic ability, exhibition of sportsmanship, their competitive nature, the level of effort they put into training and competition (Kersh and Siperstein, 2012; Sweeney et al., 2016). Findings from Kersh and Siperstein (2012) demonstrated that 65% of parents remarked how SO elevated their expectations of their children, making them more aware of their child's potential and capabilities to succeed both on and off the sports field. It is evident that SO provides people with ID a platform to succeed and provides an opportunity for families to see their children demonstrate these competencies and qualities that they might not have seen prior to their participation in SO.

Further research has been carried out specifically on the YA programme and the benefits gained by families and parents from letting their child attend including; helping parents understand what an ID diagnosis means, generating opportunities for increased family involvement, changing parents attitudes in a positive manner and creating support networks (Favazza and Siperstein, 2006; Favazza et al., 2014). These findings align with those found from parents of athletes participating in the general sports programme as previously discussed above. SO carried out a survey with over 1,400 family members globally to investigate the impact of YA programme and found that 91% parents agreed/strongly agreed that they were more hopeful about their child's future as a result of the YA programme while 89% parents strongly agreed/agreed that their expectations of their child were higher as a result of their participation (Favazza and Siperstein, 2006; Favazza et al., 2014).

2.3 Fundamental Movement Skills of Children with Intellectual Disabilities

Introduction to FMS

The definition of motor skill proficiency encapsulates the quality of an individual's movement coordination and their performance outcome when demonstrating different movement skills (Robinson et al. 2015; Kavanagh et al. 2019). FMS are one aspect under the umbrella of motor skill proficiency that is commonly investigated in the literature (Logan et al. 2017). FMS are also known as the 'building blocks' required for taking part in sport, exercise and physical activity (Cohen et al., 2014; Behan et al. 2019). There are three components which are classified under FMS including locomotor, ball skills and balance (Gallahue and Ozmun, 2006). Locomotor skills involve an individual moving their body through space (e.g. running, jumping, skipping), ball skills are those that involve the manipulation of an external object (e.g. throwing, kicking, catching) and balance skills involve stability while remaining upright (e.g. balance beam, standing on one leg, walking heel to toe on a line) (Gallahue and Ozmun, 2006). Children are not born with the ability to accurately perform FMS, they are skills which children can acquire over time once they are taught them and given opportunities to learn, practice and reinforce these skills (Valentini and Rudisill, 2004; Clark, 2005; Barnett et al., 2016; Haywood and Getchell, 2019). Once children have mastered the FMS they can then begin to refine and combine the skills to support the development of more complex skills used in sport and PA (Metcalfe and Clark, 2002).

A topic widely discussed in the literature is the mastery progression rate differences that exist between boys and girls (Cliff, Okely, Smith, & McKeen, 2009). Typically amongst children of the same age, girls demonstrate higher FMS proficiency than boys in locomotor and balance skills while boys achieve higher scores in ball skills (Barnett et al., 2009; Hardy et al., 2010; Goodway, Robinson, & Crowe, 2013). These results are further supported by a meta-analysis carried out by Zheng et al. (2022) which investigated gender differences in FMS of children aged 3-6 years. The results demonstrated that boys had higher FMS proficiency in overall FMS scores and ball skills scores (SMD = 0.17 (95% CI 0.03, 0.31), $p = 0.02$; SMD = 0.48 (95% CI 0.38, 0.58), $p < 0.00001$), while girls displayed comparatively higher performance in locomotor skills (SMD = −0.07; 95% CI −0.15 to 0.01; $p = 0.09$; I2 = 66%), although the effect was not deemed statistically significant.(Zheng et al., 2022). Gender differences in FMS performance can be attributed to the type of activities in which boys and girls participate in, as these can often be determined by factors such as the physical environment, family preference and peers (Booth et al., 1999; Hardy et al., 2010; Zheng et al., 2022).Prior to puberty, girls and boys possess similar biological characteristics such as body composition, strength, limb length and genotype (Malina, Bouchard, & Bar-Or, 2004; Bolger et al., 2018). What is typically seen, is that girls tend to participate more in activities that promote the development of locomotor and balance skills (e.g., gymnastics and dance) while boys tend to participate in activities that predominantly promote the development of ball skills (e.g., ball sports like football) (Booth et al., 1999; Bardid et al., 2016; Peral-Suárez et al., 2020; Zheng et al., 2022). Previous research has indicated that girls are provided with few opportunities to practice ball skill games (Ogden et al., 2002; Thornton, 2006) which may be linked to parental educational attitudes (Fagot and Leinbach, 1989). Furthermore, a Canadian study by LeGear and colleagues (2012) presented findings on the perception of physical ability from the perspective of girls aged 5 years, which was related to their locomotor skills proficiency but not ball skills, indicating that girls potentially do not value ball skills.

When children are provided with opportunities to learn, practice and reinforce the FMS, they can combine these skills to develop transitional movements and sports specific skills required for lifelong PA participation (Robinson, et al., 2015). While comprehensive experimental validation of these effects remains limited, the findings from numerous longitudinal studies substantiate the idea that acquiring mastery in fundamental motor skills contributes to an increase in physical activity (Barnett et al., 2009; Lopes et al.,2011; Lloyd et al., 2014; Jakkola et al., 2016). Barnett and colleagues (2009) investigated a sample of 276 children aged ten years over a six-year period demonstrating that childhood proficiency in ball skills was positively and significantly associated with self-reported time spent in MVPA, six years later (*r squared* = .127, accounting for the variance in the model). Additionally, higher ball skills performance in childhood resulted in adolescents demonstrating 10-20% higher levels of vigorous intensity PA participation (Barnett et al., 2009). Similarly, Jakkola et al. (2016) examined the association between FMS performance (at age 12) and self-reported PA after a six-year period in a sample of 224 children. Baseline FMS proficiency levels were found to be a predictor of light ($\beta = 0.27$, $P < 0.001$), moderate ($\beta = 0.17$, $P = 0.009$) and vigorous VPA ($\beta = 0.38$, $p < 0.001$) intensity PA at follow up. These studies suggest that obtaining high levels of FMS proficiency during childhood results in higher levels of PA during adolescence and potentially through to adulthood (Bremer and Cairney, 2016).

Differences in FMS proficiency levels between CwID and TDC

While this topic is covered extensively in chapter 3 of this thesis in the format of a systematic review and meta-analysis, I will briefly introduce the topic in the context of the literature review. Within the literature, it is acknowledged that TDC have the potential to achieve mastery of the majority of the FMS by six years of age (Gallahue and Ozmun, 2006) and all of the FMS should be acquired by the time the child is ten years old (Hardy et al., 2010). It has been documented that age positively influences FMS proficiency due to biological maturation, increased duration of practice and receiving feedback (Charlesworth, 2016; Bolger et al., 2018). Age-appropriate FMS proficiency levels were first established by the theoretical models of childhood motor development which attempt to describe and explain motor behaviours using inductive or deductive methods (Goodway, Ozmun and Gallahue, 2021). An example of such a model is Gallahue and Ozmun's (2006) hourglass model for motor skill development which suggests that both girls and boys have the potential to master the FMS between the ages of five to seven years, with the critical FMS development period being in the child's early years from ages 3-7 (Gallahue, Ozmun, & Goodway, 2012). From the literature it appears that the cut off age for mastering the FMS was set at ten years as it is up to this age in which the most considerable changes in children's gross motor skill development occurs (Ulrich, 2000). Studies amongst TDC have demonstrated that once children reach ten years of age their FMS proficiency improvements tend to plateau (Bardid et al., 2016; Valentini et al., 2016; Behan et al., 2019; Kelly et al., 2019). This plateau is not as a result of mastering the FMS but rather due to lack of opportunities to practice and reinforce the FMS while receiving feedback (Kelly et al., 2019).

Unfortunately, in countries around the world, TDC are failing to demonstrate age appropriate FMS proficiency levels as a direct result of increased sedentary time and decreased time spent participating in PA (LeGear et al. 2012; Mukherjee et al. 2017; Behan et al., 2019; Lawson et al., 2021). Compared to their typically developing peers, CwID are 65% more likely to demonstrate lower motor competence (Gkotzia et al., 2017). While there has been numerous studies including a systematic review carried out by Maïano et al. (2019) comparing the motor competence of CwID with TDC, generalisability of results were poor due to low number of included studies, small participant numbers, not assessing all three subcomponents of FMS (locomotor, ball skills and balance) and inconsistencies in FMS assessment tools used (Kavanagh et al., 2023a). The meta-analysis presented in chapter 3 aims to quantitatively synthesise and summarise the precise estimate of the magnitude of difference in FMS proficiency between CwID and TDC.

Studies from Alesi et al. (2018), Capio et al. (2018) and Magistro et al. (2018) examined the differences in FMS proficiency levels (locomotor and ball skills) between children with ID and TDC using variations of the TGMD. The results derived from all three studies found that CwID performed significantly lower in ball skills and locomotor scores than the TDC. Capio et al. (2018) found that children with DS who have better balance ability compared to their peers, tend to perform better in overall motor competence scores. Sretenović et al. (2019) investigated balance proficiency differences using the Bruininks-Oseretsky Test of Motor Proficiency (BOT) and reported that CwID scored significantly lower in both static and dynamic balance compared to their typically developing peers.

Measurement of FMS in children with ID

In order to assess and measure the FMS performance of children with ID, practitioners including physiotherapists, researchers, clinicians and PE teachers need field-based assessments that are feasible, valid and reliable (Robertson et al., 2017; Downs et al., 2020). FMS assessment tools can be used for cross-sectional measurements as well as investigating the impact of motor skill interventions (Hands et al., 2008; O'Brien, Belton and Issartel, 2016). A number of systematic reviews (Griffiths et al., 2018; Scheuer et al., 2019; Hulteen et al., 2020) have investigated FMS assessment tools used to assess TDC, highlighting the abundance of product oriented and/or process-oriented measures available. Process based assessments are deemed by the research community as more informative due to their focus on analysing the movement technique and quality (Ulrich, 2000; Downs et al., 2020). This enables the assessor to highlight components of weakness within skills and provide feedback when needed (Ulrich, 2000). A limitation of this type of assessment is that they require extensive assessor training as more expertise is required for scoring skill criteria as present or absent (Downs et al., 2020). Additionally, process measurement tools allow the observer to determine differences in development which can be attributed to technical development or development as a result of physical growth and maturation (Downs et al., 2020). On the other hand, product-oriented assessments focus on the outcome of a movement (e.g. running speed, number of throws) and are easier to score as they are more objective in nature while being less time consuming (Bardid et al., 2019). It is important to note that while these motor competence assessment tools are deemed valid, reliable and feasible for use with TDC, it cannot be assumed that these tools are appropriate for assessing children with ID.

The only systematic review to date aiming to identify the gold standard motor competence assessment tools for children with ID was carried out by Downs et al. (2020). This study identified the most commonly used motor competence assessment tools used with this population including TGMD-2, TGMD-3, PBDS-2, BOT-2, Ages and Stages Questionnaire, MABC-2 and Test of Motor Proficiency (Downs et al., 2020). The recommendations from this study identified the BOT-2 and TGMD-2 as having the strongest psychometric properties to measure FMS in children with ID (Downs et al., 2020). Within the current PhD project, the assessment tools that were used to measure FMS as outlined in Chapter 4, 5, and 6 were the TGMD-3 and the BOT-2 Short Form.

One of the most commonly used forms of assessing FMS amongst both TDC and children with ID is the process-based Test of Gross Motor Development (TGMD) (Ulrich, 2017). The TGMD-2 has been extensively used in research with children with ID (Simons et al., 2008; Hartman et al., 2010; Rintala and Loovis, 2013; Eugia, Capio and Simons, 2015; Schott and Holfelder, 2015; Capio et al., 2018; Kavanagh et al., 2023b). Now in its third iteration, the TGMD-3 is composed of six locomotor skills and seven ball skills (Ulrich, 2013), including one more skill than in the previous version, with the addition of the one-handed strike. Each sub skill of the TGMD-3 contains between three to five components which are assessed in order to ascertain the proficiency level of the participant. The participant performs one trial version of the skill, followed by two trials in which the skill components are assessed. Originally, the TGMD was designed for children between the ages of three to ten years (Hardy et al., 2010; O'Brien et al., 2016) however it has been demonstrated as a reliable tool for use with children across the full primary school age range (4-12 years) (Behan et al., 2019). The TGMD-3 has been found to have established clinical validity (Pitchford and Webster, 2021; Temple and Foley, 2017), instructional sensitivity (Staples et al., 2021), and reliability ($\alpha = .81$) for children with and without ID in the primary school years (Rey et al., 2020; Magistro et al., 2018). In the context of the TGMD, clinical validity refers to the ability of the assessment tool to distinguish FMS competency between children with disabilities and TDC, with the purpose of identifying deficits and delays in motor skill performance (Pitchford and Webster, 2021). The instructional sensitivity of the TGMD-3 refers to its ability "to detect changes in response to direct instruction in fundamental motor skills" (Staples et al., 2021, p.96). In summary, the TGMD-3 has demonstrated its effectiveness as the gold standard for FMS assessment tools and is most appropriate for use in field-based settings to assess children with ID. However, the TGMD-3 is not without its limitations and has been criticised for the lack of a stability component (Rudd et al., 2015), which along with locomotor and ball skills is an integral component of FMS (Gallahue and Ozmun, 2006).

To ensure a comprehensive overview of FMS performance amongst children with ID, researchers who use the TGMD version 2 or 3, also often use BOT-2 to assess balance. Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) and the Bruininks- Oseretsky Test Second Edition (BOT-2) (Bruininks, 2005) is another form of FMS assessment. This test is unique in that it assesses both fine and gross motor skill development and was designed to identify children who may be experiencing motor delays or deficits (Baharudin et al., 2020). This assessment tool is suitable for children and adolescents between ages four to twenty-one years and consists of eight sub domains with 53 items of assessments (Bruininks, 2005). There is also a short form version of the assessment tool available (Bruininks, 2005). Nocera et al. (2021) found that the BOT-2 Short Form demonstrates excellent reliability ($\alpha = .75$) when assessing motor competence in children with ID. The BOT-2 is also not without its limitations which include the duration of time needed to complete the tasks is 45-60 minutes, with the short form taking between 15-20 minutes (Cools et al., 2009), making it impractical to assess large numbers of children (Peerlings et al., 2007). Moreover, the number of skills assessed with the BOT-2 is lower compared to other assessment tools and therefore does not provide the assessor with a full picture of the participants' FMS. Irrespective of the FMS assessment tools that are used, low levels of FMS proficiency are seen worldwide amongst children with ID (Maïano et al., 2019; Kavanagh et al., 2023).

Another area of FMS measurement which is of interest to researchers is the ability level of coaches, physical educators and parents to accurately assess and report on children’s MC (Liong et al., 2015; Estevan et al., 2018). A measurement tool called the Perceived Movement Skill Competence (PMSC) Scale was originally developed to assess children’s self-perception of their own MC ability and is aligned with the FMS tested through the TGMD (Barnett et al., 2015). This scale was then adapted into a written survey for each FMS listed and supported with an accompanying image (Liong et al., 2015; Estevan et al., 2018). The survey has been validated for use with parents and physical educators to assess children's MC, demonstrating significantly positive associations between their rating and children’s actual MC scores as assessed by researchers (Liong et al., 2015; Estevan et al., 2018). Further details in relation to the survey and its use can be found in Chapter 6 of this thesis in which we utilised the survey to determine whether SO coaches could accurately report on the motor competence of children with ID. To our knowledge this was the first study to date examining coaches rating ability.

FMS as a precursor to sports specific skills

Numerous models of child development motor development including Clark and Metcalfe's Mountain of Motor Development (2002) (described previously), Gallahue's Hourglass Model of Motor Development (1998) and Seefeldt's Motor Skill Proficiency Barrier (1986) indicate that children must master the FMS as a prerequisite for the acquisition of more advanced movement skills needed to participate in lifelong sport and PA (Seefeldt, 1986; Clark, 2005; Gallahue, Ozmun and Goodway, 2012). These models describe the acquisition of movement skills in a hierarchical manner (Seefeldt, 1986; Clark, 2005; Gallahue, Ozmun and Goodway, 2012) in which previous opportunities to learn, practice and reinforce these FMS directly impacts performance and future progression (dos Santos et al., 2022). The phases of the motor development pathway are highly interdependent beginning with FMS, advancing to transitional movement skills (TMS) then progressing to sports specific skills (SSS) (Seefeldt, 1986; Pacheco et al., 2021). These phases are described in depth in Chapter 5 of this thesis.

Seefeldt's model depicts that children who demonstrate low proficiency in FMS will experience difficulties learning and performing TMS (Seefeldt, 1986). This hypothetical 'glass ceiling' is known as the proficiency barrier. Certain populations consistently demonstrate low levels of motor competence, CwID are one of these cohorts (Maïano et al., 2019; Kavanagh et al., 2023a) and thus we can hypothesise that this cohort will experience the proficiency barrier to a significant degree. Chapter 5 of this thesis examines potentially how far below the proficiency barrier CwID are at, at both an individual and behavioural skill level. The development of high proficiency in FMS amongst CwID, is particularly important for SO as an organisation who want their athletes to participate in sports specific programmes and remain active for life.

Benefits of FMS for children with ID

It is widely recognised that being proficient in FMS is associated with a range of health benefits for all children in the cognitive, physical and social development domains (Lubans et al., 2010; Westendorp et al., 2011). The physical health benefits are derived from increased participation in PA as a result of high proficiency levels in FMS (Okely et al., 2001; Barnett et al., 2016; Hulteen et al., 2018; Wang et al., 2022). Participating in the recommended levels of PA contributes to increased health and wellbeing such as reducing the risk of developing lifestyle mediated diseases including CVD, diabetes, cancers, improving bone health and maintaining a healthy weight (Ortega et al., 2011; Pate et al., 2012; WHO, 2019). These health benefits derived from PA participation are particularly important for CwID, as previously discussed in this thesis people with ID are at an increased risk of developing these lifestyle mediated diseases from a younger age compared to the general population (Reichard et al., 2011; Recihard and Stolzle, 2011). Unfortunately, CwID are not currently meeting the recommended PA guidelines (Einarsson et al., 2015; Wouters et al., 2019), potentially as a result of low FMS proficiency levels and lack of opportunities to engage in PA suited to meet their needs (Gallahue et al., 2012). Therefore, interventions and programmes like SO Young Athletes are extremely important in providing CwID opportunities to learn, practice and develop their FMS.

In addition to the physical health benefits, proficiency in FMS encourages children to interact and play with their peers across a range of environments which provides opportunities for cognitive development (Capio & Eugia, 2021; Ommundsen et al., 2010; Piek et al., 2008) and for improvements in social adaptation skills (Schalock et al., 2010; Tassé et al., 2012). Both of these domains are especially important for CwID who experience limitations in both intellectual functioning and adaptive behaviour as a result of the ID diagnosis (Shcalock, Luckasson and Tassé, 2021). Cognitive functioning is described "an individual's ability to acquire, organise and use knowledge and is essential for everyday behaviour" (O'Hagan et al., 2022, p.872). Cognitive functioning aids individuals to understand and react to the world around them. Development of cognitive skills including executive functions, working memory, response inhibition, attention, planning etc. are important during childhood development and as the child progresses through to adolescence and into adulthood (Munakata, Synder and Chatham, 2012). These skills provide children with the ability to process and manipulate information as well as respond accurately and quickly to move between tasks (Davidson et al., 2006). Research from Piek et al. (2008) demonstrated that the working memory and information processing speed of young children could be predicted by their early FMS development. Additionally, similar results were found in school aged children identifying a strong relationship between FMS performance, information processing speed and working memory (Piek 2004a, b). Schott and Holfelder (2015) found that children with DS aged 7-11 years present with impairments in higher order cognitive functioning and exhibit low FMS proficiency levels. These findings highlight the importance of early motor skill interventions which facilitate cognitive abilities for CwID (Schott and Holfelder, 2015).

2.4 The Coach

The role of the coach in youth sport

A systematic review by Tremblay et al. (2016) found that across 38 countries worldwide, approximately 50% of children participate in youth sports. In line with these findings, it is clear that youth sports play a dominant role in the lives of many children and youth around the world. Within the European Union (EU), there are approximately 7-9 million youth sport coaches, majority of whom have no qualifications or hold a lower-level coaching qualification (Lara-Bercial et al., 2017). The art of coaching is multifaceted and complex (Jones and Turner, 2006), however "virtually anyone can assume the role of a youth coach" (Gilbert and Trudel, 2001, p.16). It is widely acknowledged that unlike professionals in other fields, youth sports coaches are not provided with comprehensive formal training or highly organised work environments to provide them with strong examples of how they should undertake their role (Gilbert and Trudel, 1999; Weirsma and Sherman, 2005; Lara-Bercial et al., 2017). The lack of coach education is also apparent in youth disability sport as highlighted by the YA coaches in Chapter 7 of this thesis. An example provided by Gilbert and Trudel (2004) highlights how teachers undertake numerous years of university level education to work with children and how they have clearly identified performance outcomes to assess their teaching performance. While on the contrary, youth sport coaches have limited opportunities to engage in continuous professional development opportunities, lack tangible role descriptions and do not have a set criterion to assess their performance as a coach (Gilbert and Trudel, 2004). Further to this point, the social institution that is youth sport (Coakley, 2007) is driven by thousands of adult volunteers, majority of whom are coach-parents (Hedstron and Gould, 2004; Weirsma and Sherman, 2005; Leberman and LaVoi, 2011) with little prior knowledge of coaching or sport.

As a result, youth sport coaches are ultimately left to construct their own approach to coaching (Gilbert and Trudel, 2004). The lack of education and support for youth sport coaches can be seen with some coaches placing more value on winning and technical skills while others focus on social skill development and enjoyment of the sport. Research has found that the behaviours of youth sport coaches influence the quality of sport participation for children (Weirsma and Sherman, 2005) and can impact their enjoyment (Weirsma, 2001), motivation (Duda and Hom, 1993) and sense of self-worth (Brustad, 1996). For young children who are participating in sport, the goal is for them to be physically active, to enjoy themselves and have a positive experience of sport through learning and development of the FMS (Seefeldt, Ewing and Walk, 1992; Gould and Petlichkoff, 1998; Merkel, 2013). If children are not ready to participate in organised sport and do not have the necessary skills developed, this can lead to anxiety and stress for the child which ultimately leads to dropout (Purcell, 2005; Breuner, 2012; Merkel, 2013). Youth sports coaches must recognise that sport itself is "no magic bullet" (Lara-Bercial et al., 2022, p.1) and acknowledge the vital role they play in providing positive experiences and environments for children in youth sport (Lara-Bercial et al., 2022). The ICoachKids (ICK) Movement stresses the importance of coaches creating environments that not only encourage children to play sport but also keep them in sport for life (Lara-Bercial et al., 2022).

One of the recent developments from the ICK Movement includes the 'ICOACHKIDS Pledge: 10 Golden Principles for Coaching Children', which was developed as a practical tool for coaches to support them to create environments that put children first within youth sport (Lara-Bercial et al., 2022). Each of the 10 principles helps coaches to identify the role they play and encourages them to consider how they can implement each of these principles within their own youth sport setting (Lara-Bercial et al., 2022).
The 10 principles include:

1. Be child centred
2. Be holistic
3. Be inclusive
4. Make it fun and safe
5. Prioritise the love for sport over learning sport
6. Focus on foundational skills
7. Engage parents positively
8. Plan progressive programmes
9. Use different methods to enhance learning
10. Use competition in a developmental way

Coaching athletes with ID

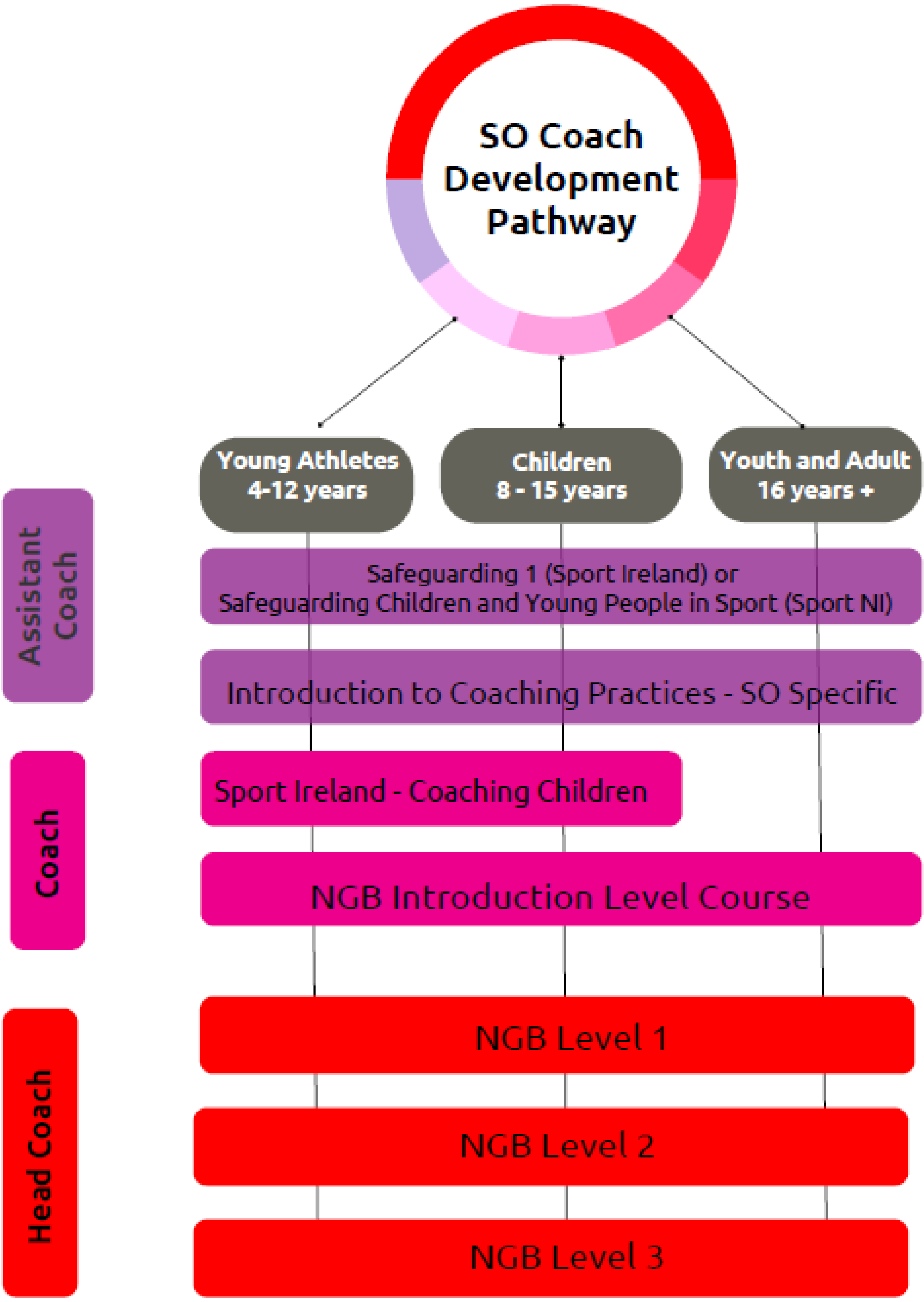
As an organisation, SO International has more than 1 million coaches and volunteers supporting athletes with ID in 200 accredited programmes worldwide (Special Olympics, 2023). Despite this large number of coaches, Turgeon et al. (2022) highlighted the dearth of high-quality research available on coaching training and practices for athletes with ID, in the context of SO. As outlined in Chapter 7 of this thesis, SOI has 855 trained sports coaches, 13 of whom are YA head coaches (data provided from SOI administrative records, May 2023), who deliver a year-round sports training programmes to people with ID in their local community. A coach education framework focused on 'Coaching People with Disabilities' was established in 2009 by Sport Ireland Coaching (formerly known as Coaching Ireland) as part of the Coaching Development Programme for Ireland (CDPI) (Sport Ireland, 2023). This framework identifies how National Governing Bodies (NGB) of Sport can include this important topic within their coach education courses (Sport Ireland, 2023). Disability Sport organisations like SOI often develop their own coach education pathways to train and upskill coaches to work with people with ID (see Figure 2.2). In order to become a Young Athletes coach, the volunteer must complete mandatory safeguarding training, the 'Introduction to Coaching Practices' course, followed by the 'Sport Ireland - Coaching Children Workshops' (as previously discussed) (see Figure 2.2). The outcomes of the 'Introduction to Coaching Practices' course as as follows (provided by SOI, July 2023): (1) Identify the role of a Special Olympics coach and utilise the qualities and skills required to coach athletes in training and competition, (2) Identify key factors which should be considered when working with athletes with an intellectual disability and apply adaptations in practice and (3) Organise, plan and deliver a coaching session. In order to be able to coach a specific sport, a volunteer must complete the 'NGB Introduction Level' course for that particular sport e.g. Basketball Ireland's 'Intro to Coaching' course to coach SO basketball. When discussing participation in youth sport, Côté et al. (2008) describes three concepts of coaching called the *3Ps,* which include fostering performance, enhancing personal development and encouraging participation. Looking at the mission statement of SO, it is evident that the organisation touches upon these three key concepts (Turgeon et al., 2022).

It is important to remember that the majority of considerations involved in coaching people with ID are exactly the same as those applicable to coaching children and adults in the general population (Campbell and Stoneridge, 2020). However, the nature of the role of coaching disability sports has the potential to be more multifaceted due to additional factors such as communicating with the athletes' families, support workers or caregivers, taking time to ensure accessibility of facilities for training and transport considerations (Cregan et al., 2007). Campbell and Stoneridge (2020) note that a significant part of the role of a disability sports coach is to aid in diminishing any barriers to sports participation for the athletes you work with. One such barrier may actually be the parents or the support network of the athletes with ID and the coach may find they may initially need to 'coach' this group also (Campbell and Stoneridge, 2020). As coaches highlighted in Chapter 7 of this thesis, they felt pressure to help manage parental expectations in relation to their child's development and progression. Research has found that children with disabilities may experience unintentional delays to their psycho-social development due to parents limiting independent participation opportunities as a result of emotional overprotection and perceived lack of child's ability (Rimmer et al, 2007; van Ingen et al., 2008; Cunningham et al., 2014). Therefore, if the coach spends time instilling confidence in the parent or caregiver of the athlete with ID, in turn the athlete's own confidence will continue to be developed and they will be given more autonomy (Campbell and Stoneridge, 2020).

New coaches entering the world of ID sport for the first time may feel overwhelmed by the pedagogical misalignment, environmental disorder, the varying degrees of ID and differences in the practical delivery implications of their session (Campbell and Stoneridge, 2020). A metaphor used by Bowes and Jones (2006, p.241) may begin to describe this experience of coaches "working at the edges of chaos". Similarly, a coach-parent sets the scene in Chapter 7, for what a new coach coming into the YA programme might look like ("for somebody coming in as a volunteer with no link to any child with special needs to do the course and then go into a hall with 20 or 25 kids, it must be mayhem for them": Coach Paul). What this highlight is the need for practical, hands on training and experience for new coaches wanting to coach people with ID. Research suggests that coach education should incorporate a problem-based learning approach for youth sport coaches in order to bridge the gap between theory and practice (Gilbert and Trudel, 2001; O'Connor and Bennie, 2006).

An important consideration for coaches in ID sport is to ensure that they adapt their coaching and training sessions to cater for specific needs of athletes on an individual basis (McConkey et al., 2019). Additionally, research by Farrell et al. (2004) presented findings demonstrating that coaches play an important role in motivating athletes to continue participating in sports with SO. These findings suggest that coaches not only impact a person's desire to participate in sport but also influence the overall development of an individual (MacDonald et al., 2016; McConkey et al., 2019). Moreover, Robinson et al. (2018) and Weiss et al. (2020) found that a strong contributor to athletes' continued participation in SO programming is attributed to the strong coach-athlete relationship that coaches build with the athletes they work with. Therefore, it is clear that while coaching in ID sport may be challenging for new coaches, over time they build strong, positive relationships with the athletes they work with and have an enormous impact on the athlete’s motivation to stay involved in sport for life, which is incredibly rewarding.

Figure 2.2 Coach Development Model from Special Olympics Ireland



The role of the coach in developing FMS

The role of the coach in developing children's FMS is not well documented in the literature. Instead, the focus is on primary school teachers developing children's FMS through curriculum-based activities (Breslin et al., 2012; Hands, 2012) or encouraging parents to become actively involved in delivering FMS programmes to children at home (Barnett et al., 2019; Flynn et al., 2023). While the school setting is often deemed most suitable to support the development of FMS amongst children (Morgan et al., 2013; Cohen et al., 2014; Kelly et al., 2020), research has demonstrated that as few as 15% of teachers have the capability and knowledge to deliver effective FMS programmes and assess children's motor competence (Eddy et al., 2021). Primary school teachers are not PE specialists and have received little to no upskilling on how to implement FMS interventions and develop children's FMS ((Eddy et al., 2021). Despite this, school-based interventions have presented positive outcomes for improving children's FMS performance and increasing PA levels (Lai et al., 2014; Chan et al., 2019). As a result, the school setting has been the main focus of research and interventions, with less emphasis placed on investigating community and home FMS programmes, even with children spending a large portion of time at home (Johnstone et al., 2018; Ha et al., 2021; Lane et al., 2022).

In addition to teachers and parents, sports coaches play an integral role in influencing a child's desire to participate in sport and PA, as well as having an impact on their overall development (MacDonald et al., 2016). Research specific to the intellectual disabilities sporting context found that coaches maintain a gatekeeper role in motivating people with intellectual disabilities to continue engaging in sport with Special Olympics (SO) (Farrell et al., 2004). For children with intellectual disabilities, sport and PA need to be a vehicle for the development of FMS (Downs et al., 2014) due to the low levels of motor competence exhibited by this population (Kavanagh et al., 2023a). Therefore, it is vital that future research investigates the role of the sports coach in developing the FMS of children with and without ID in the community setting.

Recruitment and retention of coaches

All sport organisations, while unique in how they operate, share one similarity with the challenges experienced with volunteer recruitment and retention (Bouchet and Lehe, 2010; Ronkainen et al., 2022). Volunteer sports coaches give up hours of their time to support people within the community, which can go largely unnoticed (Bouchet and Lehe, 2010; Ronkainen et al., 2022). Volunteers are the most important asset to not-for-profit sporting organisations like SO (Busser and Carruthers, 2010; Long and Goldenberg, 2010), without them sports would not be possible (Bouchet and Lehe, 2010). Unfortunately, research indicates that volunteer positions, especially youth sport coaches are difficult to fill with low retention rates (Paiement, 2007). The motivations of volunteers have been widely discussed in the literature with motives depending on factors such as life stage, years of experience, gender and type of activity (Clary et al. 1996; Cuskelly et al., 2006; Bouchet and Lehe, 2010; Busser and Carruthers, 2010). With low levels of PA participation and rising levels of obesity among children and youth (Chaput et al., 2018), the recruitment, retention and upskilling of quality sports coaches has never been more vital (Busser and Cynthia, 2010).

Often there is a mismatch between the ideal competencies of volunteer sports coaches and the coaches' actual skill set (Gilbert and Trudel, 2001). The ability of sports organisations to meet the developmental needs of children through sport depends on their capability to recruit and retain volunteer coaches that are motivated to upskill in order to acquire the necessary skills and also their ability to provide the high-quality training needed by coaches (Busser and Carruthrers, 2010). Retention of excellent youth sports coaches is important for sports organisations as the ability to be a good coach and contribute to youth development is an acquired skill (Gilbert and Trudel, 2001). Development of coaches in practical settings that includes knowledge, reflective practice and support is optimal (Jones and Turner, 2006). Better trained sports coaches produce better developmental outcomes for the children they coach (Conroy and Coatsworth, 2006; Caldwell et al., 2008).

Limited research is available specifically on the motivations of SO coaches. However, Siperstein et al. (n.d) conducted a national study of SO programmes in the U.S. reporting that 44% of coaches had a family member with an ID and 39% had a family member who was currently participating in SO sports programming. Further motivations to become a SO coach (35%) included occupational or educational background within the ID sector e.g. teaching special education, PE or care settings. Another perspective from the SO context, highlighted by Ives et al. (2021) which included commentary from the Sports Director of SO New Zealand, spoke about the ageing volunteer cohort, with the average age of coaches sitting at fifty-five years plus. The attrition rates of coaches were spotlighted as a grave concern with limited recruitment of coaches into SO clubs and lack of succession planning from clubs to replace coaches who step down (Ives et al., 2021). It appears that the main way to increase and further enhance the reach of participants within disability sport is through coach education and development. These findings and assumptions are further supported by research outlined in Chapter 7 of this thesis in which YA coaches discuss the need for improved coach education and support.

Chapter 3: Comparing the fundamental movement skill proficiency of children with intellectual disabilities and typically developing children: a systematic review and meta-analysis

Abstract

Children around the world, particularly those with intellectual disabilities (ID), are exhibiting poor motor skill proficiency. Compared with typically developing children (TDC), children with intellectual disabilities (CwID) are 65% more likely to exhibit low levels of motor competence. The purpose of this meta-analysis was to compare the motor skill proficiency levels, in terms of fundamental movement skills (FMS) of CwID to TDC. FMS are the building blocks required for lifelong participation in sport and physical activity. The meta-analysis was conducted according to PRISMA statement guidelines. 6 electronic databases were searched and 16, 679 studies were found. A total of 26 studies (total participants n = 3,525) met the inclusion criteria. A multivariate maximum likelihood multivariate random effects model was fitted to the data using the metafor package in R. The study showed that the standardized mean difference (Hedges' g) in FMS between TDC and CwID is large (g = 1.24; CI 95% [.87, 1.62]). Specifically, significant differences between the two groups emerged in all five outcomes: (1) total locomotor score, (2) total object manipulation score, (3) balance, (4) run skill and (5) throw skill. Further investigation into effective intervention strategies is required in order to reduce the magnitude of difference in motor skill proficiency between the two groups. In addition to developing, implementing and evaluating these interventions, researchers need to work hand in hand with national governing bodies (NGB) of sport and policy makers to ensure that teachers and coaches are being provided with opportunities to upskill in the area of FMS.

Keywords: balance, children with intellectual disabilities, fundamental movement skills, locomotor skills, object manipulation skills

Introduction

The global definition of 'Motor Skill Proficiency' is reflective of a range of terminologies (e.g. motor skill performance, motor ability, motor coordination, fundamental movement skills, motor competence) that portray goal-directed human movement (Robinson et al. 2015; Logan et al. 2018; Laukkanen et al. 2020). Motor skill proficiency can be defined as the quality of a person's movement coordination and the level of their performance outcome when performing different movement skills (Robinson et al. 2015; Kavanagh et al. 2019). Fundamental movement skills (FMS) are one aspect of motor skill proficiency that has been commonly investigated in literature (Logan et al. 2017). FMS are the 'building blocks' required for taking part in exercise and physical activity (Behan et al. 2019). Clark (2005) defined FMS as 'gross motor skills that involve the large force producing muscles of the trunk, arms and legs' (p. 245). They do not develop naturally but are rather learned or practiced (Barnett et al. 2016). It is important that children are given opportunities to practice, learn and reinforce these skills (Goodway & Branta 2003; Valentini & Rudisill 2004; Clark 2005). FMS are the gateway to more advanced movement skills that are required for games, sports, and physical activity (Logan et al. 2018). Having a solid foundation in FMS is an important contributing factor to physical activity participation and, in turn, to receiving exercise-induced health benefits (Lubans et al. 2010; Holfelder & Schott 2014; Hulteen et al. 2018), in addition to facilitating children's cognitive development (Piek et al. 2008). Piek et al. (2008) found that working memory and information processing speed could be predicted by infants' early gross motor development. Previous research identified a relationship between motor skill ability, working memory and information processing speed in school-going children (Piek 2004a,b).

It is recognised that typically developing children (TDC) have the potential to master FMS between 6 and 10 years of age (Gallahue & Ozmun 2006; Hardy et al. 2010). Unfortunately, increases in sedentary time and lack of physical activity participation directly impact the development of FMS with evidence showing, in many countries around the world, that TDC are failing to perform age appropriate FMS proficiency: Singapore (Mukherjee et al. 2017), UK (Lawson et al. 2021), Canada (LeGear et al. 2012) and Ireland (Behan et al. 2019). The role of the specific subcategories of FMS are important to consider to further untangle the relationship between cognitive function and motor skill proficiency.

There are three categories of FMS: (1) object manipulation skills, which involve the manipulation and projection of objects (e.g. underhand throw, overhand throw, catching, kicking, dribbling); (2) locomotor skills, which require the body to move through space (e.g. running, walking, skipping, jumping, hopping); and (3) balance skills (e.g. single leg balance, twisting, bending) (Barnett et al. 2016; Logan et al. 2018). Over the last decade, there have been numerous studies (Simons et al. 2008; Gkotzia et al. 2017; Maïano et al. 2019b) carried out comparing the FMS proficiency levels of children with intellectual disabilities (ID) with TDC. Compared with TDC, children with ID are 65% more vulnerable to having lower competence in FMS (Gkotzia et al. 2017). The results display that children with ID present with lower motor skill proficiency and reduced ability to perform FMS when compared with TDC of the same age (Simons et al. 2008; Gkotzia et al. 2017; Maïano et al. 2019b).

Children with ID exhibit delayed achievement in motor milestones (Jeoung 2018), with impairments in sensorimotor function, motor development delays, movement control deficiencies, motor sequencing deficits, low concentration levels and poor comprehension (Uyanik et al. 2003; Piek et al. 2012; Jeoung 2018). This affects their locomotor (Hartman et al. 2010; Westendorp et al. 2011a), object manipulation (Simons et al. 2008; Rintala & Loovis 2013) and balance skills (Gallahue et al. 2012), which influences their activities of daily living, sports, physical activity and recreational activities. Poor motor skill proficiency exhibited by children with ID is also accredited to the impairment of their intellectual functioning seen by Jeoung (2018) who found that compared with children with moderate ID (IQ = 38.9), children with mild ID (IQ = 58.7) or borderline ID (IQ = 68.8) scored significantly higher in their total motor composite score. Those results indicate a relationship between the level of ID and motor skill proficiency. In addition, low levels of motor skill proficiency hinders children with ID in their social, psychological and physical development, resulting in negative health outcomes (Frey & Chow 2006; Westendorp et al. 2011b).

Research carried out by Hartman et al. (2010), Westendorp et al. (2011a) and Zikl et al. (2013) compared the FMS of children with borderline and mild ID to TDC of the same age using the Test of Gross Motor Development (TGMD-2). The TGMD-2 is an assessment tool that is considered to be the gold standard for measuring FMS, ensuring a true representation and accurate reflection of the locomotor and object control components of the FMS. All three studies found that the locomotor and object control skills of children with ID were significantly lower than their typically developing peers, with large effect sizes for children with a mild ID and moderate to large effect sizes for children with a borderline ID (Westendorp et al. 2011a). For both ID groups, the object control skill results were relatively lower than the locomotor skills tested, showing that even with borderline ID, object control performance is affected (Westendorp et al. 2011a). A closer look at the literature shows a shortcoming in the methodology of the above studies. The authors failed to measure the FMS of balance as part of their FMS assessment battery, despite the literature indicating balance is an area of weakness for children with ID (Palisano et al. 2001; Capio & Rotor 2010). They display lower motor skill proficiency compared with TDC, particularly in the area of balance; as a result of the FMS deficits, they experience as a population (Capio et al. 2017).

Maïano et al. (2019b) recently published a systematic review with a broad research question, examining the FMS of children and adolescents with ID. More specifically, these authors focused on mastery, deficits and developmental delays in FMS, as well as the correlates of FMS among this population. Although their review provided some valuable insights, there are still some limitations that need to be addressed. Firstly, only a section of the review, composed of six studies, was dedicated to comparing the motor skill proficiency levels of children with ID to TDC. As a result, the review only shows a snapshot of the breadth of research available in this area. Thus, the findings of all studies comparing motor skill proficiency between these groups have not previously been synthesised and summarised using quantitative methods to give a precise estimate of the magnitude of difference. This limitation presents difficulties for the readers in terms of interpreting results and deriving firm conclusions. The precise estimate of the magnitude of difference increases the accuracy of results and conclusions by increasing participant numbers, provides readers with an objective appraisal of the evidence and guides intervention development.

Secondly, the majority of studies included in the systematic review by Maïano et al. (2019b) exclusively focused on specific FMS assessed within the TGMD (Ulrich 2000) to include locomotor and object manipulation skills. As a result of this, the subcategory of balance was not comprehensively examined. Thus, it is possible that the researchers overlooked studies focusing on all subcategories of FMS and those involving alternative motor and movement batteries. As a result, the performance of children with ID compared with TDC in the FMS dimension of balance was not sufficiently investigated.

Based on the aforementioned limitations, which demonstrate the need for further and more advanced analysis comparing motor skill proficiency between children with ID and TDC on a macroscopic level, the main objective of this meta-analysis is to establish a statistical significance across studies in the field of ID research in order to ensure generalisability of results for researchers and practitioners. Generalisability of results would not have been previously possible due to the inconsistencies in FMS assessment tools used across studies in the field and the smaller participant sample sizes. In addition, we want to quantify the direction, the magnitude and its precision (confidence intervals) of the effect between children with ID and TDC, as well as find out if there are study and participant-related variables that might moderate the size of the standardised mean difference. The findings will provide sports coaches, physical education (PE) teachers and policymakers with more reliable and valid evidence. Such findings will in turn influence the development and modification of current practices and policies in this domain. Similarly, the moderators between FMS proficiency and ID level have not been previously synthesised, which potentially has important implications for the design of FMS interventions for children with ID. Therefore, the aim of this study was to synthesise and meta-analyse evidence from cross-sectional, experimental and longitudinal studies comparing the motor skill proficiency level of children with ID and TDC aged 4–12 years.

Method

Literature search

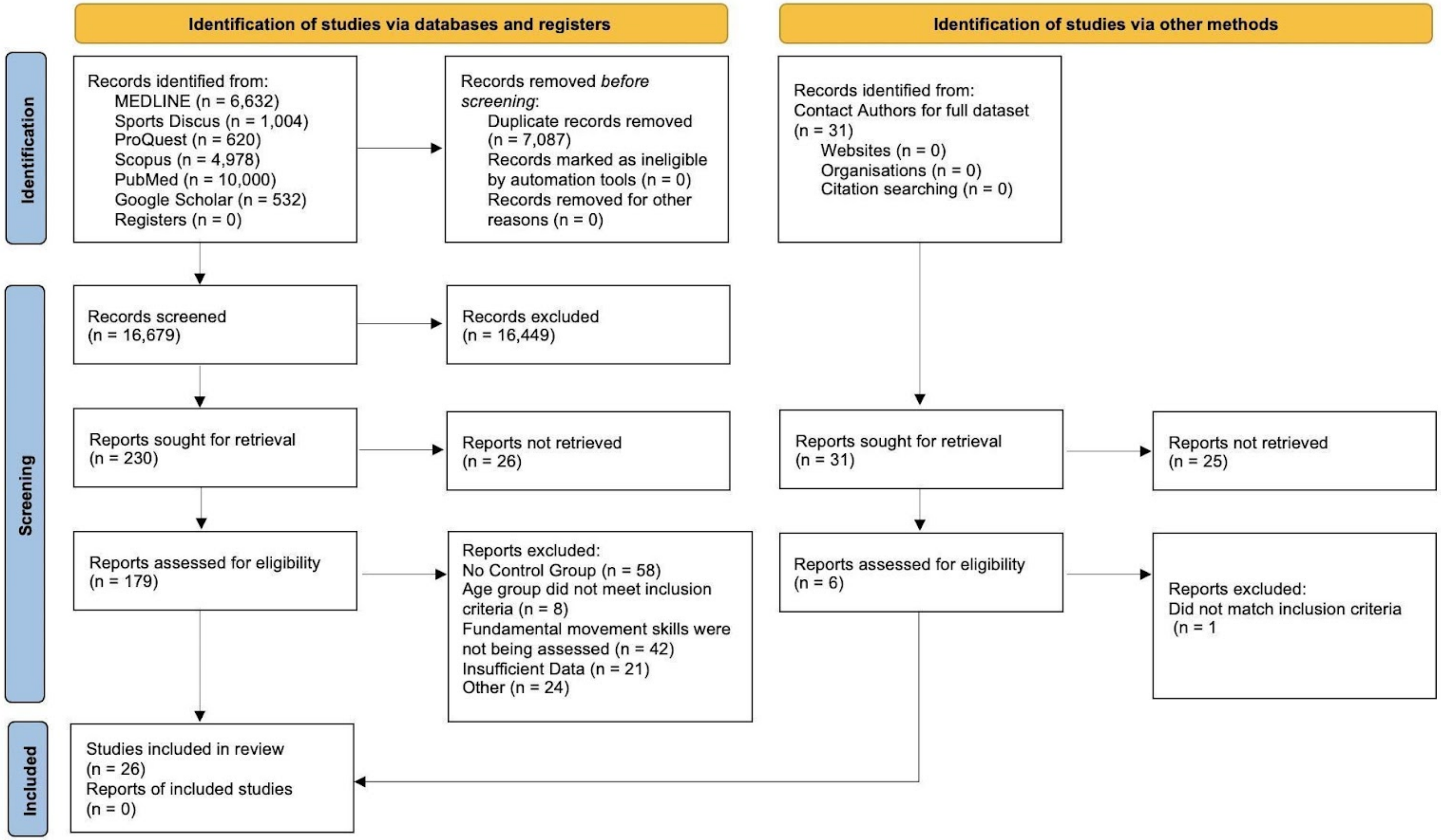
The meta-analysis was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) statement guidelines (Moher et al. 2015). This meta-analysis was pre-registered on Open Science Framework. The articles used in this meta-analysis were conducted before September 2021. Six electronic databases were searched: MEDLINE, Sport Discus, ProQuest, Scopus, PubMed and Google Scholar. The authors of

the study gathered the articles from these databases using different combinations of keywords, such as intellectual disability, developmental disability, intellectual impairment AND fundamental movement skill, motor skill proficiency, movement skills and gross motor skills. The complete Boolean search string is listed in Supplementary Table 3.4

Firstly, 16,679 articles including published, unpublished, Doctoral dissertations and conference presentations found were uploaded in RIS reference format to the software Covidence (Covidence systematic review software). At this point, all duplicate publications were removed. After this, each article found was scanned independently by the title and abstract by two of the study authors. Each article that was carried forward was finally fully reviewed by the same authors.

In addition to the database search, the authors reviewed the reference lists of all studies included in the quantitative analysis as well as every relevant review article found. Lastly, we tried to identify unpublished research and missing data by contacting individual authors of the articles that were included in the qualitative analysis via email or via the website ResearchGate. The authors were contacted a maximum of three times with a 2-week time between the contact efforts.

Figure 3.1 PRISMA flow diagram for the identification, screening, eligibility and inclusion of studies.



Inclusion and exclusion criteria

The inclusion criteria for this meta-analysis were as follows: (1) Study design: cross-sectional, longitudinal and experimental studies. (2) Participant characteristics: children with ID including those with borderline ID, mild ID, moderate ID, developmental disability and Down syndrome and those with a dual diagnosis of ID and/or autism spectrum disorder, attention deficit hyperactivity disorder (case) and TDC (comparison). All participants had a mean age between 4 and 12 years. (3) Outcome measurements: motor skill assessment tests used to measure FMS and/or at least one of the following FMS categories of (a) object control skills, ball skills or manipulative skills (e.g. catching, kicking, throwing), (b) locomotor skills (e.g. running, hopping, jumping) and (c) balance or stability skills (e.g. single leg balance). (4) Publications written in English. The exclusion criteria were as follows: (1) Study design: qualitative and review papers. (2) Participant characteristics: youth aged 13 years plus and adults. Participants with an ID in addition to presenting with additional diagnostic criteria such as cerebral palsy, ADHD, dyspraxia, physical disabilities and visual impairments were excluded on the basis that these additional cognitive, behavioural and/or physical conditions could influence participants motor performance. (3) Outcome measurements: motor skill assessment tests used to measure physical fitness (e.g. endurance, flexibility, strength) or fine motor skills (e.g. manual dexterity, bilateral co-ordination).

Study Selection

Together, all the different search strategies identified 23,766 studies, of which the first and the second authors initially fully reviewed 16,679 papers, after 7,087 duplicates were removed. Out of these papers, 230 were included for further screening. One hundred and seventy-nine papers were deemed eligible for full-text review. All the conflicts were resolved by discussion. In the case of two studies with incomplete reporting of standard deviations or errors, we calculated the standard deviations as the means of the standard deviations that were retrieved. In total, 26 articles were carried to the quantitative analysis. Data extraction was completed in dependently by two of the study authors. The complete flowchart representing the study selection process is provided in Figure. 3.1.

Effect size calculation

We computed the standardised mean difference with heteroscedastic variances between the TDC and children with ID by subtracting the ID group mean values from the TDC group means and by pooling the standard deviations of the two groups by taking the square root of their mean variance (Bonett 2009). The positive bias in the standardised mean difference was corrected, resulting in Hedges' g effect sizes (Hedges 1981). In the studies that had several measurement points, the statistics of the first time point was used. TDC performed better than children with ID, resulting in a positive effect size. Cohen's (1988) criteria of small (.2), medium (.5), and large (.8) were used to estimate the magnitude of the effects.

Selection and coding of moderators

A moderator selection based on reason and relevant literature was conducted to explain the expected variation in the effect sizes. A total number of three moderators were categorised as the ID categories (Down syndrome, mild ID, ID and mixed group, meaning those who had an ID and another condition, e.g. ID and autism spectrum disorder), age, IQ and study quality measured by a modified JBI checklist (Moola et al. 2020) for correlational studies (see Supporting Information for additional tables). The agreement of moderator coding between the raters was initially high [2, 17198 = .93, $z = 76.6$, $p < .001$, 95% CI = [.89, .96]; rough percentage agreement = 92.9%). The differences in coding were reconciled via a discussion before the analyses.

Statistical Analysis

A multivariate maximum likelihood multivariate random effects model (Berkey et al. 1998) was fitted to the data using the metafor package (Viechtbauer 2010) in R (version 4.1.0) (R Core Team 2018). The selected modelling approach considers possible non-independence of the effect sizes by including a random effect for each effect size within a study and using a variance–covariance matrix in the model. In this study, this dependence resulted from several comparisons within studies and multiple effects sizes coming from a same study.

The between outcome correlations required for the variance–covariance matrix were derived from the study by Behan et al. (2019) with almost 2000 participants.

However, as the precise amount of dependence of the effects was unknown, a robust variance estimator from the club Sandwich package was applied to improve the accuracy of the estimates (Pustojevsky & Tipton 2022). We modelled the standardised mean differences together for balance, locomotion and object skills and for run and throw skills as the run and throw scores were part of the locomotion and object total scores in some studies.

The standard parameters tau^2 and I^2 were computed to examine the between-study heterogeneity of the true standardised mean differences (Higgins et al. 2003; Jackson et al. 2012). Additionally, a likelihood ratio test examining the effect of tau2 on all the outcomes was used as an indicator of significant between study heterogeneity.

A between study heterogeneity of the mean estimates was specified if the likelihood ratio test ($\chi 2$) reached a significance level of $p < .05$, and the sampling error contributed to the observed total variance less than 75% (Hedges & Olkins 1985; Lipsey & Wilson 2001). The precision of effect sizes was indicated by 95% CIs.

The selected moderators were used in a linear regression analysis as univariate categorical or continuous independent variables in order to explain the heterogeneity of the mean differences. To detect publication bias, we used a modification of the Egger's test (Egger et al. 1997) using the standard error of the observed outcomes as a predictor in a multivariate model. Furthermore, we visually examined the normal and contour enhanced funnel plots to detect asymmetry and potential publication bias. Lastly, the influential studies and effects were located using Cook's distances and the existence of outlier studies and effects were determined by analysing the distribution of studentised residuals (Viechtbauer & Cheung 2010).

Results

Study characteristics

In total, 91 effects from 26 studies were analysed for six outcomes: total FMS (k = 11), locomotor skills (k =23), object manipulation skills (k = 22), balance (k = 17), run skill (k = 9) and throw skill (k = 9). The total number of participants in the experimental group (children with ID) was 1,232 (sample size ranged from 7to 156) and 2, 293 in the control group (TDC) (sample size ranged from 14 to 977). The average percentage of male participants in the ID group was 65%, whereas in the TD group it was 64%, with four studies not reporting gender distribution. In the 25 studies with the detailed ages of the participants, the weighted mean age for TDC was 8.21 years, and for children with ID was 8.15 years. Eighty per cent of the studies were cross-sectional by design. The most frequently used FMS tools to measure locomotor and object manipulation skills were the Test of Gross Motor Development (TGMD) (n = 15) and the MABC (n = 2), whereas for balance it was the BOT (n = 4) or a variation of a single leg stand (n = 4). Thirteen of the studies were conducted in Europe, eleven in the USA and two in Asia. The full details of the independent studies are listed in Table 3.1.

Table 3.1 Study Characteristics Table

Study	Country	Design	Gross Motor Assessment Tool	FMS Assessed	Sample Size ID	% Males ID	Age ID	ID Type	Sample Size TD	% Males TD	Age TD
Alesi,2018	Italy	CS	TGMD	Loco & OM	18	50%	9.32 ± 6.1	Mild ID	18	50%	9.28 ± 8.1
				Loco & OM	18	72%	8.22 ± 2.82	DS			
Bruiniks, 1977	USA	CS	BOT	Bal	55	69%	9.25	Mild ID	55	69%	9.25
Capio, 2018	Hong Kong	CS	TGMD-2	Loco & OM	20	60%	7.10 ± 2.90	DS	20	80%	7.25 ± 2.5
Craig, 2018	Italy	CS	MABC-2	Bal	42	76.20%	4.8 ± 1.3	ID	43	62.80%	4.6 ± 1.5
				Bal	46	82.60%	4.6 ± 1.1	Mixed (ASD + ID)			
Folsom-Meek, 1987	USA	CS	BOT	Bal	20	100%	8-11	ID	20	100%	8-11

Golubović, 2012	Serbia	CS	Flamingo Balance Test	Bal	42	Not stated	8.6 ± 1.89	Mild ID	45	Not stated	8.6 ± 1.89
Hartman, 2010	Netherlands	CS	TGMD2	Loco & OM	97	58%	9.76 ± 1.50	Mild ID	97	58%	9.76 ± 1.50
Howe, 1959	USA	CS	Balancing on one foot	Bal	43	72%	6-12	ID	43	72%	6-12
Jung, 2017	USA	CS	TGMD2	Loco & OM	32	59.40%	4.25 ± 0.66	Mixed (DD)	28	57.10%	4.25 ± 0.66
Le Blanc, 1977	USA	CS	Cratty SCGMT	Bal	25	Not stated	12.32 ± 2.07	DS	25	Not stated	12.33 ± 1.99
Lejčarová, 2009	Czech Republic	CS	One Leg Standing Endurance Test (eyes closed)	Bal	139	56.30%	10.62 ± 0.56	Mild ID	14	85.70%	10.62 ± 0.56
Majistro, 2018	Italy	LG	TGMD3	Loco & OM	98	72%	8.28 ± 1.98	Mixed (ID, ASD, ADHD)	977	50%	8.68 ± 1.84

Merhamn, 1983	USA	CS	Southern California Perceptual-Motor Tests (SCPMT)	Bal	17	Not stated	7	Mild ID	20	Not stated	7
Pitchford, 2021	USA	CS	TGMD3	Loco & OM	22	55%	6.41 ± 2.01	ID	22	55%	6.41 ± 2.01
Rider, 1983	USA	CS	Stork Stand	Bal	31	65%	7.63 ± 1.02	ID	31	52%	7.41 ± 1.27
Rintala, 2013	Finland	CS	TGMD2	Loco & OM	20	65%	9.5	ID	20	60%	9.5
Schott, 2014	Greece	CS	TGMD2 & MABC-2	Loco & OM	18	61%	9.06 ± 0.96	DS	18	61%	8.99 ± 0.93
Smith, 1990	USA	E	TGMD, Jump & Throw	Loco & OM	7	26%	9.4 ± 1.30	ID	18	62%	7.5 ± 0.63
Sretenović, 2019	Serbia	CS	BOT2	Bal	15	100%	7.8	ID	23	100%	7.8

Staples, 2021	USA	E	TGMD3	Loco & OM	13	54%	5.09 ± 0.68	DS	35	60%	5.63 ± 0.33
Wang, 2002	China	E	BOT	Bal	20	55%	4.6 ± 1.0	DS	30	60%	4.3 ± 0.9
Westendorp, 2014	Netherlands	LG	TMGD2	Loco & OM	35	Not stated	9.5 ±1.2	Mild ID	253	49%	9.5 ±1.2
Westendorp, Hartman 2011	Netherlands	CS	TMGD2	Loco & OM	104	66%	10.1 ± 1.4	Mild ID	104	59%	10.1 ± 1.4
Westendorp, Houwen, 2011	Netherlands	CS	TMGD2	Loco & OM	156	66%	9.55 ±1.45	Mild ID	255	54%	9.7 ± 1.3
Woodard, 2001	USA	CS	TGMD	Loco & OM	22	55%	6-8	Mild ID	22	55%	6-8
Zikl, 2013	Czech Republic	CS	TGMD	Loco & OM	57	60%	11.05	Mild ID	57	61%	10.46

CS, Cross sectional; E, Experimental; LG, Longitudinal; TGMD, Test of Gross Motor Development; MABC, Movement Assessment Battery for Children; BOT, Bruininks-Oseretky Test of Motor Proficiency; Loco, Locomotor; OM, Object Manipulation; Bal, Balance; ID, Intellectual Disability; DS, Down Syndrome; ASD, Autism Spectrum Disorder; DD, Developmental Disability; ADHD, Attention Deficit Hyperactivity Disorder; TDC, Typically developing children.

Standardised mean difference in motor skill proficiency

The observed mean estimates of 17 effects for balance ranged from .16 to 3.76, with 94% of the effects favouring the TD group (see Fig. 3.2). Based on the multivariate model, the standardised mean difference between the TD and ID groups for balance was 1.26 (CI 95% [.52, 1.99], $t = 3.79$, $p = .004$). The difference was strongly heterogeneous ($\chi 2(1) = 67.24$, $p < 0.001$, $tau^2 = 0.99$, $I^2 = 92.76\%$).

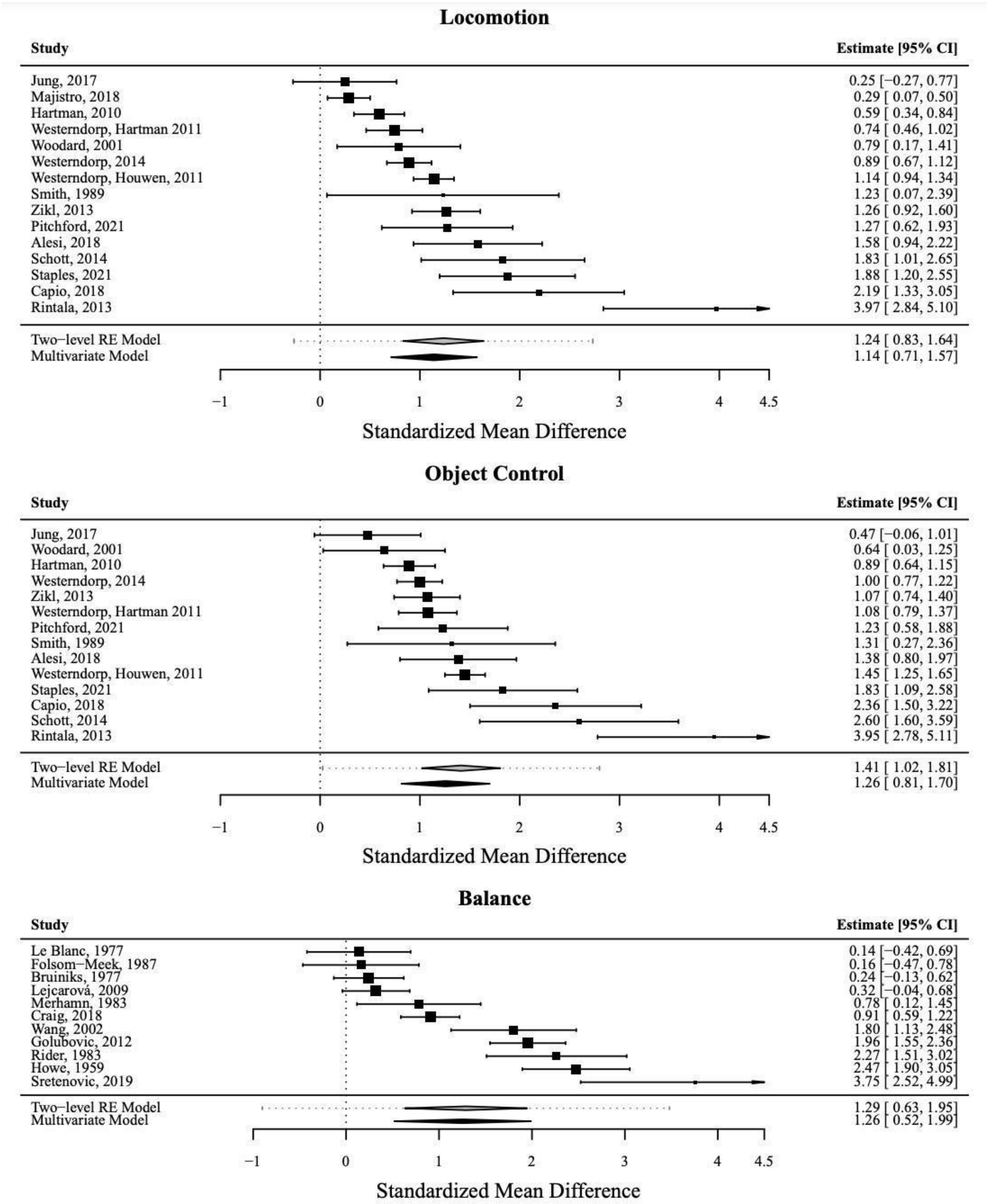
For locomotion skill, the mean outcome estimates of 23 effects ranged from .09 to 4.87 with 100% of the effects favouring the TDC. The standardised mean difference based on the multivariate model was 1.14 (CI 95% [.71, 1.57], $t = 5.68$, $p = <.001$. The mean estimate was strongly heterogeneous ($\chi 2(1) = 50.56$, $p < 0.001$, $tau^2 = 0.48$, $I^2 = 93.50\%$).

For object manipulation, the outcomes of 22 effects ranged from .09 to 4.87 with 100% of the effects having a positive estimate. The standardised mean difference based on the multivariate model was 1.26 (CI 95% [.81, 1.70], $t = 6.09$, $p < .001$). The estimated standardised mean difference was strongly heterogeneous ($\chi 2(1) = 29.33$, $p<0.001$, $tau^2 = 0.50$, $I^2 = 92.50\%$).

For the run skill, the estimates of nine effects ranged from .07 to 3.89 with all the effects favouring the TD group. The multivariate model indicated that the standardised mean difference between the groups was .86 (CI 95% [.33, 1.39], $t = 3.99$, $p = .008$. The standardised mean difference was strongly heterogeneous ($\chi 2(1) = 50.88$, $p < 0.001$, $tau^2 = 0.21$, $I^2 = 89.49\%$).

The observed standardised mean differences for throw skill of nine studies ranged from .11 to 3.11 with all outcomes measures being positive. According to the multivariate model, the standardised mean difference between the TD and ID children was .89 (CI 95% [.02,1.75], $t = 2.51$, $p = .046$). The estimate of the standardised mean difference was 15 heterogeneous ($\chi 2(1) = 24.92$, $p=0.0195$, $tau^2 = 0.68$, $I^2 = 96.28\%$).

Figure 3.2 Forest plots with an aggregated two-level RE model and a Multivariate model displayed

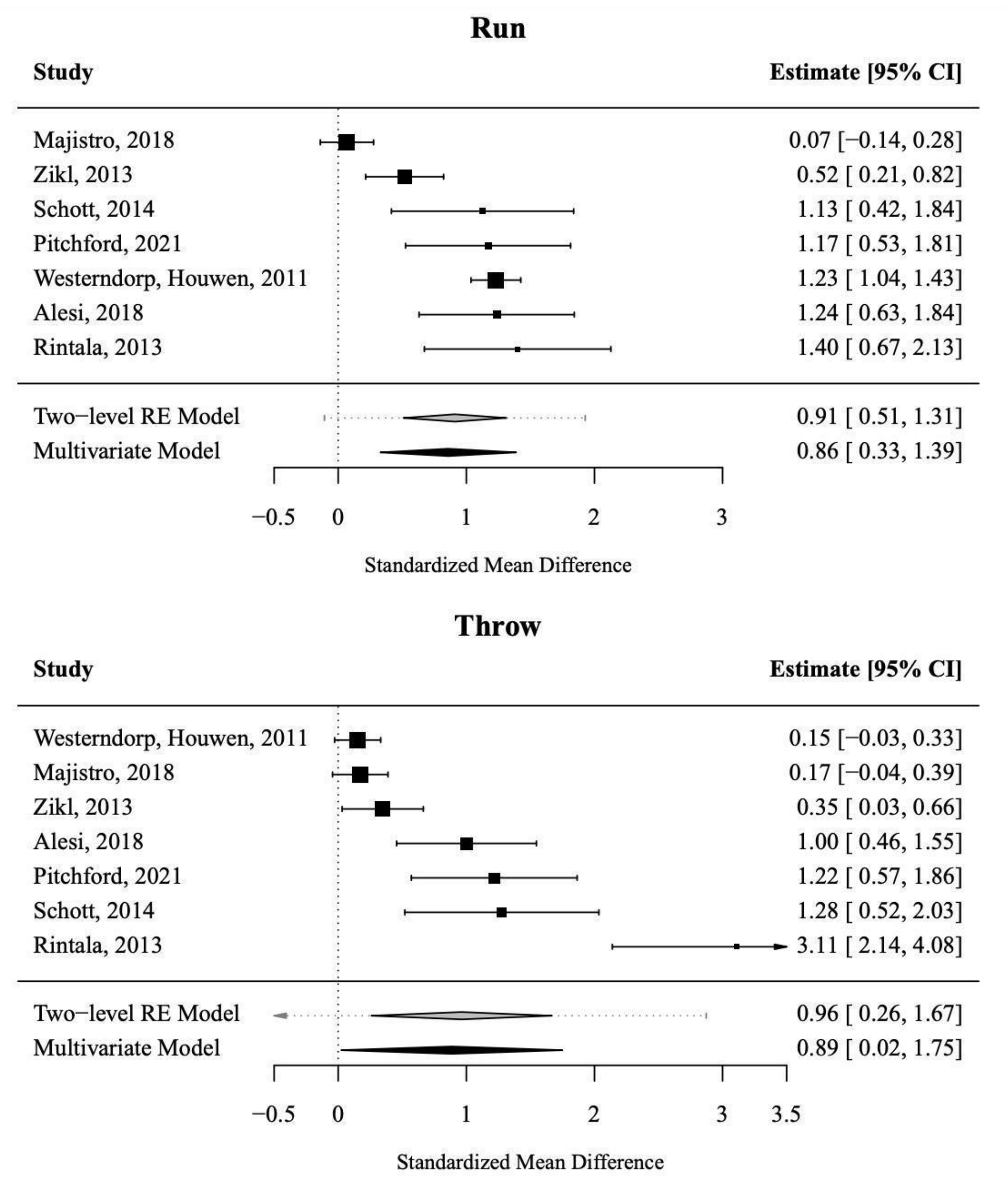


Moderator Analysis

Due to high significant likelihood ratio tests and high I^2 values for all the outcomes, we pursued to explain the between-study variability using two categorical and four continuous moderators in multivariate meta-regression analyses. Based on the analyses, the standardised mean differences in locomotion skill were larger between children with Down syndrome and TDC compared to the difference between TDC and children categorised as mixed (t = -4.298, p = 0.35), Furthermore, for run skill, the difference between children with Down syndrome and TDC was larger compared with the difference between TDC and children with mild ID y (z = -4.44, p <.001), ID (z = 1.98, p =.0475), and children categorized as mix (z = -3.72, p <.001). For throw skill, the difference in skill between children with Down syndrome and TDC was larger compared with the difference between TDC and children with mild ID (z = -6.05, p <.001) and mix (z = -5.65, p <.001). Similarly, the difference between TDC and children with ID in throw skill was larger than the difference between TDC and children with mild ID (z = -5.71, p <.001) and mix (z = 5.47, p <.001) see Fig. 3.3).

Regarding the continuous moderators, the IQ of the children with ID moderated the effect between the TDC and children with ID with higher IQ reducing the difference between the groups (β = -0.017. t = -4.65, p= .015). Lastly, for the difference in run skill, the age difference in the two groups moderated the effect size with studies having older typically developing than children with ID, yielding larger standardised mean differences (β = 2.142. t = 4.25, p = .025). The full results of the moderator analyses are displayed in Supplementary Table 3.2 for categorical moderators and in Supplementary Table 3.3 for the continuous moderators.

Figure 3.3 Forest plots with an aggregated two-level RE model and a Multivariate model displayed



Discussion

Summary of evidence

The aim of this meta-analysis was to assess the quality and certainty of the evidence from cross-sectional, experimental and longitudinal studies comparing the motor skill proficiency level, in terms of FMS, of children with ID and TDC aged 4–12 years, whereas the secondary aim was to explore the moderators causing the variability in the outcomes (SMDs). This meta-analysis provides convincing quantitative evidence to support the hypothesis that children with ID have significantly lower motor skill proficiency levels than TDC with overall FMS score showing a very large effect size in the standardised mean difference ($g = 1.24$; CI 95% [.87, 1.62]) between the two groups. This means that whereas TDC are underperforming in FMS, children with ID are displaying even lower proficiencies than their typically developing peers.

These findings have two meaningful implications. Firstly, they demonstrate the vital importance of developing tailored interventions that meet the needs of children with ID to improve their FMS proficiency, knowing that there is a direct relationship with other constructs such as physical activity, health and overall quality of life. Secondly, the results demonstrate the need for a deeper understanding of FMS proficiency on an individual skill level basis with specific consideration of the skill complexity in relation to children ID levels.

The lack of motor skill proficiency among children with ID (Gkotzia et al. 2017; Maïano et al. 2019a) further emphasises the importance of developing, implementing and evaluating FMS interventions for this cohort.

In theory, PE classes are an optimal environment for children to learn, practise and reinforce their FMS (Lander et al. 2015). Globally, at the core of the primary school PE curriculum, the aim is to provide children with a baseline proficiency in FMS, in addition to providing knowledge and skills to engage in lifelong physical activity (Irish Primary School Physical Education Curriculum 1999; Australian Curriculum Assessment Reporting Authority 2014; European Education and Culture Executive Agency, Eurydice 2015). However, as demonstrated by the low FMS proficiency levels in this meta-analysis among both CwID and TDC, the impact of primary school PE on FMS proficiency is not sufficient. Research has highlighted some of the barriers faced for delivering quality PE in primary schools, including lack of teacher knowledge and confidence, importance level of PE as determined by the school/teacher, sports provision models that are not child-centred, lack of funding and facilities, lack of specialist PE teachers and lack of support from school management (Decorby et al. 2005; Morgan & Hansen 2008). A commonality among all of this research that is echoed by primary school teachers themselves is the lack of training and education provided to teachers on how to deliver PE, resulting in lack of confidence and knowledge (Decorby et al. 2005; Ma et al. 2021). This will provide children with activities where they would maximise learning opportunities and support children's skill acquisition process. This point is even more salient for those who work with children with ID considering that they may need additional support and assistance to develop their FMS. For example, Ma et al. (2021) found that teachers in primary and secondary schools have limited capacity to advance children's FMS due to lack of education in their initial training and gaps in professional development opportunities. This is relevant for both children with and without ID as all teachers undergo similar training and professional development. As a result, many children miss out on the opportunity to be taught FMS through targeted, developmentally appropriate motor skill programmes (Goodway & Branta 2003; Valentini & Rudisill 2004; Robinson & Goodway 2009) and leave primary school without having mastered the FMS (Okely et al. 2001; Lander et al. 2015).

As illustrated in the Results section, one of the key findings of this meta-analysis indicates that an area of weaknesses in motor skill proficiency for children with ID is object manipulation skills, with a large effect size seen in the standardised mean difference ($g = 1.21$) between children with ID and TDC. The results found in this study support the findings of previous literature by Zikl et al. (2013), Jung et al. (2017), Pitchford & Webster (2021) and ErginSıtkı & Özbek (2021), suggesting that this subcategory of FMS for this population is weaker in comparison with their locomotor skills. The results of the locomotor skills also indicated a large effect size ($g = 1.14$) between the two groups; however, as expected and in line with other studies, the standardised mean difference was not as large as with object manipulation skills. Research by Westendorp et al. (2011b) further compliments the results as they compared FMS scores between children with borderline and mild ID, which demonstrated that the children from the borderline group had a higher proficiency in locomotor skills; however, the children's proficiency in object manipulation skills was of a similar level. Therefore, it can be argued that even with lower severity of ID and higher cognitive function, proficiency in object manipulation skills is still significantly impacted.

Majority of studies included in this meta-analysis measured FMS proficiency as a whole or only observed one construct. Studies rarely focus on individual specific skills like throwing, catching, running and skipping. Therefore, a question still remains whether children with ID have poor proficiency in all FMS or only in the skills considered to be more complex.

To investigate this question within our results, further examination of individual differences in object manipulation and locomotor skills revealed that the skills of throw ($g = .88$) and run ($g = 0.85$) had large effect sizes in their standardised mean differences. Contrary to this, locomotor skills, described as 'simple skills', are less dependent on cognitive functioning and are more automatised (Bernstein et al. 1996). These results once again demonstrate that object manipulation skills are weaker compared with locomotor skills for children with ID, with their overall FMS proficiency being significantly poorer than their TD peers. This result corresponds with research by Jeoung (2013) who investigated object manipulation skill and performance level in students with varying degrees of ID and found that the skill of throwing (3.21 ± 0.15) showed the weakest proficiency of all of the object manipulation skills. A possible reason for the poor proficiency in object manipulation skills demonstrated by children with ID is because these motor skills are complex and can be described as 'open skills', which rely heavily on environmental factors including external objects and other players (Wall 2004; Westendorp et al. 2011b). Object manipulation skills are mastered during sports and play that demand rapid adaptations to changing environmental situations (Houwen et al. 2007) and involve more cognitive functions and processes (Planinsec 2002; Planinsec & Pisot 2006; ErginSıtkı & Özbek 2021). As previously discussed, children with ID experience deficits in cognitive functioning, thus indicating that due to the higher complexity of object manipulation skills and the extent to which cognitive processes are required to successfully execute and master these skills, this can account for the poor performance observed in this population (Planinsec 2002; Planinsec & Pisot 2006; Westendorp et al. 2011b; ErginSıtkı & Özbek 2021).

It can be argued that balance is another important construct of FMS, demonstrating low-performance outcomes as the results indicated that the largest effect size difference found in the standardised mean difference between children with ID and TDC was for balance skills (g= 1.26; CI 95% [.52, 1.99]). Gallahue et al. (2012) described balance skills as 'the most basic skills within the FMS family'. They are considered as the ability of the body to adapt appropriately to changes in the movement of body parts that alter a person's stability with compensating movements (Gallahue et al. 2012; Rudd et al. 2015). Few studies comparing the FMS proficiency of children with ID and TDC include balance, despite it being one of the three pillars of FMS; this is the key reason why we included studies focusing on balance in this meta-analysis. Our findings further strengthen the existing literature in which balance has also been highlighted as an area of FMS weakness for children with ID (Palisano et al. 2001; Capio & Rotor 2010). Sretenović et al. (2019) measured balance using the BOT assessment tool and found that TDC had a total balance score (dynamic and static) of 31.07 compared with children with ID who scored 11.34. Nikolić & Ilić-Stošović (2009) identified that 28.7% of TDC present with a balance disorder compared with 86.8% of Sretenović et al. (2019) sample of children with ID who presented with balance difficulties. Further emphasis needs to be placed on the importance of assessing balance in children with ID alongside locomotor and object manipulation skill scores. From the evidence found, there is a vital need to include balance skills for this population in future FMS interventions.

As discussed in the above methodology and results sections, large variation in the outcomes (or SMDs) was found within and between studies. Potential causes of the variations include relatively small number of studies included, gender distribution and age of participants of studies, methods used to assess FMS and description of ID. Despite these variations in studies, all results favoured the TDC with the overall conclusion being that children with ID have poorer motor skill proficiency levels than TDC, up to as much as 4 standard deviations (Rintala & Loovis 2013; 3.97 [2.84, 5.10]). To further investigate the findings and variations found, a univariate categorical moderator analysis was run on all outcomes to identify if any effects could be explained by specific moderator variables. From previous literature, the level of IQ is a variable of particular interest. We wanted to see if the level of IQ impacted FMS proficiency levels of children. Some individual papers included in this meta-analysis show differences in FMS proficiency depending on the level of IQ of the participants. On the contrary, once the robust variance estimators were applied to all the data available for this meta-analysis, the effects observed on FMS proficiency in individual papers were not observed for all outcomes. It was found that the level of IQ of participants was a statistically significant moderator only for locomotor skill proficiency (-0.017, $t = -4.65$, $p = 0.015$). This result indicates that as IQ level increases in the ID group, the difference in locomotor skill proficiency between the children with ID and TDC decreases. No significant difference for object manipulation or balance skills related to level of ID were found. A potential explanation for this is because not many of the included studies measured IQ and those that did use different IQ measurement tools. However, with this result and trends shown from previous literature, it can be gathered that there is potentially a positive association between level of ID and overall FMS proficiency and that IQ level does impact FMS proficiency of children with ID. These findings suggest a complex relationship exists between IQ and motor development. Further research is required to investigate this complex relationship and its impact on motor skill intervention planning and development.

In a review conducted by Gkotzia et al. (2017), it was concluded that the degree of ID, otherwise known as IQ level, negatively impacted the motor skill proficiency score of children. Four studies included in the meta-analysis have divided children according to their ID level into borderline (BID) and mild ID (MID) (Lejčarová 2009, Hartman et al. 2010, Westendorp et al. 2011b) and autism spectrum disorder (ASD) with ID (Craig et al. 2018). In all of these studies, the ID groups scored significantly lower than the TDC. Participants with MID scored lower on the locomotor skill subtest (36 ± 0.79/ 34.5 ± 0.61) and the object control test (34.73 ± 0.72/ 31.8 ± 0.56) compared with participants with BID who scored (38.09 ± 0.61/ 36.9 ± 0.41) and (35.53 ± 0.55/ 33.2 ± 0.51), respectively (Hartman et al. 2010, Westendorp et al. 2011b) using the TGMD assessment tool. Craig et al. (2018) used the MABC-2 to assess motor skill proficiency and found that children with ID scored significantly higher $P < 0.001$ in their overall test score (2.7 ± 1.4) compared with children with a dual diagnosis of ASD and ID (1.87 ± 1.2). Differences in balance scores between participants with BID and MID were investigated by Lejčarová (2009) who found a large effect size existed for the balance skill of 'Standing on one leg' for these groups; participants with MID scored significantly lower (7.55 ± 5.77) than those with BID (19.49 ± 12.94). To summarise, from the results displayed in the literature and those found in the meta-analysis, the level of IQ or degree of ID must be taken into consideration when designing, developing and implementing FMS interventions for children with ID.

Limitations

A limitation observed among all articles analysed in this meta-analysis is the inconsistent language and descriptions used to describe the participants with ID and their degree of ID. Many terms within the included studies such as learning disability, developmental delay, ID, mild ID, borderline ID, autism spectrum disorder and ID, mental and behavioural disorder, appeared to be used interchangeably across the studies. Although these terms can be used to describe ID without the level of IQ stated and different methods of assessing IQ used between studies, grouping participants according to degree of ID was difficult. The low number of papers and unclear reporting in some cases in the current field of research hindered the analyses as some of the moderators' analyses were underpowered to detect potential statistical differences relating to degree of ID and its impact on FMS proficiency level. This highlights the need for researchers to be as specific as possible when describing the participants included in their studies and their ability level. Future studies could benefit from defining the level of IQ of their participants or at least could be more precise in describing the ID groups. More accurate reporting of IQ is important for studies like this meta-analysis, as it allows for a deeper understanding and further discussions of the impact of IQ level on FMS proficiency.

Implications for research, practice and policy

To the authors knowledge, this study is the only meta-analysis to date that examines the differences in FMS proficiency between TDC and children with ID at a global level with a large sample size (n = 3,525). This study has extended the current evidence-base by providing researchers with a precise estimate of the magnitude of difference in FMS proficiency levels between children with ID and TDC (Hedges $g = 1.24$) for the first time and incorporates the latest state-of-the-art multivariate meta-analysis methods, and takes into meticulous consideration factors including ID categories, age, IQ and study quality. Generalisability of results would not have been previously possible due to the inconsistencies in FMS assessment tools used across studies in the field and the smaller participant sample sizes. The practical implications of this study, highlight the immediate need for developmentally appropriate FMS interventions for children with ID in the community setting to improve motor competence and close the skill proficiency gap between children with ID and their TD peers. A key focus for these interventions should centre around improving balance proficiency which was the largest FMS effect size difference found in the standardised mean difference between children with ID and TDC (g= 1.26). Similarly, the moderators between FMS proficiency and ID level have not been previously synthesised, which potentially has important implications for the design of FMS interventions for children with ID. The findings will provide sports coaches, PE teachers and policymakers with more reliable and valid evidence. Such findings will in turn influence the development and modification of current practices and policies in this domain particularly highlighting the need for national strategies to target the development of FMS amongst all children, not only in school settings but also in the community and at home. Aswell as demonstrating the importance of National Governing Bodies of Sport working alongside researchers for evidence-based development of FMS interventions that can be easily implemented and are sustainable for the target groups. Future research needs to assess the knowledge level of teachers and coaches working with children with ID, alongside evaluating the current continuous professional development opportunities available in the area of FMS.

Supplemental Information

Supplementary Table 3.1 PRISMA checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	1-5
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	6
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	6-7
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	7
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplemental File
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	7-8

Section and Topic	Item #	Checklist item	Location where item is reported
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	8-9
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	9-11
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	11-17
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	10-11
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	9-11
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Table 1.
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	10-11
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	13-14
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	9-11

Section and Topic	Item #	Checklist item	Location where item is reported
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	11,15
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Supplemental File
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	11
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	10-11, 15
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	6-8
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	8
Study characteristics	17	Cite each included study and present its characteristics.	11-14
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	10
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Figure 2. Figure 2.
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	9,11
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Table 2. Table 3.
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	11,15
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Supplemental File

Section and Topic	Item #	Checklist item	Location where item is reported
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	11
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	6,9
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	19-27
	23b	Discuss any limitations of the evidence included in the review.	27-28
	23c	Discuss any limitations of the review processes used.	27-28
	23d	Discuss implications of the results for practice, policy, and future research.	28-29
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Supplemental file
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Supplemental file
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	NA
Competing interests	26	Declare any competing interests of review authors.	NA
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Supplemental File

Registration Information

The title of this Meta-analysis was pre-registered on Open Science Framework on the 28/07/2021. The pre-registration link and protocol can be found here: 10.17605/OSF.IO/BYS8J

Data Availability

Data extracted from included studies can be accessed by emailing the corresponding author.

Supplementary Table 3.2 Categorical moderator analyses

Moderator	Balance		Locomotion		Object Control		Run		Throw	
ID	k	SMD (95% CI)	k	SMD (95% CI)	k	SMD (95% CI)	k	SMD (95% CI)	k	SMD (95% CI)
ID	9	1.392 (.19, 2.59)	10	1.304 (.28, 2.33)	10	1.326 (0.33, 2.33)	2	1.256 (.46, 2.05)[a]	2	1.8 (1.26, 2.34)[a]
Down	2	0.955 (-.70, 2.61)	5	2.402 (1.02, 3.78)[a]	5	2.463 (1.46, 3.47)	2	2.433 (1.58, 3.29)[b]	2	1.925 (1.36, 2.49)[a]
Mild	6	1.084 (-.67, 2.84)	6	0.586 (-.15, 1.32)	6	0.764 (.07, 1.46)	4	0.489 (-.04, 1.02)[a]	4	0.157 (-.01, .32)[b]
Mix	0		2	0.269 (.23, .31)[b]	1	0.494 (.46, .53)	1	0.07 (-.84, .98)[a]	1	0.172 (-.05, 0.39)[b]
Quality										
Low	3	1.538 (.24, 2.84)	0		0		0		0	
Intermediate	11	1.147 (.03, .2.27)	6	1.076 (.57, 1.59)	6	1.029 (.69, 1.37)	2	0.802 (-3.26, 4.87)	2	0.765 (-4.76, 6.29)
High	3	1.3334 (.55, 2.12)	17	1.18 (.52, 1.84)	16	1.365 (.67, 2.06)	7	0.882 (.03, 1.73)	7	0.937 (-.45, 2.32)

Note. ab = within a categorical moderator, mean estimates without a common superscript differ ($p < .05$)

Supplementary Table 3.3 Continuous moderator analyses

Moderator	Balance			Locomotion			Object Control			Run			Throw		
	β	t	sig.	β	t	sig.	β	t	sig.	β	t	sig.	β	t	sig.
Age	-0.182	-1.57	0.21	-0.072	-1.67	0.24	-0.207	-1.74	0.24	-3.458	-1.78	0.25	-3.96	-1.83	0.26
IDIQ	-0.033	-1.7	0.33	-0.017	-4.65	0.015	-0.007	-1.74	0.17	0.005	0.32	0.75	-0.001	-0.91	0.37
Gender imbalance	0.532	0.38	0.76	-3.93	-1.51	0.25	-3.61	-1.49	0.25	-12.15	2.53	0.17	-11.19	-2.76	0.19
TD older (y.)	-1.52	-2.15	0.25	1.477	1.34	0.29	1.255	1.51	0.26	2.142	4.25	0.025	2.064	3.98	0.12

Supplementary Table 3.4 Boolean List of Search Terms Used

	Intellectual disabilit* OR Intellectual disabilit* OR Intellectually disabled OR Mentally retarded OR Developmental disabilit* OR Developmental disabilit* OR Learning disabilit* OR Intellectual functio* OR intellectual impairmen*
AND	Basic motor skill* OR Movement skill* OR Motor abilit* OR Basic movement skill* OR Fundamental motor skill* OR Fundamental movement skill* OR Gross motor OR Gross motor skill* OR Gross-motor skill* OR Motor competenc* OR Motor coordination OR Motor skill* OR Motor proficienc* OR Motor development OR Motor performance OR Locomotor skill* OR Object control OR Manipulative skill* OR Balance OR Stability skill* OR Psychomotor performance OR Psychomotor test* OR Basic skills test OR Bruininks-oseretsky OR BOT OR Test of motor proficienc* OR CHAMPS motor skills protocol OR Cratty test OR Cratty gross-motor test OR Frostig movement skills battery OR Gross motor function measure OR Körperkoordinationtest für Kinder OR KTK* OR lincoln oseretsky test of motor proficiency OR lincoln oseretsky motor development scale OR lincoln adaptation of the oseretsky test of motor proficiency OR maastrichtse motoriek test OR McCarron assessment of neuromuscular development OR movement assessment battery for children OR MABC OR motoriktest für vier-bis sechsjährige kinder OR oseretsky motor development scale OR peabody developmental motor scales OR test of gross motor development OR TGMD

Selection and Coding of the Moderators

A moderator selection based on reason and relevant literature were conducted to explain the expected variation in the effect sizes. A total number of three moderators were categorized as the ID categories (Down-syndrome, Mild intellectual disability, Intellectual disability and Mixed group meaning those who had an intellectual disability and another condition eg. ID and Autism Spectrum Disorder), Age, IQ, and Study quality measured by a modified JBI checklist (Moola et al., 2020) for correlational studies.

The agreement of moderator coding between the raters was initially high (Cohen's kappa, [2, 198 = .93, z = 76.6, $p < .001$, 95% CI = [.89, .96]; rough percentage agreement = 92.9%). The differences in coding were reconciled via a discussion before the analyses.

Sensitivity Analyses

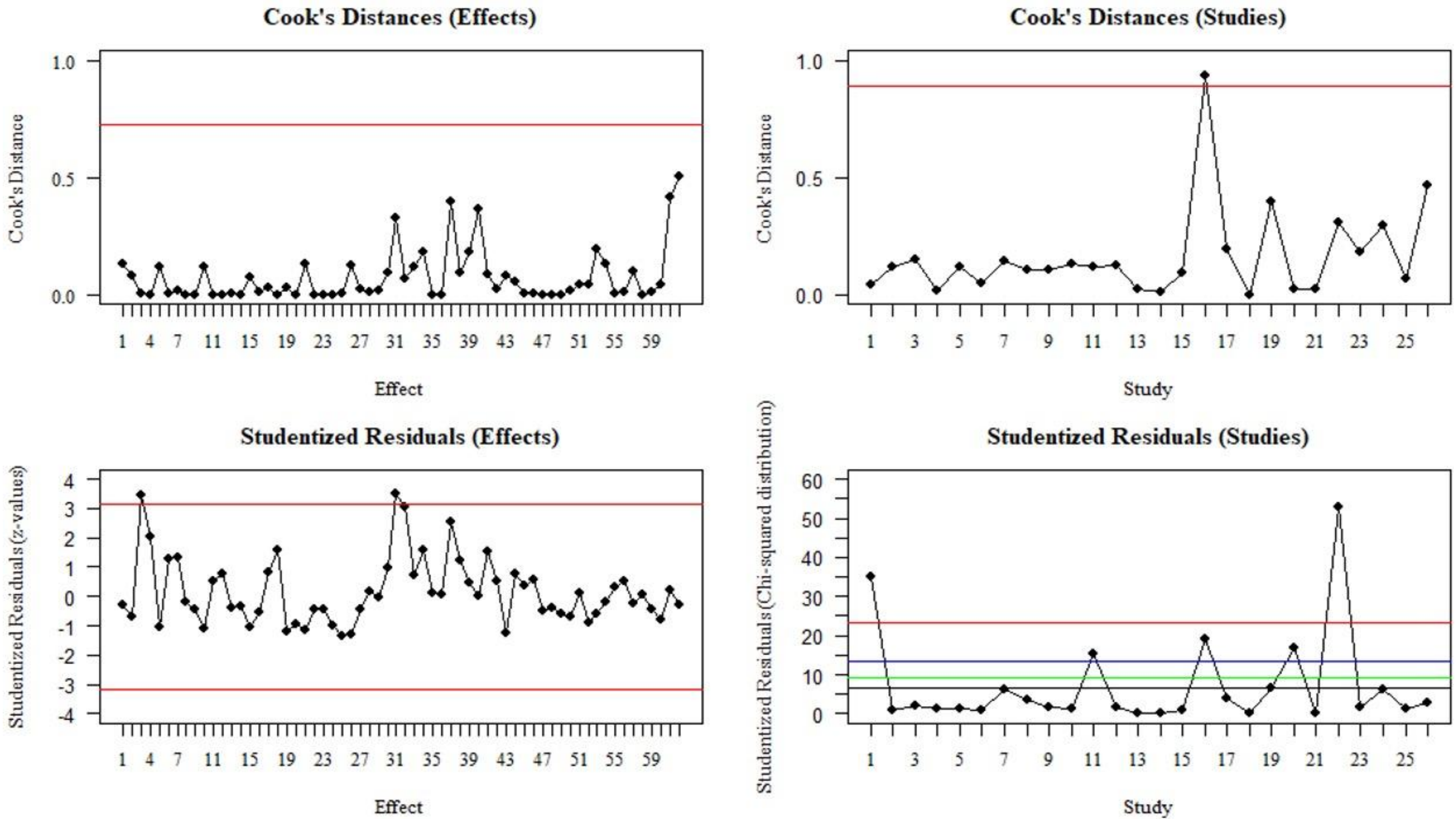
Sensitivity analyses were conducted based on Cook's distance (influential studies and effects) and studentized residual (outlier studies and effects) analyses and the study quality assessments. The Cook's distance and studentized residual analyses were done separately for a model including balance, locomotion, and object manipulation skill estimates and for a model including run and throw skill estimates. For the study quality sensitivity analysis, we formed a total quality score and excluded all studies that had a score between zero and two out of a maximum of five (high risk of bias).

For the model including balance, locomotion, and object manipulation skill estimates, no single effect was deemed influential. However, the mean differences in the study by Rintala and colleagues (2013) were influential at the study level. Moreover, the estimate between typically developing children and children with Down syndrome from the same study was an outlier effect based on studentized residuals together with an estimate comparing typically developing children and children with Down syndrome in the study by Alesi and colleagues (2018). Lastly, for this model, based on the studentized residuals, five studies could be considered to be outliers overall (Alesi et al., 2018; Lejcarova et al., 2009; Rintala et al., 2013; Staples et al., 2021; Westendorp et al., 2014).

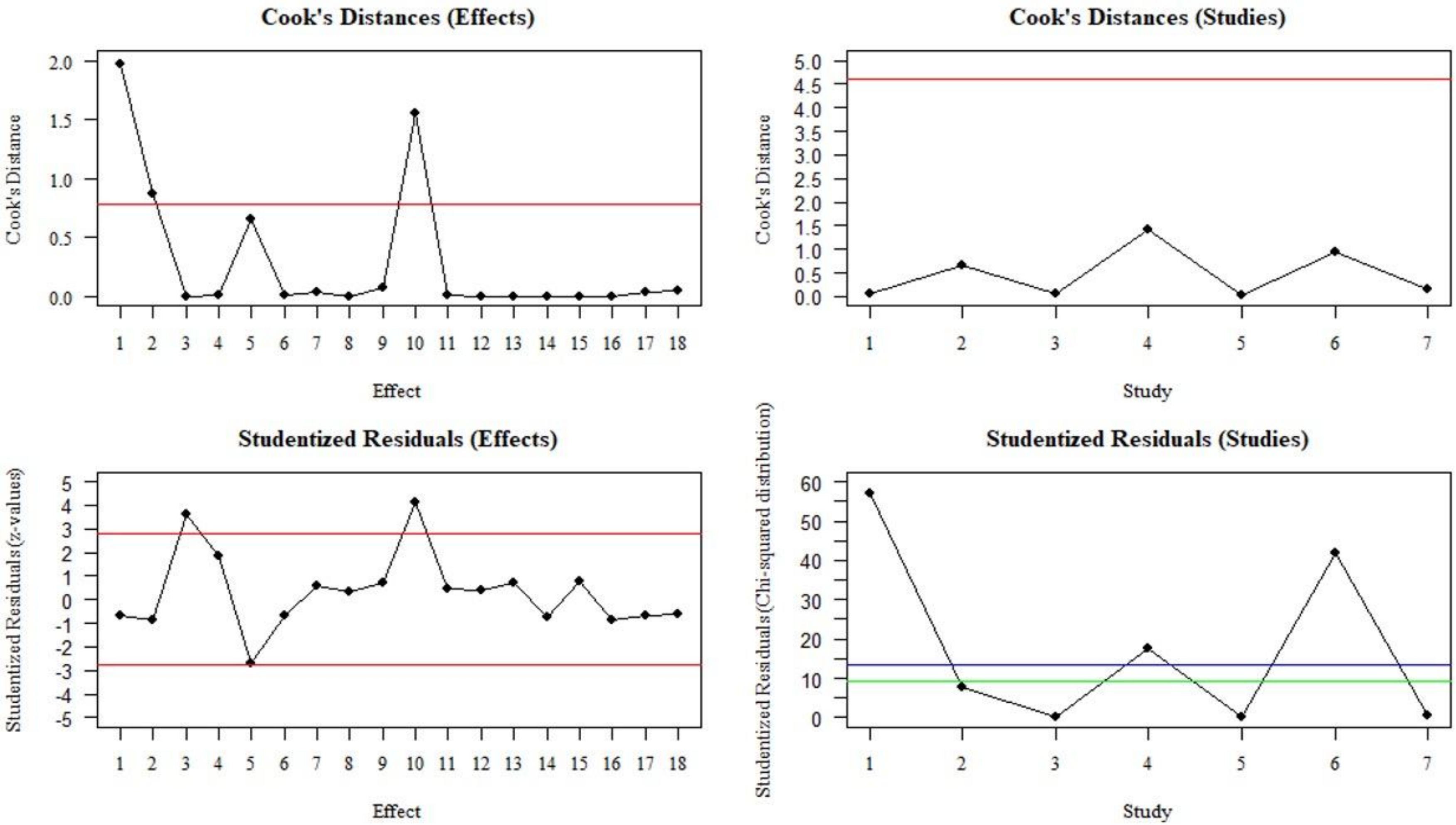
For the model including standardized mean differences in run and throw skill, four effects from the studies by Alesi and colleagues (2018) and Rintala and colleagues (2013) could be considered both influential and outlier effects. These effects were standardized mean differences between typically developing children and either children with Down syndrome or borderline intellectual disability. Lastly, based on the studentized residuals, three studies could be considered outliers overall (Alesi et al., 2018; Rintala et al., 2013; Westendorp et al., 2011).

Overall, the mean estimates are based on the sensitivity analyses except for run and throw skill differences when excluding the outlier studies from the analyses. The full results of the different sensitivity analyses are displayed in supplementary table 3.5 and the study quality assessment in supplementary table 3.6. The results of the influential and outlier effect and study diagnostic analyses are displayed in supplementary figure 3.1 and 3.2.

Supplementary Figure 3.1 Cook's distances and Studentized residuals for effects and studies (clustered). For Cook's distances, values exceeding the median plus six times the interquartile range are considered influential. For studentized residuals (effects), cut-off z-value is set at 3.16. For studentized residuals for studies, three chi-squared critical values are displayed (red line = studies with ten effects, blue line = studies with four effects, green line = studies with two effects and black line = studies with one effect).



Supplementary Figure 3.2 Cook's distances and Studentized residuals for effects and clustered for studies. For Cook's distances, values exceeding the median plus six times the interquartile range are considered influential. For studentized residuals (effects), cut-off z-value is set at 2.77. For studentized residuals for studies, two chi-squared critical values are displayed (blue line = studies with four effects, green line = studies with two).



Supplementary Table 3.5 Sensitivity analyses based on the influential and outlier effect/study diagnostic and study quality

Sensitivity analysis procedure	Balance		Locomotion		Object		Run		Throw	
	Hedges' g	95% CI	Hedges' g	95% CI	Hedges' g	95% CI	Hedges' g	95% CI	Hedges' g	95% CI
1. All studies included	1.26	[.52, 1.99]	1.14	[.71, 1.57]	1.26	[.81, 1.70]	0.86	[.33, .1.39]	0.89	[.02, 1.75]
2. Influential effects removed	NA	NA	NA	NA	NA	NA	1.26	[.29, 2.24]	0.9	[.03, 1.78]
3. Influential studies removed	1.26	[.52, 1.99]	0.95	[.66, 1.25]	1.07	[.77, 1.38]	NA	NA	NA	NA
4. Outlier effects removed	1.26	[.52, 1.99]	1.09	[.72, 1.46]	1.25	[.81, 1.68]	0.84	[.32, .1.35]	0.53	[.04, 1.01]
5. Outlier studies removed	1.36	[.58, 2.15]	0.98	[.59, 1.37]	1.14	[.76, 1.52]	0.68	[-.27, .1.63]	0.67	[-.16, .1.49]
6. Low quality studies removed	1.47	[.62, 2.33]	1.24	[.72, 1.77]	1.37	[.85, 1.89]	NA	NA	NA	NA

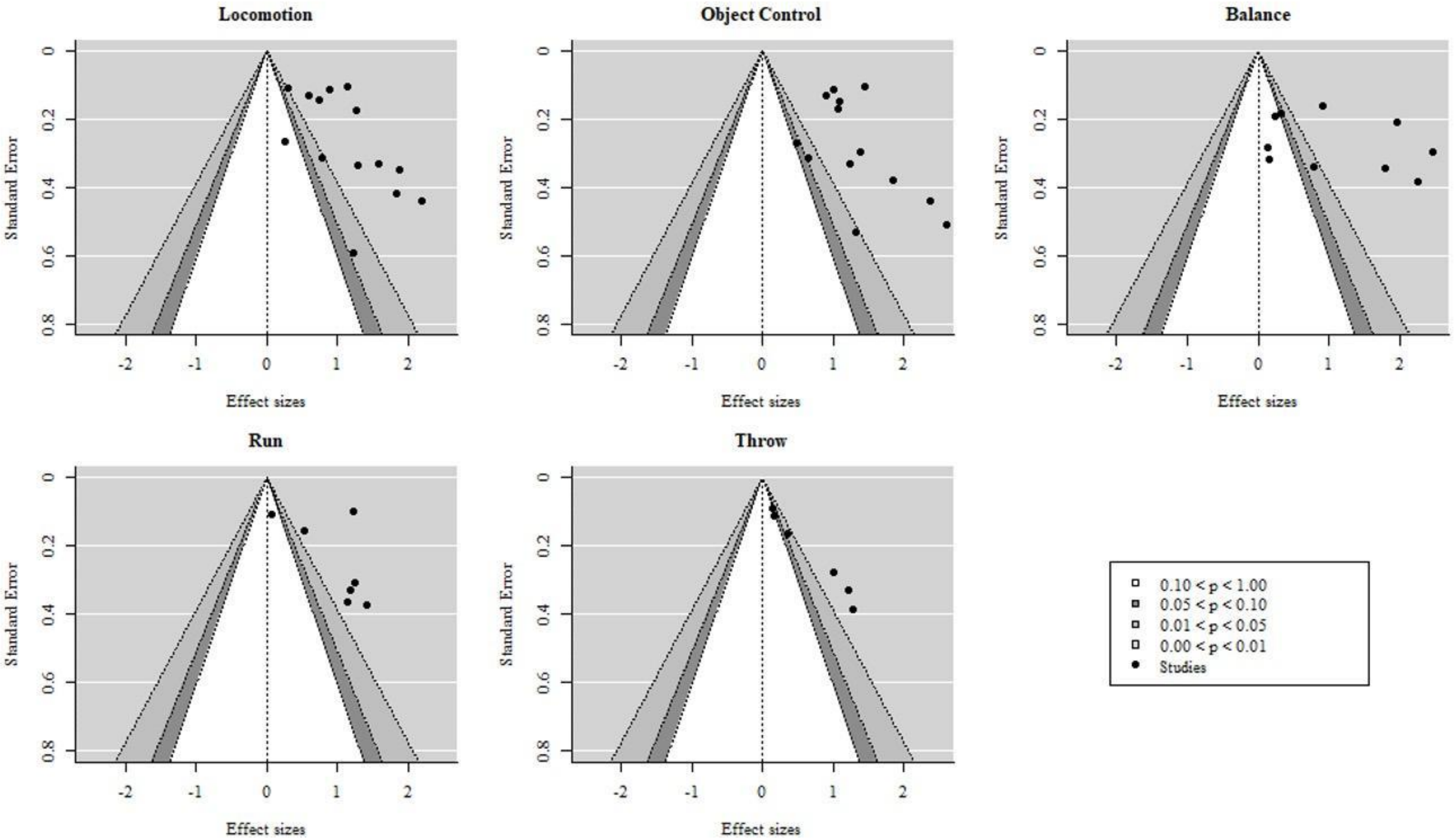
Supplementary Table 3.6 Quality Assessment of Studies

	JBI Assessment Tool					
Authors and Year	Inclusion	Desc. Subjects	Measurement Condition (TD vs. ID)	Outcome measure Valid and Reliable	Appro. stats used	Total
Alesi, 2018	2	2	2	2	2	10
Bruiniks, 1977	1	2	1	2	1	7
Capio, 2018	2	2	2	2	2	10
Craig, 2018	2	2	2	2	2	10
Folsom-Meek, 1987	1	1	1	2	2	7
Golubovic, 2012	1	1	2	2	2	8
Hartman, 2010	1	2	2	2	2	9
Howe, 1959	1	1	1	1	1	5
Jung, 2017	1	2	1	1	2	7
Le Blanc, 1977	1	1	2	0	2	6
Lejčarová, 2009	1	2	1	0	2	6
Majistro, 2018	0	2	2	2	2	8
Merhamn, 1983	1	1	1	0	2	5
Pitchford, 2021	1	2	1	2	2	8
Rider, 1983	1	2	1	1	2	7
Rintala, 2013	1	2	2	2	2	9
Schott, 2014	1	2	2	2	2	9
Smith, 1990	1	2	1	2	2	8
Sretenovic, 2019	1	1	1	2	2	7
Staples, 2021	1	2	1	2	2	8
Wang, 2002	1	2	2	2	2	9

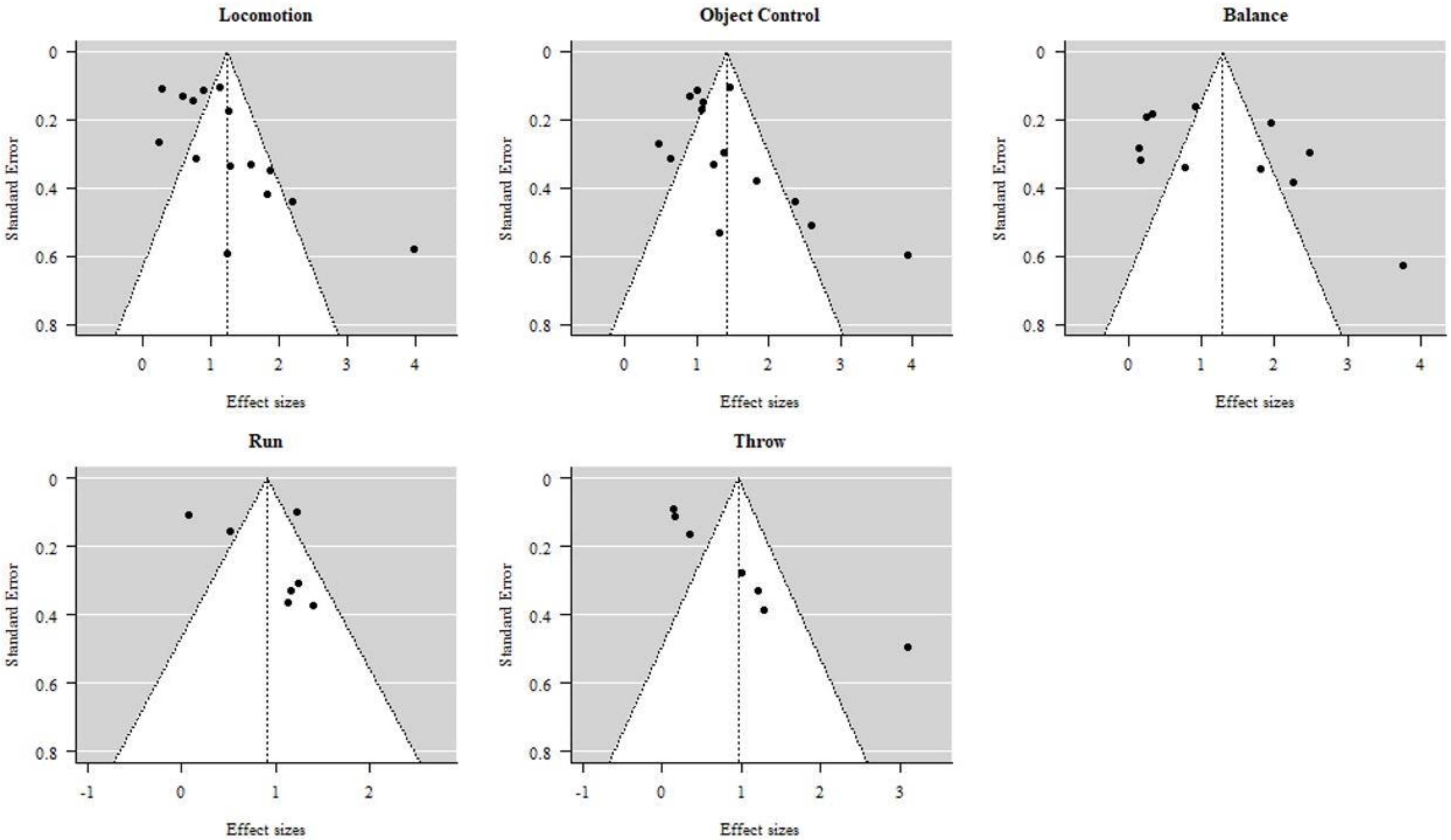
Westendorp, 2014	1	2	2	2	2	9
Westendorp, Hartman 2011	0	2	2	2	2	8
Westendorp, Houwen, 2011	2	2	2	2	2	10
Woodard, 2001	2	2	2	2	2	10
Zikl, 2013	1	2	1	2	2	8

Scoring of Answers 0 = Unclear 1 = No 2 = Yes

Supplementary Figure 3.3 *Contour enhanced Funnel plots for Locomotion, Object Control, Balance, Run, and Throw Skills. Effects aggregated at the study level (i.e., only one effect per study is plotted)*



Supplementary Figure 3.4 Standard Funnel plots for Locomotion, Object Control, Balance, Run, and Throw Skills. Effects aggregated at the study level (i.e., only one effect per study is plotted).



Linking Chapter 3 to Chapter 4

Chapter 3 systematically reviewed the existing literature and synthesised the quantitative evidence comparing the motor skill proficiency level of children with ID and TDC aged 4-12 years. In particular, this review was interested in collating the evidence from cross sectional data, including also experimental and longitudinal studies examining FMS proficiency differences between these cohorts. The findings from this study provide convincing evidence to support the hypothesis that children with ID have significantly lower motor skill proficiency levels than TDC, with overall FMS score showing a very large effect size (g = 1.24; CI 95% [.87, 1.62]) between the two groups. These findings have two meaningful implications. Firstly, they demonstrate the vital importance of developing tailored interventions, especially early interventions, that meet the needs of children with ID to improve their FMS proficiency, knowing that there is a direct relationship with other constructs such as physical activity, health and overall quality of life. Secondly, the results demonstrate the need for a deeper understanding of FMS proficiency on an individual skill level basis with specific consideration of the skill complexity in relation to children's ID levels. To the best of the authors knowledge, this is the first study to systematically review and meta-analyse the magnitude of difference in FMS proficiency between children with ID and TDC, therefore adding valuable knowledge to the field and improving generalisability of results.

Chapter 4 aims to build on these findings, to compare the FMS proficiency of a large sample of Irish children with ID and TDC aged 5-12 years. Specifically, this chapter will investigate how the motor skill proficiency of the Irish cohort compares to the global findings demonstrated in Chapter 3. Additionally, this chapter will detail the methods and findings of a study which investigates the role of age and gender on FMS proficiency between children with ID and TDC, as well as evaluate the mastery/near mastery of FMS for both groups. Only one previous study to date has examined the mastery/near mastery of FMS amongst children with ID.

Chapter 4: Assessing the Fundamental Movement Skills of Children With Intellectual Disabilities in the Special Olympics Young Athletes Programme

Abstract

Mastering the ability to move proficiently from a young age is an important contributor to lifelong physical activity participation. This study examined fundamental movement skill (FMS) proficiency in children with intellectual disabilities (n = 96, 60% boys, age 5–12 years) and typically developing children (n = 96, 60% boys, age 5–12 years). Participants were assessed using the Test of Gross Motor Development–3rd edition and balance subtest from the Bruininks–Oseretsky Test of Motor Proficiency 2. The FMS proficiency of typically developing children including mastery/near mastery level (combined variable representing mastery, which is achieving all criteria for the skill, over both trials and near mastery, wherein a participant performs all but one of the components of the skill correctly) was significantly higher than for children with intellectual disabilities. A similar observation was made with multiple linear regression analysis testing the interaction effect of participant group and age/gender on all three FMS subcomponents. The results presented will help establish a baseline of FMS proficiency and guidelines for future intervention for children with intellectual disabilities.

Keywords: mastery/near mastery, motor-skill proficiency, motor-skill assessment,TGMD-3, BOT-2

Introduction

Mastering the ability to move proficiently from a young age is well documented as an important contributor to lifelong physical activity participation and overall improved well-being (Hulteen et al., 2018; Lubans et al., 2010). In addition, proficiency in fundamental movement skills (FMS) enables children to play and interact with their peers across multiple environments leading to the development of social adaptation skills (Schalock et al., 2010; Tassé et al., 2012) and enhanced cognitive development (Capio & Eugia, 2021; Ommundsen et al., 2010; Piek et al., 2008). FMS are defined as "gross motor skills that involve the large force producing muscles of the trunk, arms and legs" (Clark, 1994, p. 245). Research indicates that children with low FMS proficiency engage in less social play interactions, are less physically active (Logan et al., 2018), and tend to have higher levels of obesity (Okely et al., 2004). All of the

aforementioned risks associated with poorer FMS proficiency levels in youth impact future well-being and quality of life, extending far beyond childhood. The condition of intellectual disability (ID) is defined by the Diagnostic and Statistical Manual of Mental Disorders(5th ed.) as "neurodevelopmental disorders that begin in childhood and are characterized by intellectual difficulties as well as difficulties in conceptual, social, and practical areas of living" (Boat & Wu, 2015). Advancements in cognitive development and adaptive skills are extremely important for children with IDs (CwID) who are recognized as having significant limitations in both of these areas (Boat & Wu, 2015; Schalock et al., 2021; Tassé et al., 2012).

CwID often demonstrate delays in achieving motor milestones (Jeoung, 2018) which manifest as decreased mastery in FMS (Capio & Eugia, 2021; Eguia et al., 2015). FMS encompass three domains of movement known as locomotor (e.g., running and jumping), ball skills (e.g., catching and kicking), and balance (e.g., stability) skills (Barnett et al., 2016; Logan et al., 2018). FMS do not develop naturally over time unless children are provided with opportunities to learn, reinforce, and practice their skills (Barnett et al., 2016; Clark, 2005; Robinson & Goodway, 2009).

The challenges faced by CwID when attempting to learn new motor skills include poor control of their bodily movements, decreased body awareness, and motor sequencing deficits (Cavanaugh, 2017). According to Gkotzia et al. (2017), CwID are 65% more likely to have lower FMS proficiency than their aged-matched typically developing peers.

Studies from Hartman et al. (2010), Westendorp et al. (2011), and Zikl et al. (2013) examined the difference in FMS proficiency levels between children with borderline ID, mild ID, and typically developing children (TDC) using the Test of Gross Motor Development—Second Edition (TGMD-2). The results derived from all three studies found that CwID performed significantly lower in ball skills and locomotor scores than the TDC. Large effect sizes were seen for children with mild ID, and moderate to large effect sizes were seen for children with borderline ID (Westendorp et al., 2011). The FMS of balance were assessed by Sretenović et al. (2019) using the Bruininks–Oseretsky Test of Motor Proficiency (BOT) assessment tool, and they concluded that CwID scored significantly lower for overall balance (static and dynamic) compared to TDC. Awareness of this vast gap in FMS proficiency between CwID and their typically developing peers may affect CwID motivation for participating in sport and physical activity, which has a direct consequence on motor skill acquisition and may decrease the child's perceived competence and confidence (Skinner & Piek, 2001).

In addition to the challenges already experienced by CwID when learning new motor skills, biological factors of age and gender may also play a role in FMS performance. While these factors have been thoroughly explored among TDC (Barnett et al., 2010; Behan et al., 2019; Hardy et al., 2010), a gap in the literature exists for CwID. An example of this includes Gallahue and Ozmun (2006) reporting that TDC have the ability to master majority of the FMS by 6 years of age. Similarly, gender differences in FMS performance for TDC have been widely discussed with researchers presenting findings of boys achieving higher ball skills scores, while girls demonstrate elevated proficiency in locomotor and balance skills (Behan et al., 2019; Hardy et al., 2010). Studies investigating gender differences in FMS performance among CwID are relatively scarce. A recent study by Jeoung (2013) on the influence of gender and age on ball skills scores among CwID reported that gender had no effect while age only affected the dribbling subskill. Further research is required to explore gender differences in all three subcomponents of FMS for CwID to establish if differences exist and, if so, are the patterns similar to those seen among TDC.

FMS proficiency differences between CwID and TDC have thoroughly been explored (Hartman et al., 2010; Magistro et al., 2018). However, only one study to date has evaluated the development of FMS in terms of percentage mastery, allowing the readers to grasp the level of proficiencies and deficiencies. Mastery of FMS is when a participant performs all components of a skill correctly, while near mastery is when the participant performs all but one of the components of the skill correctly (van Beurden et al., 2002). Rintala and Loovis (2013) examined mastery of FMS in a sample of 40 Finnish children (20 CwID and 20 TDC) and found that only 20% of CwID achieved mastery across three skills, namely running, sliding, and catching. The analysis indicated that 0% of the CwID group mastered the skills of the hop, horizontal jump, leap, underhand throw, and striking a stationary ball. The conclusions drawn from this study clearly showed that FMS proficiency of CwID issignificantly lower than their age-matched typically developing peers. This demonstrates the extent to which motor skill acquisition for CwID is significantly delayed and that certain motor skills are entirely outside of their repertoire.

The aim of this study was threefold: (a) to assess and compare the FMS proficiency of a large sample of CwID and their typically developing peers aged 5–12 years, (b) to investigate the role of age and gender on FMS proficiency between these groups, and (c) evaluate the mastery/near mastery of FMS for both CwID and TDC. Overall, this study will provide an in-depth analysis on the FMS proficiency and mastery levels of CwID from a large sample size, in order to increase the statistical power and generalizability of results for this population. This research will provide insight for coaches, physical education teachers, and movement practitioners on the ground and will highlight where the proficiency deficiencies exist between CwID and TDC.

Method

Participants

Cross-sectional data were collected as part of the "SO Fun" project with Special Olympics Ireland. Fifteen Special Olympics Young Athletes clubs were contacted with 10 clubs agreeing to participate in the study. The eligibility criteria for participating in this study included CwID who are registered with the Special Olympics Ireland Young Athletes program, aged 5–12 years, who are fully mobile, and can walk without the use of an aid.

The Young Athletes program is a yearlong "play and sports activity programme" (Favazza et al., 2013) that takes place on a weekly basis and introduces CwID to a wide range of play activities in a supportive, fun environment (SpecialOlympics, i.e., 2022).

The program was designed to provide CwID with an introduction to FMS (Special Olympics, i.e., 2022).

Participants, CwID (n = 96, 60.5% boys, aged 5–12 years, mean age 7.7 ± 2), were then recruited from the clubs across eight counties. The clubs were situated in each of the four provinces of Ireland and Northern Ireland. 65.7% of the CwID were reported as having Down syndrome (DS), and all other participants reported their condition as ID. Data were collected during the period of October 2021 to June 2022. Data from a sample of TDC (n = 96, 60.5% boys, aged 5–12 years, mean age 7.7 ± 2) were obtained from the anonymized data set of a national physical literacy study called "Moving Well-Being Well" (Behan et al., 2019) to be used as a comparison group. Data from this control group were collected from March to June 2017 in primary schools across the four provinces of Ireland and Northern Ireland by a team

of researchers from Dublin City University (Behan et al., 2019). We used propensity score matching (predicted probability of belonging to a group; Ho et al., 2007) to create the sample of 96 TDC from the data of Behan et al. (2019) to accurately estimate the differences between CwID and TDC in FMS. Propensity score matching is a technique used with observational data that aims to reduce the effect of confounding variables when comparing two groups in respect of an outcome of interest. In this study, the outcome of interest was FMS proficiency and the confounding variables were age and gender. As the first step, we fitted a logistic regression model to estimate a propensity score of each participant to be categorized as CwID using two covariates of gender and age. Next, the computed propensity scores were used to match the TDC with CwID participants on a ratio of 1:1 using the nearest neighbor method and without replacements. Lastly, we inspected the covariate balance between the two groups visually and via Welch's t tests, and average absolute standardized differences. All analyses indicated the two groups to be perfectly matched in terms of age and gender (average absolute standardized difference equaled zero). All propensity score matching procedures were done with the MatchIt package in R (Ho et al., 2011).

Ethical approval was obtained from Dublin City University, Research Ethics Committee (DCUREC/2021/100). The coaches of each of the participating clubs provided initial consent for the research team to visit the club, while parental consent and participant assent were also obtained and required in order for participants to partake in the study. Anonymity was maintained with each participant assigned a unique numerical code.

Measures

Participants' demographics including age and gender were collected through the consent forms and questionnaires completed by parents (see Table 4.1). Proficiency of participants' FMS was assessed using a subset of the process-oriented battery, the Test of Gross Motor Development–Third Edition (TGMD-3), established clinical validity (Pitchford & Webster, 2021; Temple & Foley, 2017), instructional sensitivity (Staples et al., 2021), and reliability (α = .81) for children with and without ID in this age cohort (Rey et al., 2020; Magistro et al., 2018). The TGMD-3 is an individually administered test which focuses on two subcategories of FMS, locomotor, and ball skills (Ulrich, 2019). In this study, the subset of skills we used were as follows: locomotor skills (run, skip, horizontal jump, and hop) and ball skills (catch, kick, overhand throw, underhand throw, stationary dribble, and one-hand strike; Ulrich, 2019).

A known limitation of the TGMD assessment tool despite its widespread use globally is the absence of a stability component (Rudd et al., 2015). Therefore, in order to ensure the authors gathered a holistic measure of children's motor skill competency, balance was assessed using a subtest of the BOT-2 Short Form. The BOT-2 Short Form measures the motor skill performance of gross and fine motor skills in children who may experience motor impairments or delays (Baharudin et al., 2020). Nocera et al. (2021) found that the BOT-2 Short Form demonstrates excellent reliability (α = .75) when assessing motor competence in CwID. The balance assessment consisted of two tasks, single-leg stand on a balance beam with the eyes open and walking forward heel-to-toe on the line. The TGDM-3 and the BOT-2 were the preferred motor competence assessment tools for use in this study as a recent review found them to be the most psychometrically appropriate tools for assessing FMS proficiency in CwID in field settings (Downs et al., 2020).

"Mastery" of the skills within the process-oriented locomotor and ball skills subtests and product-oriented balance subtests is defined as achieving all criteria for the skill, over both trials (van Beurden et al., 2002). "Near Mastery" is defined as achieving all but one of the criteria correctly, over both trials (van Beurden et al., 2002). Any participant who failed to meet the criteria to achieve mastery or near mastery status was classified as "poor" (van Beurden et al., 2002). An additional variable was created, and the raw scores for each skill were coded into mastery/near mastery or poor, for both groups (Okely & Booth, 2004). Frequencies were calculated to report both mastery/near mastery and poor percentages for each individual skill and group.

Table 4.1 Descriptive Statistics by Group (CwID and TDC) of Motor Skill Proficiency Level

	Means (±SD)		Score Range	F	Sig. p<0.05	ES
	CwID	TDC				
1. Locomotor	12.2 ± 7	22.7 ± 6.1	0 – 30	124.4	.001	1.61
2. Ball Skills	14.88 ± 9.7	25.39 ± 9.7	0 - 44	56.6	.001	1.1
3. Balance	0.70 ± 1.8	6.57 ± 1.6	0 - 8	596.5	.001	3.6
4. Age	7.7 ± 2	7.7 ± 2				
5. Gender	60.5% M	60.5% M				

ES = Cohen's d

M = Males

Data Collection

All members of the research team undertook formal training in order to ensure an in-depth understanding of the skill assessment batteries, in addition to establishing consistency when visually demonstrating the skills to each participant. The visual demonstration of the skill was in line with Ulrich’s (2013) and Bruininks’s (2005) protocols that are frequently documented in the literature (Maïano et al., 2019). The TGMD-3 was individually administered to each participant during their Young Athletes club training session. No cues or verbal feedback were given to the participants. Participants performed a practice trial to become accustomed with

each skill, followed by two opportunities to perform the skill. All the participants’ performances were video recorded.

A trained member of the research team observed each trial retrospectively, and assessed and scored each skill component. A score of 1 was given if the participant successfully performed the criteria, and a 0 was recorded if the participant failed to meet the criteria. Participants’ raw scores per skill were calculated by collating the scores from both trials.

Once all skills were assessed, raw subtest scores for locomotor and ball skills were calculated and were then combined to provide a total raw FMS score.

The balance subtests were scored based on their performance outcome. Walking forward heel-to-toe on the line was graded based on the number of steps taken by the participant, while adhering to strict criteria (Bruininks, 2005). Participants were then awarded points based on the number of successful steps taken, for example, six continuous steps in line with criteria, equals a top score of 4 points. The single-leg stand on the balance beam was graded on the amount of time the participant could maintain their balance while adhering to the strict criteria

(Bruininks, 2005). Participants were then awarded points based on the time they maintained their balance, for example, maintaining balance for 10 s in line with the criteria equals a top score of 4 points. Second trials were only carried out if the maximum score was not reached in the first trial.

Data Analysis

All data were analyzed using SPSS (version 27; IBM Corp., 2022) and R (R Core Team, 2022). To describe the characteristics of the data, means, standard deviations, and bivariate correlations on the variables of interest were computed. The main analyses were undertaken on the locomotor, ball skills, and balance subtest scores. The impact of ID level on participants locomotor, ball skills, and balance was assessed using a simple linear regression analysis. Furthermore, a multiple linear regression model was used to test the interaction effect of

participant group and gender/age on FMS proficiency. The percentage of CwID and TDC who had achieved mastery or near mastery in each skill was examined by producing descriptive statistics and frequency tables. Cohen's d (Cohen, 1992) was used as the effect size in group mean difference measures, and an alpha level of .05 was established for all statistical analysis. Finally, potential differences between the groups' mastery and near mastery of the skills within the locomotor, ball skills, and balance subtests were assessed using chi-square analyses. Cramér's V (Cramér, 1946) measure of association between two nominal variables and corresponding significance levels was reported based on the chi-square analysis (Table 4.2). Cramér's V ranges from 0 to + 1, and a value of 0 means no effect or association. To summarize, Cohen's d effect sizes were used to describe the continuous variables while Cramer's V was used to describe the categorical variables.

Table 4.2 Comparison of Mastery/Near Mastery between Children with Intellectual Disabilities and Typically Developing Children

	CwID		TDC				
	MNM	Poor	MNM	Poor	Chi Square	Cramer's V	Significance
Locomotor subset							
Run	60.4%	39.6%	92.7%	7.3%	27.893	.381	.001
Hop	16.7%	83.3%	37.5%	62.5%	10.549	.234	.001
Horizontal jump	27.1%	72.9%	41.7%	58.3%	4.525	.154	.033
Skip	8.3%	91.7%	68.8%	31.3%	73.968	.621	.001
Ball Skills subset							
One Hand Strike	10.4%	89.6%	41.7%	58.3%	24.338	.356	.001
Dribble	19.8%	80.2%	44.8%	55.2%	13.721	.267	.001
Catch	32.3%	67.7%	60.4%	39.6%	15.269	.282	.001
Kick	22.9%	77.1%	53.1%	46.9%	18.588	.311	.001
Overhand Throw	6.3%	93.8%	38.5%	61.5%	28.799	.387	.001
Underhand Throw	21.9%	78.1%	36.5%	63.5%	4.941	.160	.026
Balance subset							
Total Balance	0%	100%	75%	25%	115.2	.775	.001

MNM = Mastery/Near Mastery

Results

A simple linear regression was carried out to investigate whether ID level was a predictor of FMS proficiency. Results of the simple regression analysis revealed that there was a statistically significant difference in the locomotor score $F(1,190) = 124.446$, $p < .001$; ball skills score $F(1, 190) = 56.615$, $p < .001$; and balance score $F(1, 190) = 596.485$, $p < .001$. Balance demonstrated the largest effect size of all of the skill subsets. Across all the models, TDC scored significantly higher in all subsets compared with CwID ($p < .001$; Table 4.1). Correlations presented in Supplementary Tables 4.1 and 4.2 (available online) demonstrate how individual subskills relate to each other, for both CwID and TDC. In addition, the correlations provide insight into how the variables of age and gender are linearly related to the three subskills. These correlations will be valuable for researchers interested in implementing more complex modeling and statistics, for example, in a meta-analysis.

A multiple regression was carried out to investigate whether the interaction of age and participant group was a predictor of FMS proficiency. The model demonstrated a significant interaction effect was found to predict locomotor score $F\ (3,188) = 61$, $p < .001$, $R^2 = .49$; ball skills score $F\ (3,188) = 33.99$, $p < .001$, $R^2 = .34$ and balance $F\ (3,188) = 233.5$, $p < .001$, $R^2 = .79$. Across all the models, the significant interaction between age and participant group indicates that the gap between the groups FMS proficiency level increases as the children's age increases (see Figure 4.1).

A multiple regression was carried out to investigate whether the interaction of gender and participant group was a predictor of FMS proficiency. No significant interaction effect was found for locomotor score $F\ (3,188) = 42.36$, $p = .193$, $R^2 = .39$ nor ball skills score $F\ (3,188) = 19.87$, $p = .134$, $R^2 = .23$. However, a significant interaction effect was found for balance ($F\ (3,188) = 218.5$, $p < .001$, $R^2 = .77$). The post hoc test with a Tukey family-wise error correction indicated that a gender difference exists with females outperforming the males in the CwID group ($p < .001$) but not in the TDC group ($p = .976$; see Figure 4.2). Descriptive statistics of the gender differences for the FMS subtests can be found in Supplementary Table 4.3 (available online).

In addition, we examined the degree to which CwID "mastered" the skills within the locomotor, ball skills, and balance subtests compared with their typically developing peers. Comprehensive analysis of the mastery/near mastery across both participant groups and the percentage of participants demonstrating poor performance by skill can be seen in Table 4.2. The percentage of participants demonstrating poor performance is noteworthy for both groups, particularly for the CwID. Poor performance in the individual skills ranges from 39.5% to 100% for CwID. The percentage difference in mastery/near mastery between TDC and CwID is represented for each skill (see Table 4.2).

Discussion

At a macroscopic level, this study demonstrates with a large sample size, the vast FMS proficiency differences that exist between CwID and TDC. FMS are the "building blocks" required to participate in sport and physical activity (Behan et al., 2019). Low FMS proficiency levels have the potential to impact lifelong sport and physical activity participation (Hulteen et al., 2018; Lubans et al., 2010) for CwID. Further insight into FMS proficiency levels for both groups is seen by the mastery/near mastery calculations, which demonstrate on an individual skill level those skills in which CwID are exhibiting poor performance. These findings are beneficial for coaches, PE teachers, and movement practitioners to identify at an individual skill level basis where CwID are failing to perform to an adequate level. These skills can be incorporated into FMS interventions to increase overall FMS proficiency levels.

FMS Proficiency

First, the findings showed a significant difference between CwID and TDC with very low levels of proficiency in all three subskills for CwID (Table 4.1). CwID demonstrate lower levels of FMS proficiency compared with their typically developing peers, and these results are comparable in terms of significance to other studies including: (a) locomotor and ball skills (Alesi et al., 2018; Capio et al., 2018; Hartman et al., 2010; Schott et al., 2014; Zikl et al., 2013) and (b) balance skills (Craig et al., 2018; Golubovic et al., 2012; Lejčarová, 2009).

The FMS proficiency gap between the groups is quite significant for locomotor, ball skills, and balance, demonstrated by the effect sizes (see Table 4.1). These effect sizes are comparable to a recent meta-analysis which assessed the motor skill proficiency of 1,232

CwID and 2,293 TDC for all three of the FMS subcomponents and total FMS proficiency (Kavanagh et al.). This study provided convincing quantitative evidence to give a precise estimate of the magnitude of difference in FMS proficiencies between these two groups (Kavanagh et al., 2023). In the same study, similar effect sizes were found by Kavanagh et al. (2023) for locomotor skills (1.14 vs. 1.61 TDC) and ball skills (1.21 vs. 1.1). The effect sizes for balance in both studies were the largest of all the effect sizes found. However, the biggest magnitude of difference can be seen in this study with an effect size for balance of 3.6 compared with 1.26 found by Kavanagh et al.

Researchers (Enkelaar et al., 2012; Maïano et al., 2018) have proposed two mechanisms to determine a cause of the balance deficit among youth with ID: (a) cognitive development delays which impact motor skill proficiency and (b) increased level of physical inactivity leading to less time reinforcing the FMS. This balance deficit exhibited by CwID is a cause for concern as this group gets older, particularly as balance proficiency is an important indicator for risk of falls (Enkelaar et al., 2012; Maïano et al., 2018; Patikas, 2015). Compared with typically developing youth, the incidence rate of falls among young people with ID is higher, often resulting in injury (e.g., fractured bones; Maïano et al., 2018; Sherrard, 2001). In addition, improving the balance proficiency of CwID is a critical issue, as it also improves overall FMS proficiency, encouraging CwID to participate in lifelong sport and physical activity (Maïano et al., 2018).

Another important point of discussion is that 65.7% of the participants in this study report their cause of ID as Down Syndrome. Readers should keep this in mind when interpreting the results as previous research by Alesi et al. (2018) reported that children with Down Syndrome exhibited lower FMS proficiency in both locomotor and ball skills, compared to children with borderline intellectual functioning and TDC. Further to this, a meta-analysis by Kavanagh et al. (2023) examined ID category (Down Syndrome, Mild ID, ID and mixed group, e.g., those who have an ID and another condition such as ID and Autism) as a categorical moderator to explain the variability between studies. The results found that the standardised mean differences in locomotor skills were larger between children with Down syndrome and TDC compared to the difference between TDC and children categorised as mixed group (t = -4.298, p = 0.35). Furthermore, for the run skill, the difference between children with Down syndrome and TDC was larger compared with the difference between TDC and children with mild ID y (z = -4.44, p <.001), ID (z =

1.98, p =.0475), and children categorized as mix (z = -3.72, p <.001). For throw skill, the difference in skill between children with Down syndrome and TDC was larger compared with the difference between TDC and children with mild ID (z = -6.05, p <.001) and mix (z = -5.65, p <.001). The poorer performance in FMS proficiency demonstrated by children with Down Syndrome compared to other ID diagnosis can be attributed to impairments such as joint hypermobility, low muscle tone (hypotonia), poor balance and poor postural control (Capio and Rotor, 2010; Zakaria et al., 2020). Hypotonia affects muscular co-contraction and balance reactions that result in postural control challenges (Lauteslager et al. 1998; Capio and Rotor, 2010).

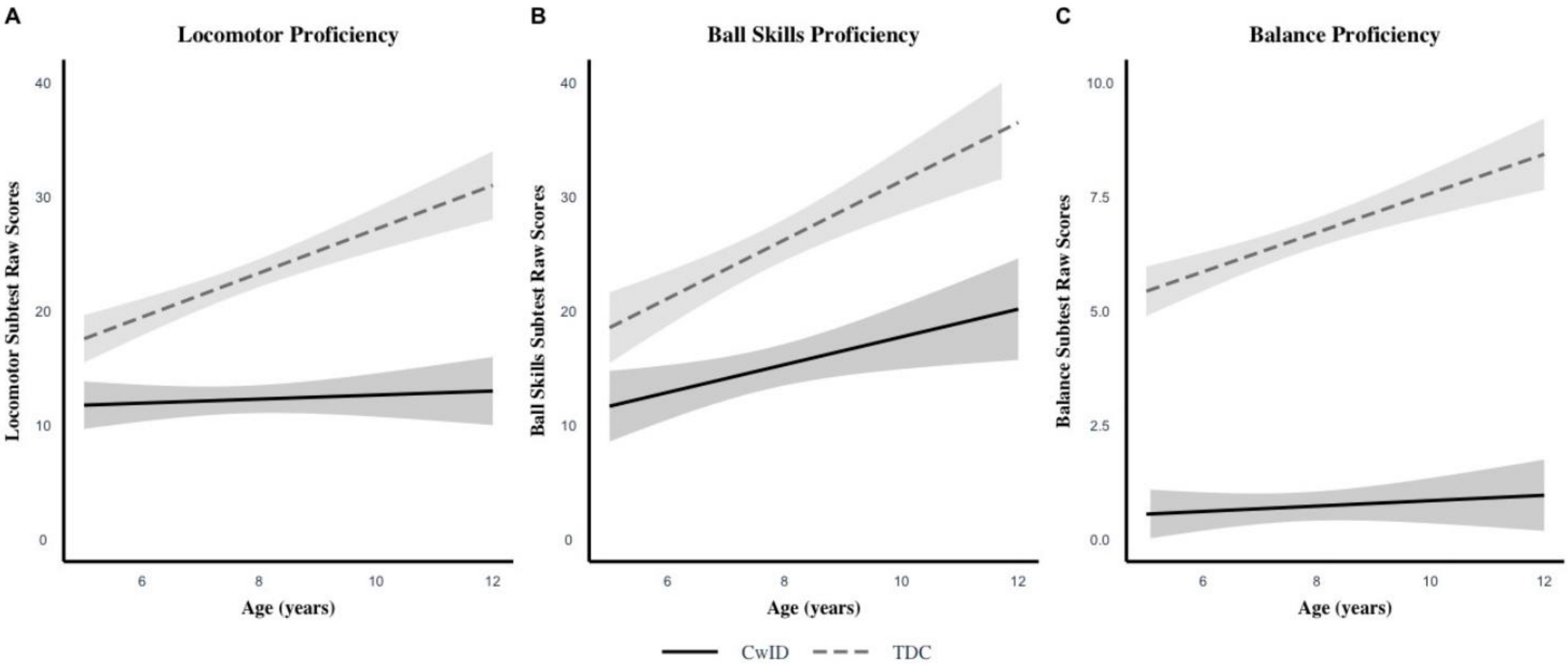
While the results of the current study are not entirely surprising, they are important for establishing a baseline of FMS proficiency among Young Athletes within the Special Olympics Ireland program. It is widely recognized that FMS are the "building blocks" required for sport and physical activity participation (Barnett et al., 2016), and they are the gateway to more advanced movement skills needed for games and sports (Logan et al., 2018). These findings will enable the National Governing Body of Sport for people with ID to work alongside coaches to implement a structured and developmentally appropriate motor skills program (Goodway & Branta, 2003; Robinson & Goodway, 2009; Valentini & Rudisill, 2004), which will improve athletes' FMS proficiency levels and impact the trajectory of their pathway to developing sport-specific skills. In turn, the long-term aim is to keep people with ID participating in sport and physical activity for life, as the health, social, and cognitive benefits are well documented (Holfelder & Schott, 2014; Hulteen et al., 2018; Lubans et al., 2010; Piek et al., 2008). The positive impact that sport can have on the lives of people with ID is internationally recognized (Robertson & Emerson, 2010). In particular, the benefits that participation in Special Olympics has include improved social competence, with time spent participating in the program correlating with participation in more recreational activities, household work, jobs, and friendships (Dykens & Cohen, 1996), and enhanced psychological well-being (Crawford et al., 2015), in addition to feelings of social approval, opportunity to learn new skills, and having fun (Farrell et al., 2004).

Age and Gender

Participant group and age/gender were examined to determine their role on locomotor, ball skills, and balance scores. The results demonstrated that for TDC, FMS proficiency was significantly impacted by age with the higher scores favoring the older children (Figure 4.1). Previous research (Behan et al., 2019; Bolger et al., 2018; Jeong et al., 2017) also confirms this finding that age positively influences FMS proficiency due to biological maturation, increased duration of practice, and receiving feedback (Charlesworth, 2016). However, the results did not demonstrate this pattern among CwID. The gap in proficiency increases as the participant's age increases (Figure 4.1). This result can be viewed through the lens of the developmental skill-learning gap hypothesis proposed by Wall (2004). This hypothesis indicates that as children who experience motor skill deficiencies get older, the skill-learning gap between them and TDC who have better skill proficiency continues to grow (Wall, 2004). This proficiency gap becomes evident across a range of settings including physical education class, sports practice, and competition (Wall, 2004). The potential impact of this skill-learning gap is that TDC continue to participate in sports and physical activity which means they continue to increase their FMS proficiency levels, while CwID may withdraw from sports activities, thus limiting their opportunities for further FMS proficiency development (Bremer & Cairney, 2016). CwID self-perception of their physical competence could also be negatively impacted if they continue to perceive themselves as not being as proficient as their peers (Bremer & Cairney, 2016). With that said, future longitudinal research would be required to get more specific insight into this to comprehend the nature of motor skill delays between CwID and TDC and provide insight into appropriate method of intervention approaches and provision (Staples & Reid, 2009).

The only interaction effect of participant group and gender on FMS was detected with balance, with girls in the CwID group demonstrating significantly greater proficiency compared with boys in the CwID group. No gender differences existed between the genders within the TDC group (Figure 4.2). Typically, research shows that among school-aged children, girls outperform boys in balance skills, particularly in the single-leg stand skill (Mickle et al., 2011, Rodríguez-Negro et al., 2019). This gender difference can be explained by the type of activities in which boys and girls participate, as this can often be determined by factors such as their peers, family, and the physical environment (Booth et al., 1999; Hardy et al., 2010). More often than not, girls tend to participate in activities in which the focus is predominantly on locomotor and balance skills (e.g., gymnastics and dance) while boys participate in activities that predominantly involve ball skills (e.g., ball sports like football; Booth et al., 1999; Bardid et al., 2016; Peral-Suárez et al., 2020).

Figure 4.1 Interaction Effect of Participant Group (CwID and TDC) and Age on Locomotor Proficiency (A), Ball Skills Proficiency (B), Balance Proficiency (C). Grey areas shown are the confidence interval



Mastery/Near Mastery

On an individual skill level, the highest mastery/near mastery for both groups was seen in the run, the catch, and the kick (see Table 4.2). For TDC, these relatively high levels of performance are to be expected, as Gallahue and Ozmun (2006) established that all of the basic FMS should be mastered by 8 years of age. As CwID have been shown to experience motor skill delays of 5–6.5 years behind TDC (Rintala & Loovis, 2013), it is positive to see that there are similarities in the skills in which both groups of children score the highest levels of proficiency. These results also align with studies from Rintala and Loovis (2013) and Behan et al. (2019) who demonstrated that CwID and TDC had relatively high mastery/ near mastery for the run and catch, respectively.

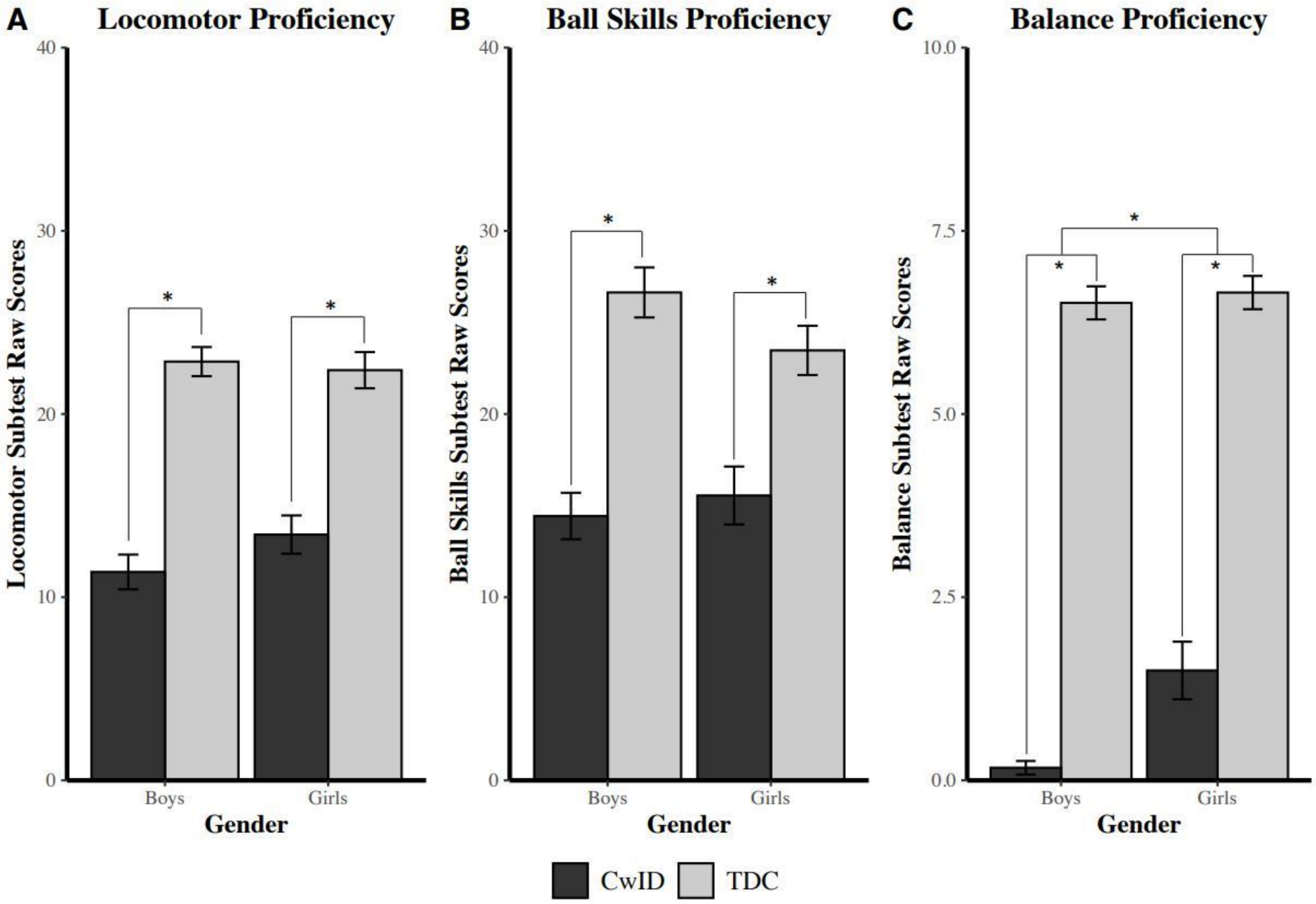
The three skills in which both CwID and TDC demonstrated the poorest performance included the one-hand strike (10.5% vs. 41.7%), overhand throw (6% vs. 38.6%), and hop (16.7% vs. 37.5%), comparable with findings from Behan et al. (2019) among TDC. Rintala and Loovis (2013) presented findings that mastery at its highest level was only achieved by 20% of the CwID compared with 59% in this study. In addition to this, mastery was not achieved in five skills, in which CwID scored 0%, for the hop, leap, horizontal jump, striking a stationary ball, and underhand roll (Rintala & Loovis, 2013) compared with the current sample who achieved 16.7% in hop, 27.1% in horizontal jump, and 21.9% in underhand throw. The differences may be due to the small sample size in Rintala's study, which was indicated as a limitation as it influences results' generalizability and reduces statistical power.

For CwID, the balance subtest demonstrated the biggest challenge, with 0% of the group mastering the skills compared with 75% of the TDC cohort. Wang and Ju (2002) found similar results when investigating balance using a subtest of the BOT with children with DS. Participants with DS scored 0.47 ± 0.69 on the beam balance and 2 ± 1.94 on walking heel-to-toe on the line compared with TDC who scored 4.71 ± 3.2 and 5.9 ± 0.30, respectively. CwID, in particular, those with DS, experience muscular hypotonia and joint ligament laxity which have been attributed to poorer balance performance (Ma et al., 2019; Wang & Ju, 2002). In a systematic review by Maïano et al. (2019) exploring the effects of motor skill interventions on FMS performance of CwID, balance was the subtest most investigated in the paper. They found that motor skill interventions were effective in significantly improving balance skills of CwID. These findings and the dearth of proficiency in balance of CwID in this paper indicate an immediate need for motor skill interventions to incorporate balance training.

Limitations

There were several limitations within this study. First, all participants in the CwID group take part in the Special Olympics Ireland Young Athletes program. Going forward, it would be ideal to have access to a control group of CwID to gain further indication of the role and impact of the Special Olympics Ireland Young Athletes program. Furthermore, a large number of participants have a Down Syndrome diagnosis (65.7%) indicating that the sample is not representative of all children with ID, as DS is only one cause of ID. Other causes of ID include Fragile X syndrome, phenylketonuria, foetal alcohol syndrome, other genetic conditions, birth defects and infections. Future studies examining FMS performance in CwID should aim to include different groups of children with other causes of ID diagnosis to provide researchers with a clearer understanding of how different ID's may impact motor competence. In addition, due to the time constraints presented to the researchers during data collection, the full battery of the TGMD-3 was not administered. Researchers omitted three skills as a result (gallop and slide from the locomotor subtest and two hand strike from the ball skills subtest). Furthermore, while the interaction effect of age indicated that the gap in FMS proficiency levels between CwID and TDC widened as participants get older, further longitudinal research would be beneficial to confirm these findings. A final limitation important to note is that the FMS data collected from the TCD group were gathered pre-COVID in 2017 while data from the CwID group were collected during/post-COVID in 2021/2022. Therefore, there is a potential that the discrepancies in FMS proficiency between the two groups are greater given the lack of opportunities to be physically active during COVID and the overall declines in physical activity and health outcomes that people experienced during this time period.

*Figure 4.2 FMS Differences between Gender and Participant Group (CwID and TDC) for Locomotor Proficiency (A), Ball Skills Proficiency (B), Balance Proficiency (C). Standard error bars shown. * denotes statistically significant differenc*



Conclusions and Implications for Future Research

The results of this study highlight the fundamental movement skill (FMS) proficiency gap that exists between children with intellectual disabilities (CwID) and typically developing children (TDC), contributing to the wider body of knowledge on the differences in FMS proficiency that exist for these groups. This study further supports the hypothesis that CwID exhibit low levels of FMS mastery, particularly in balance skills. The results presented will help to establish a baseline of FMS proficiency for CwID in the Special Olympics Young Athletes programs in Ireland and further afield. Future research should seek to analyze FMS at a behavioral component level in order to provide coaches and teachers of CwID tangible and practical areas in which to improve children's FMS. This will enable researchers to see similar patterns in prevalence of failure or mastery for behavioral components across multiple skills. This information can then be utilized to develop and implement interventions targeting the poorest performing skills, to try to decrease the proficiency gap that currently exists between CwID and TDC.

Supplemental Information

Supplementary Table 4.1 Correlations of Motor Skill Proficiency Levels for CwID

	1	2	3	4	5
1. Locomotor	-	.57**	.29**	.05	.14
2. Object Manipulation	.57**	-	.32**	.24*	.06
3. Balance	.29**	.32**	-	.07	.38**
4. Age	.05	.24*	.07	-	.05
5. Gender	.14	.06	.38**	.05	-

CwID (n = 96). Gender coded 1 = Males, 2 = Females. *p < .05; **p <.01

Supplementary Table 4.2 Correlations of Motor Skill Proficiency Levels for TDC

	1	2	3	4	5
1. Locomotor	-	.53**	.42**	.61**	-.04
2. Object Manipulation	.53**	-	.44**	.51**	-.16
3. Balance	.42**	.44**	-	.52**	.04
4. Age	.61**	.51**	.52**	-	.05
5. Gender	-.04	-.16	.04	.05	-

TDC (n = 96). Gender coded 1 = Males, 2 = Females. *p < .05; **p <.01

Supplementary Table 4.3 Mean (±SD) by Gender of Motor Skill Proficiency Levels

	Means (±SD)					
	CwID			*TDC*		
FMS Subskills	*Males*	*Females*	*ES*	*Males*	*Females*	*ES*
Locomotor	11.4 ± 7.3	13.5 ± 6.5	0.4	22.9 ± 6.1	22.4 ± 6.1	0.09
Ball Skills	14.5 ± 9.7	15.6 ± 9.8	0.2	26.7 ± 10.4	23.5 ± 8.3	0.4
Balance	.17 ± .70	1.5 ± 2.5	0.8	6.6 ±1.8	6.7 ±1.4	0.07

ES = Cohen’s d

Linking Chapter 4 to Chapter 5

Chapter 4 provided insight into the FMS proficiency levels of children aged 5-12 years, with and without ID in Ireland. Additionally, this chapter provides practitioners with knowledge on whether children are achieving mastery/near mastery levels in their FMS performance. The findings from this study will help to establish a baseline of FMS proficiency and guidelines for future interventions for children with ID. This methodological approach can be replicated by other researchers to determine the mastery/near mastery levels of FMS amongst children with ID.

Chapter 5 will build on these findings to further evaluate the FMS performance of children with ID at both an individual and behavioural component level. The behavioural component level evaluation is a key element to identify weaknesses within performances and commonality of these weaknesses across skills for children with ID. Reporting FMS at both an individual skills and behavioural component level would broaden the knowledge and understanding of FMS proficiency. This would enable researchers to provide coaches and teachers with important information regarding the developmental characteristics of children with ID. The findings will be used to support gatekeepers such as teachers and coaches, to develop appropriate evidence-based strategies to address low FMS proficiency among children with ID by focusing on activities that aim to develop and improve weaker FMS.

Chapter 5: Exploring the motor skill proficiency barrier among children with intellectual disabilities: analysis at a behavioural component level

Abstract

Models of childhood motor development began to emerge in the 1960's. Since then, numerous models have proposed the importance of obtaining a proficient level of fundamental movement skill (FMS) competence during childhood and deemed it to be critical for participation in lifelong sports and physical activity. This study examined FMS at the behavioural component level in children with intellectual disabilities (CwID) (n = 100, 60% boys, aged 5-12 years). Participants were assessed using the Test of Gross Motor Development 3rd edition (TGMD-3) and the balance subtest from Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT-2). For the whole sample, 0% participants mastered all 10 FMS, 1% (n = 1) participants mastered all 4 locomotor skills while 0% (n=100) participants mastered all ball skills. A multiple regression was carried out to investigate whether the interaction of gender and age was a predictor of FMS proficiency. Linear regressions were also carried out to investigate whether gender or age was a predictor of FMS proficiency. The results presented will help to identify weaknesses in skills at the behavioural component level and will enable researchers and practitioners to address low levels of motor skill proficiency among CwID.

Introduction

Models of childhood motor development began to emerge in the 1960's. Since then, numerous models (e.g. Seefeldt's Motor Skill Proficiency Barrier, Clark and Metcalfe's Mountain of Motor Development and Gallahue's Hourglass Model of Motor Development) have proposed the importance of obtaining a proficient level of fundamental movement skills (FMS) competence during childhood and deemed it to be critical for participation in lifelong sports and physical activity (Seefeldt, 1986; Clark, 2005; Gallahue and Ozmun, 2006). The development of movement skills described by these models follows a hierarchical structure (Seefeldt, 1986; Clark, 2005; Gallahue and Ozmun, 2006) which previous exposure and practice of FMS directly influences performance and further learning or progression (dos Santos et al., 2022). This is demonstrated by the commonly regarded interdependent phases of the motor development pathway beginning at FMS, leading to transitional movement skills (TMS) then onto sports specific skills (SSS) (Seefeldt, 1986; Pacheco et al., 2021). TMS are those which “assist with the transition from basic patterns to context-specific use of skills in games and activities" (Brian et al., 2020 eg. non sport specific skills (jump rope), small sided games and lead up activities (eg. putt a ball into a target - golf), while examples of SSS include dribbling in basketball, volleying in tennis and a back-pass in rugby (Pacheco et al., 2021).

FMS are believed to be the ‘building blocks’ required for performing activities (Barnett et al., 206; Behan et al., 2019). Children are not born with the ability to move proficiently. It is essential to give them opportunities to practice, learn and reinforce FMS overtime (Seefeldt, 1986; Clark, 2005; Barnett et al., 2016; Pacheco et al., 2021). If children cannot skip, run, kick, throw, catch etc., they will be presented with limited opportunities to participate in physical activity as they get older because they will not possess the prerequisite skills to be active (Stodden et al., 2008). Seefeldt’s model indicated that children with low FMS proficiency will experience difficulties learning TMS (Seefeldt, 1986). This ‘glass ceiling’ is known as the proficiency barrier.

Children with intellectual disabilities (CwID) are a cohort who consistently demonstrate low FMS proficiency in the literature (Kavanagh et al., 2023; Maïano et al., 2019), thus we can surmise that this population will be significantly impacted by the proficiency barrier. In order to determine how far below the proficiency barrier CwID are, it is first important to investigate FMS proficiency at both an individual skill and behavioural level basis. In essence, each FMS is composed of multiple behavioural components which are deemed essential to successfully and competently perform the skill (e.g. Ulrich’s Test of Gross Motor Development (TGMD-3)). Behavioural components can also be described as ‘performance criteria’ (Ulrich, 2013), achieving good proficiency in these performance criteria demonstrates a mature movement skill pattern (O’Brien et al., 2015). Identification of weaknesses in skills at the behavioural component level enable researchers and practitioners to address low levels of motor skill proficiency (van Beurden et al., 2002; Okely et al., 2004).

The majority of studies that document FMS proficiency of CwID, present the data as overall levels of FMS proficiency (Capio et al., 2017; Craig et al., 2018; Maïano et al., 2019; Staples et al., 2021), with a significant lack of data documenting FMS proficiency at the behavioural component level of performance. Exclusively reporting FMS at this aggregated level has left a knowledge gap in regard to CwID motor development, as many of the behavioural components are interlinked across multiple FMS, which if investigated further could demonstrate a trend of similar FMS deficiency across skills (O’Brien et al., 2015). Hence, researchers, coaches and teachers cannot determine what individual skills or skill characteristics remain underdeveloped (Lawson et al., 2021).

To date, among typically developing children (TDC) only five studies have analysed FMS proficiency at both a skill and behavioural component level (Hardy et al., 2010; Foulkes et al., 2015; O'Brien et al., 2015; Duncan et al., 2019; Lawson et al., 2021). To the best of our knowledge, no studies have yet been conducted to examine the individual skills and behavioural components of FMS proficiency in CwID. Reporting FMS at both an individual skills and behavioural component level would broaden the knowledge and understanding of FMS proficiency (Lawson et al., 2021). This would enable researchers to provide coaches and teachers with important information regarding CwID's development characteristics (Haywood and Getchell, 2019; Lawson et al., 2021). In addition to supporting gatekeepers to develop appropriate evidence-based strategies to address low FMS proficiency among CwID by focusing on activities that aim to develop and improve weaker FMS at a behavioural component level (Lawson et al., 2021).

The aim of this study is threefold: (1) to to assess FMS at the behavioural component level of performance among CwID, (2) to identify weaknesses within performance and commonality of these weaknesses across skills and (3) to investigate the role of gender and age on FMS proficiency for CwID.

Method

Participants

Cross-sectional data were collected as part of the *'SO Fun'* project with Special Olympics Ireland. Fifteen Special Olympics Young Athletes clubs were contacted with 10 clubs agreeing to participate in the study. The eligibility criteria for participating in this study included; children with intellectual disabilities who are registered with the Special Olympics Young Athletes programme, aged 4-12 years, who are fully mobile and can walk without the use of an aid. A sample of 100 children with intellectual disabilities were recruited from clubs across 8 counties in each of the four provinces of Ireland and Northern Ireland. 66% of the participants had Down Syndrome (DS), while the remaining participants reported their condition as an Intellectual Disability. The sample consisted of 60% boys with an age range of 4-12 years and a mean age of 7.53 ± 2.01. Data were collected during the period of October 2021 to June 2022.

Ethical approval was obtained from Dublin City University, Research Ethics Committee (DCUREC/2021/100). The coaches of each of the participating clubs provided initial written consent for the research team to visit the club, while written parental/guardian consent was also obtained and required in order for participants to partake in the study as they were minors. Written consent forms were collected by the research team prior to data collection. Anonymity was maintained with each participant assigned a unique numerical code.

Measures

Participants demographics including age and gender were collected through the consent forms and questionnaires completed by parents. The FMS proficiency of the participants was assessed using a subset of the process-oriented battery, the Test of Gross Motor Development-3rd Edition (TGMD-3) which has established clinical validity (Pitchford & Webster, 2021; Temple & Foley, 2017), instructional sensitivity (Staples et al., 2021), and reliability ($\alpha = .81$) for children with and without ID in this age cohort (Rey et al., 2020; Magistro et al., 2018). The TGMD-3 was individually administered to each participant, the skills focused on two subsets of FMS, locomotor skills (run, skip, horizontal jump and hop) and ball skills (catch, kick, overhand throw, underhand throw, stationary dribble and one hand strike) (Ulrich, 2013).

Balance was assessed using a subtest of the Bruininks-Oseretsky Test of Motor Proficiency 2 Short Form (BOT-2-SF). Nocera et al. (2021) found that the BOT-2 Short Form demonstrates excellent reliability ($\alpha = .75$) when assessing motor competence in CwID. Participants completed two tasks within the balance component, a single leg stand on a balance beam with the eyes open and walking forward heel-to-toe on the line. The authors chose to use the TGDM-3 and the BOT-2 as the motor competence assessment tools due to their psychometric properties in assessing CwID, particularly in field settings (Downs et al., 2020).

Data Collection

All members of the research team undertook formal training in order to ensure an in-depth understanding of the skill assessment batteries, in addition to establishing consistency when visually demonstrating the skills to each participant. The visual demonstration of the skill was in line with Ulrich's (2013) and Bruininks (2005) protocols. The skill assessment batteries were individually administered to each participant during their Young Athletes club training session. Participants received no cues or verbal feedback. Participants were provided with an opportunity to perform a practice trial to become accustomed with each skill, followed by two opportunities to perform the skill. All of the participants' performances were video recorded.

A trained member of the research team observed each trial retrospectively, assessed and scored each skill component. A score of 1 was given if the participant successfully performed the criteria and a 0 was recorded if the participant failed to meet the criteria. Participants' raw scores per skill were calculated by collating the scores from both trials. Once all skills were assessed, raw subtest scores for locomotor and ball skills were calculated and were then combined to provide a total raw FMS score.

The balance subtests were scored based on their performance outcome. Walking forward heel-to-toe on the line was graded based on the number of steps taken by the participant, while adhering to strict criteria (Bruininks and Bruininks, 2005). Participants were then awarded points based on the number of successful steps taken, e.g., six continuous steps in line with criteria, equals a max score of four points. The single leg stand on the balance beam was graded on the amount of time the participant could maintain their balance while adhering to the strict criteria (Bruininks and Bruininks, 2005). Participants were then awarded points based on the time they maintained their balance, e.g., maintaining balance for 10 seconds in line with the criteria equals a top score of four points. Second trials were only carried out if the maximum score was not reached in the first trial (Bruininks and Bruininks, 2005).

Data Analysis

All data was analysed using SPSS version 27 and R. To describe the characteristics of the data, means, standard deviations, and tetrachoric correlations on the variables of interest were computed. The main analyses were undertaken on the total FMS scores, locomotor, ball skills and balance subtest scores. Descriptive statistics and frequencies for locomotor and ball skills and their associated behavioural components were calculated. Cohen's d was used as the effect size in group mean difference measures and an alpha level of .05 was established for all statistical analysis. Additionally, a binary variable composed of "mastery" and "near mastery" was created for each skill and is reported in Table 5.2 as "% Mastery". Using procedures previously described by researchers (Behan et al., 2019; Duncan et al., 2019, O'Brien et al., 2015) 'mastery' was defined as performing all skill component criteria correctly on both trials, 'near mastery' was described as performing all but one skill component criteria correctly per trial but not twice for the same component, while 'poor' was described as any participant who scored below these two categories (i.e. their performance was incorrect on two or more skill criteria on both trials) (van Beurden et al., 2002). The proportion of children who achieved mastery in all of the 10 skills was determined. The proportion of children not achieving mastery in any of the skills was also determined. The number of skills mastered per participant was calculated. The percentage of boys and girls who achieved mastery/ near mastery in each skill was reported by producing descriptive statistics and frequency tables (procedure described below). Tetrachoric correlation coefficients were computed with two binary variables, Prevalence of Failure (Classified as 'Poor', 'Near Mastery') and Mastery, to determine correlations at an individual level between behavioural components of each skill. These findings are presented in a tetrachoric correlation matrix (Table 5.2). Finally, a multiple regression was used to determine whether the interaction of age and gender was a predictor of FMS proficiency. Simple linear regressions were used to assess the impact of gender and age on participants' locomotor, ball skills, balance and total FMS proficiency.

Results

Behavioural Component Analysis

A comprehensive analysis of the behavioural components (i.e. the performance criteria of the movement pattern e.g arms extended, knees flexed etc.) of each individual skill from the locomotor and ball skills subtests were conducted (Figure 5.1 and Supplementary Figure 5.1). For the whole sample, 0% (n= 100) participants mastered all 10 FMS, 1% (n = 1) participants mastered all 4 locomotor skills while 0% (n=100) participants mastered all ball skills. On an individual skill level, the percentage of participants not achieving mastery in any one skill is 52% (n =52). On average, each participant mastered 0.91 skills, i.e. less than 1 skill out of 10. A simple tetrachoric correlation matrix of the behavioural components is presented in Supplementary Figure 5.1, highlighting how strong or weak the associations between behavioural components are. A selection of skills with significant positive correlations (≥ .6) with multiple other skill components, were extracted from the larger tetrachoric correlation matrix and are presented in Table 5.1. A '0' indicates no association while a '1' or '-1' indicates strong positive or negative associations, respectively. The criteria for each skill in the correlation matrix are listed in the same order as outlined in Figure 5.1.

Figure 5.1 Prevalence of failure (%) (Classified as 'poor', 'near mastery') and prevalence of mastery (%) for each behavioural component of locomotor and ball skills

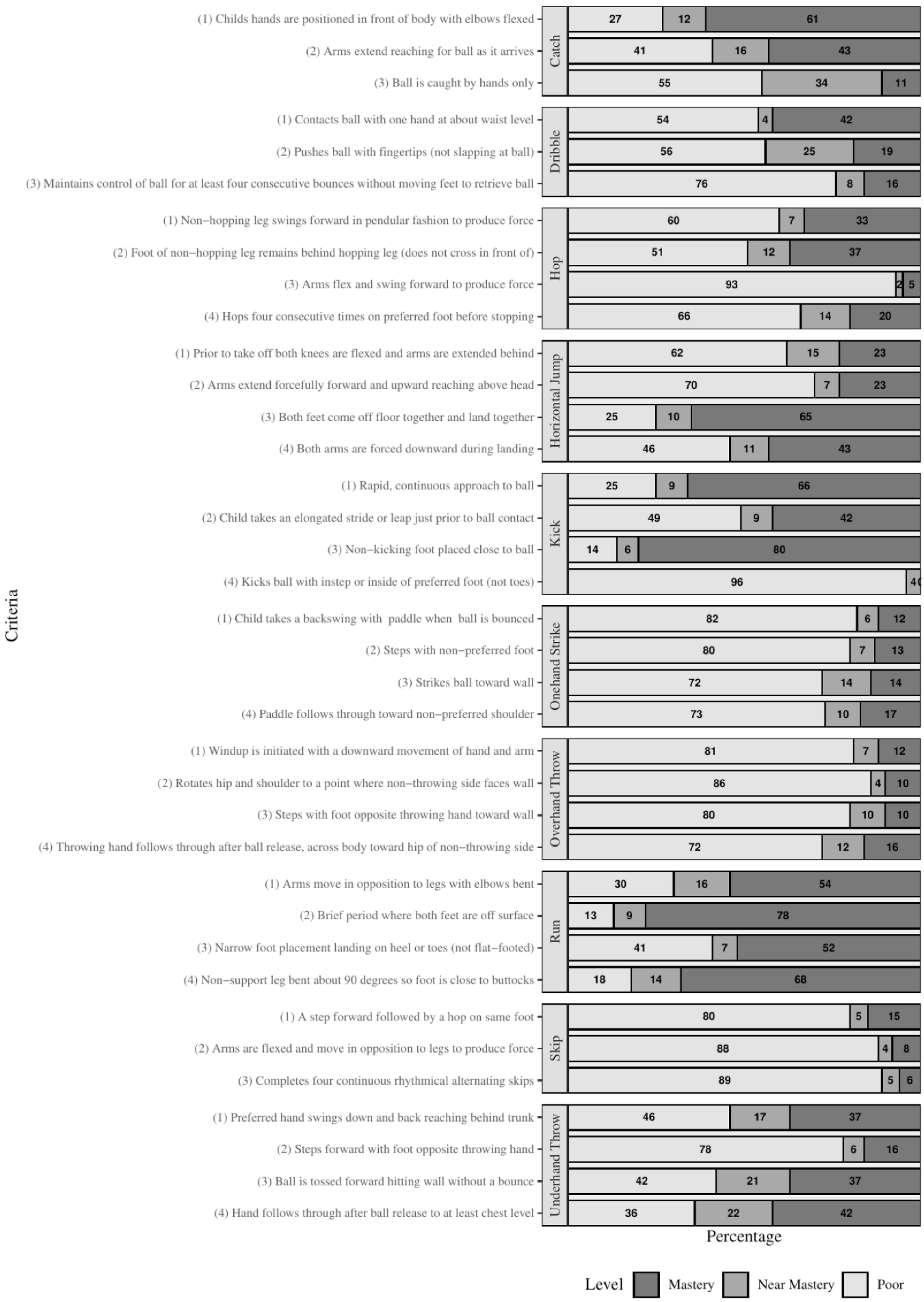


Table 5.1 Examples of significant tetrachoric correlations between behavioural components of different skills (Skills with significant positive correlations (≥ .6) with multiple other skill components)

	Kick C1	Kick C2	Underhand Throw C1	Underhand Throw C2	Underhand Throw C3
Horizontal Jump C1		0.64			
Horizontal Jump C2	0.60	0.81			
Horizontal Jump C3	0.96	0.70			
Horizontal Jump C4	0.69	0.97			
Run C2	0.60	0.61			0.65
Run C4	0.64	0.61			
Dribble C2			0.62	0.67	
Dribble C3					0.61
One hand Strike C2			0.69	0.62	
One hand Strike C3			0.67	0.67	
Overhand Throw C2				0.60	0.62

C = criteria, p < .01

Gender and Age

A multiple regression was carried out to investigate whether the interaction of gender and age was a predictor of FMS proficiency. The model demonstrated no significant interaction effect for total FMS proficiency (F(7,83) = 1.1, p = .068, R^2 = .15). Similarly, no significant interaction effect was found to predict locomotor F(7,83) = 1.99, p = .067, R^2 = .15); ball skills (F(7,83) = 1.5, p = .19, R^2 = .12) and balance scores(F(7,83) = .44, p = .88, R^2 = .04). Across all of the models, the lack of a significant interaction between age and gender suggests that FMS proficiency remains the same regardless of these variables, i.e. does not change differently between genders as the children age (Figure 5.2). A linear regression was carried out to investigate if age was a predictor of FMS proficiency. The model demonstrated a significant effect for total FMS proficiency (F(1,98) = 4.8, p = .031, R^2 = .047). Similarly, a significant effect was found to predict ball skills (F(1,98) = 7.5, p = .007, R^2 = .071). No significant effect was found to predict locomotor (F(1,98) = .81, p = .37, R^2 = .008) and balance skills (F(1,98) = .80, p = .38, R^2 = .008). Across two of the models, age had a significant effect on total FMS proficiency and ball skills meaning that older children perform better in these two domains compared to younger children.

A linear regression was carried out to investigate if gender was a predictor of FMS proficiency. The model demonstrated no significant effect was found to predict total FMS proficiency (F(1,98) = .9, p = .35, R^2 = .009), locomotor (F(1,98) = 1.75, p = .19, R^2 = .018) and ball skills (F(1,98) = .25, p = .62, R^2 = .003). In contrast to this, a significant effect was found to predict balance skills (F(1,98) = .14.9, p = .000, R^2 = .132) with girls outperforming the boys (see Table 5.2).

Additionally, we examined the degree to which boys and girls with ID “mastered” the individual skills within the locomotor, ball skills and balance subtests. The percentage of mastery/near mastery achieved by the genders (see Table 5.2). The average percentage mastery for each subtest was calculated by adding the percentage mastery of the individual skills and dividing by the number of skills. The average percentage mastery for total FMS was calculated by adding the average percentage mastery of locomotor and ball skills and dividing by two.

Figure 5.2 Interaction effect of age and gender on FMS proficiency

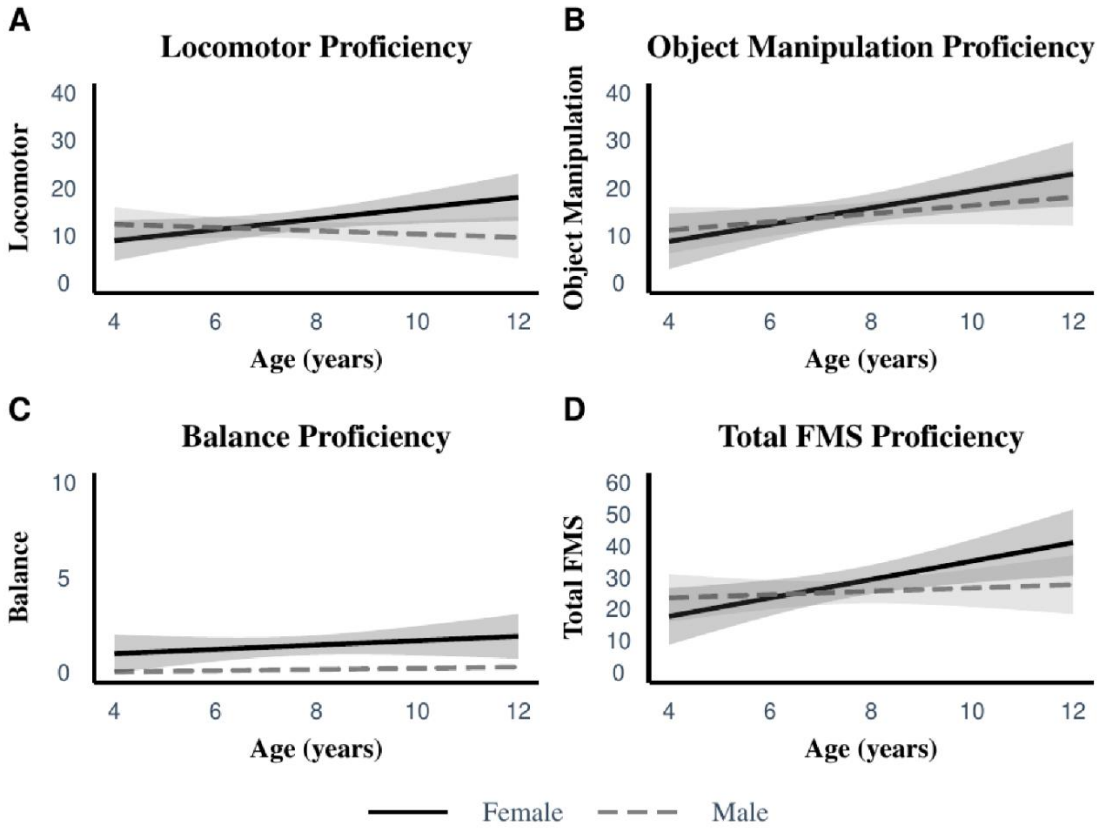


Table 5.2 Mean (±SD) FMS proficiency scores and % mastery among CwID

	Score (M ±*SD*)				% Mastery	
FMS	Boys	Girls	Sig.	ES	Boys	Girls
Locomotor						
Run	5.37 ± 2.68	5.78 ± 2.14	.42	0.17	56.7	62.5
Skip	0.59 ± 1.35	0.93 ± 1.74	.27	0.22	5.0	12.5
Hop	2 ± 2.38	2.63 ± 2.83	.24	0.25	11.7	22.5
Horizontal Jump	3.32 ± 2.94	3.8 ± 2.33	.39	0.19	28.4	22.5
Total	11.27 ± 7.16	13.13 ± 6.43	.19	0.28	25.45#	30#
(max score = 30)						
Ball Skills						
Dribble	1.65 ± 2.11	1.78 ± 2.04	.77	0.07	21.7	15.0
Catch	2.94 ± 1.6	3.03 ± 1.77	.79	0.06	38.4	22.5
Kick	4.02 ± 2.24	3.7 ± 2.11	.48	0.15	21.7	22.5
Overhand Throw	1.09 ± 1.91	1.6 ± 2.19	.22	0.25	5.0	7.5
Underhand Roll	3.1 ± 2.66	3.6 ± 2.43	.35	0.2	18.4	25.0
Strike	1.47 ± 2.37	1.53 ± 2.1	.9	0.03	13.4	5.0
Total	14.25 ± 9.55	15.23 ± 9.62	.619	0.11	19.8#	16.25#
(max score = 44)						
Balance						
Beam Balance	0.14 ± 0.66	0.58 ± 1.18	.02*	0.47	0.00	0.00
Walking on Line	0.04 ± 0.26	0.85 ± 1.48	.001**	0.77		
Total	0.17 ± 0.7	1.43 ± 2.39	.001**	0.72	0.00#	0.00#
(max score = 8)						
FMS Total						
(Loco & BS)	25.52 ± 14.7	28.35 ± 14.6	.346	0.2	22.62#	23.12#
(max score = 74)						

*p < .05; **p <.01, ES = Cohen's d, # = Average % Mastery, Loco = Locomotor, BS = Ball Skills

Discussion

The aim of this study is threefold: (1) to to assess FMS at the behavioural component level of performance among CwID, (2) to identify weaknesses within performance and commonality of these weaknesses across skills and (3) to investigate the role of gender and age on FMS proficiency for CwID.

Behavioural Component Analysis

Cumulatively, the findings of the present study suggest that FMS proficiency levels of CwID are only at the initial stage of motor development (Gallahue, Ozmun and Goodway, 2012; Salehi et al., 2017) with 0% of the participants mastered all ten FMS. Also on average, participants mastered less than one in ten skills, indicating extremely low skill execution among CwID aged 4-12. The results demonstrate that CwID do not have the "building blocks" required to develop and perform more complex FMS, therefore they may potentially be experiencing a proficiency barrier, limiting their ability to progress onto TMS and then SSS. Without achieving adequate proficiency in FMS they limit their ability to participate in lifelong sport and physical activity (De Meester et al., 2018; Duncan et al., 2019).

From perspectives rooted in theory, these motor skill delays can be described by Newell's (2020) model of motor development which explains the interaction between an individual's constraints (e.g. motivation, intellectual functioning, body mass), the task constraints (specific to task being delivered e.g. instructions of task, complexity and goal) and their surrounding environmental constraints (e.g. how others are acting around you, loud noises new environment), all factors which may limit or impair FMS development (Duncan et al., 2019; Haywood and Getchell, 2019; Lawson et al., 2021). Previous research has found that a constraints-led approach is a practical coaching/teaching method that enables the practitioner to manipulate certain constraints which best allows the learner to develop mature motor skill patterns (Renshaw and Chow, 2018; Newell, 2020). An example of where this approach has proven successful for CwID (aged 6 - 10 years) is in a study by Capio and Eugia (2021) where they designed a ball skills training program consisting of six skills. The tasks for each skill were adapted to reduce the number of errors experienced and set the child up for success e.g. distance from the target (overhand throw), size of the target (underhand throw), size of the ball, light beach ball - hard rubber (catch), distance from the goal (kick) and number of one hand dribbles before catching ball with two hands (dribble). The results displayed significant and large improvements in ball skills proficiency of CwID (Capio and Eugia, 2021). This is an example of the constraints led approach in action where the researchers adapted the task constraint in order to directly impact the motor behaviour.

It can be argued that mastery of the skills demonstrated in this current study were particularly weak due to high failure levels amongst specific behavioural components (O'Brien et al., 2015) as demonstrated in Figure 5.1 While each of the ten FMS demonstrate different outcomes, there is significant overlap between the behavioural components of these skills (O'Brien et al., 2015; Duncan et al., 2019; Lawson et al., 2021). The tetrachoric correlation coefficients presented in Table 5.1 and Supplementary Figure 5.1 provide further insight into the interdependencies of behavioural components across multiple skills and their influence on motor skill development and performance. Examples of these interdependencies include: i) criteria 2 for run and criteria 3 for horizontal jump (Supplementary Figure 5.1) with a strong correlation coefficient of .67; ii) participants who failed to have both of their feet off the ground for a brief period of time in the run, also failed to have both of their feet coming off the floor together and landing together in the horizontal jump and iii) performance in criteria 3 of the horizontal jump is strongly associated with criteria 1 (correlation coefficient .96) and criteria 2 (correlation coefficient .70) in the kick (Table 5.1). This demonstrates that the behavioural components within the horizontal jump are linked with running and kicking ability. Likewise, criteria 1-3 in the underhand throw (Table 5.1) has a strong positive performance of criteria 2 and 3 in the overhand throw (correlation coefficient .6) and criteria 2 (correlation coefficient .6) and 3 (correlation coefficient .7) in the one hand strike. This means that if CwID are performing poorly in one or more criteria of a certain skill, this is likely to negatively impact their performance across a number of other skills. Coaches and teachers of CwID should be concerned with the behavioural components which were failed by the majority of participants as this data provides the crucial components of task constraints that interventions must target (Lawson et al., 2021) in order to increase the FMS proficiency of CwID. It is also beneficial for practitioners on the ground to understand the significant overlap between behavioural components of FMS.

Upon further investigation, the behavioural components that are regarded as more difficult to master demonstrated the highest percentage failure. Typically, the performance issues arose when CwID were asked to coordinate movements that involved both sides of their bodies or moving both arms and legs sequentially as part of the overall skill production. Examples of these movements (Supplementary Figure 5.1 and Table 5.1) include, moving the arms in opposition to the legs (skip criteria 2, 92% prevalence of failure), arms flex and swing forward to produce force (hop criteria 3, 95% prevalence of failure), failing to extend the arms forcefully (horizontal jump criteria 2, 77% prevalence of failure), failing to step forward with foot opposite throwing hand (underhand throw criteria 2, 84% prevalence of failure) and (overhand throw criteria 3, 90% prevalence of failure). Moreover, a large proportion of CwID struggled when skills required them to rotate their body (overhand throw criteria 2, 90% prevalence of failure) and (one hand strike criteria 1, 88% prevalence of failure). The findings presented in this study are consistent with those found in studies also assessing the behavioural components of skills however, these studies reported on TDC of various ages including (a) Irish adolescents (O'Brien et al., 2015), (b) Australian pre-school children (Hardy et al., 2010) and (c) British preschoolers and primary school children (Foulkes et al., 2015; Duncan et al., 2019; Lawson et al., 2021).

To summarise, these findings suggest that the areas in which CwID experience the most difficulty are the "timing and coordination of movement sequences" (Westendorp et al., 2011). CwID have the ability to perform skills that are less complex and have reduced reliance on cognitive functioning (Westendorp et al., 2011), however when numerous body parts are required to move simultaneously more errors in FMS proficiency arise. The analysis of individual skills at the behavioural component level has highlighted some of the environmental and task constraints of FMS development that can be used by coaches/teachers to develop and tailor more specific, effective interventions within and across FMS that target these weaknesses (O'Brien et al., 2015; Duncan et al., 2019; Lawson et al., 2021). This in depth understanding of FMS at the behavioural component level will provide a key focus for gatekeepers to direct them to the skill components requiring improvement, in addition to assisting them in modifying task achievements to have the greatest impact on FMS progression for CwID and help this population overcome the proficiency barrier (Robinson and Goodway, 2009; Barnett et al., 2016; Lawson et al., 2021). To our knowledge, this is the only study of its kind to evaluate FMS development at a behavioural component level for CwID, so this area still remains relatively unexplored and should be investigated in future studies.

Gender and Age

Despite research describing balance as 'the most basic skill' of the FMS components (Gallhue, Ozmun and Goodway 2012), the overall balance scores for participants in this study are particularly poor compared to locomotor and ball skills scores (Table 5.2). This finding is in line with other studies analysing CwID (Golubović et al., 2012; Craig et al., 2018; Kavanagh et al., 2023). In addition, there is a large and significant difference between the two groups in the subtest of balance where the girls achieved significantly higher mean scores ($p < .001$), particularly in the walking on the line skill where the effect size is 0.77. It is important to note that despite the girls outperforming the boys, overall as a cohort their balance proficiency levels are extremely poor and far behind what is expected. Improvements in static and dynamic balance for CwID is vital, not only to improve overall FMS proficiency but also to increase stability during activities of daily living and thus decrease risk of falls (Maïano et al., 2018).

The literature demonstrates that in relation to the balance skills of school aged children, girls outperform boys, in particular with the single leg stand (Mickle et al., 2011; Rodríguez-Negro, 2019). Many articles have demonstrated that gender differences in FMS performance can be accounted for by the activities that boys and girls participate in; these are often determined by social factors such as family, friends and also the physical environment (Hardy et al., 2010; Behan et al., 2019). In terms of the developmental timelines of girls and boys, it is important to note that children in this study are between the ages of 4-12 years and therefore, possess similar biological characteristics prior to reaching puberty including body composition, limb length, strength and genotype (Malina et al., 2004). Furthermore, girls tend to participate more in activities such as gymnastics and dance which strengthen locomotor and balance skills, while boys often participate in sports and activities like football which heavily involve ball skills (Behan et al., 2019). Ultimately, these studies refer to TDC, there is a clear lack of evidence focusing specifically on gender differences of FMS in CwID. Further research is required in order to confirm if the gender differences in FMS documented for TDC are the same for CwID.

When considering specifically CwID, previous studies on FMS proficiency often only focuses on the locomotor and ball skills subtests, rather than a holistic view of all three subtests. Results from a study by Rudd et al. (2015) indicate that children's balance skills will not improve by solely focusing on performance of locomotor and object control skills. Debates within the literature exist discussing whether balance is deemed as a FMS or whether it is simply postural adjustments to different environments (Lawson et al., 2021). In this paper, we hold the view that balance is a type of FMS, aligning with Newell's (2020) in-depth analysis of FMS development. This perspective offers a comprehensive understanding of FMS proficiency among CwID. It is evident from the balance results displayed in Table 5.2 that FMS interventions need to focus on balance skills for CwID, in addition to incorporating locomotor and ball skills training.

Conclusions and Implications for Future Research

The results of this study highlight the variation in mastery of skills at a behavioural component level for the first time amongst CwID. The weaknesses presented across the FMS may indicate that CwID are experiencing a 'proficiency barrier' that could hinder their involvement in lifelong sport and physical activity. It is important to highlight that all participants in this study take part in the Special Olympics Ireland Young Athletes Programme and therefore attend weekly sports training. Going forward, it would be ideal to have access to a control group of CwID to gain further indication of the role and impact of the Special Olympics Ireland Young Athletes Programme. Additionally, this would be vital to investigate any further deficiencies in FMS proficiency that may exist for CwID who do not participate in any sports or physical activity outside of school. It is hypothesised by Seefeldt (1986) that children may need to meet a certain mastery level in FMS in order to progress and acquire more complex skills e.g. TMS and SSS (dos Santos et al., 2022). Overcoming this proficiency barrier phenomenon is particularly important for CwID in order for them to gain the health enhancing benefits from lifelong physical activity participation and improve their overall quality of life. The findings indicate the importance of coaching/teaching each individual skill component and presenting CwID opportunities to repeat the movements multiple times in order to achieve skill mastery. Coaches and Teachers could adopt a constraints-led approach to teaching FMS in order to provide CwID the chance to succeed when practising FMS. Balance appears to be the weakest component of the three FMS subtests and future interventions need to account for this. Studies focusing on TDC have empirically tested the motor skill proficiency barrier, however this has not yet been done in CwID. Future studies could test the hypothetical barrier to investigate its impact on FMS development in CwID.

Supplemental Information

Supplementary Figure 5.1 Tetrachoric correlation matrix of the behavioural components of each skill. All coloured areas in the matrix are p <.01

	cc1	cc2	cc3	dc1	dc2	dc3	hc1	hc2	hc3	hc4	hjc1	hjc2	hjc3	hjc4	kc1	kc2	kc3	kc4	uhtc1	uhtc2	uhtc3	uhtc4	rc1	rc2	rc3	rc4	sc1	sc2	sc3	ohsc1	ohsc2	ohsc3	ohsc4	ohtc1	ohtc2	ohtc3	ohtc4
cc1																																				
cc2	.20																																			
cc3	.30	.20																																		
dc1	-.01	.13	.14																																	
dc2	.04	.24	.23	.93																																
dc3	.08	.02	.16	.58	.66																															
hc1	.08	.25	.16	.48	.62	.62																														
hc2	.08	.11	.13	.50	.57	.57	.81																													
hc3	.36	-.02	.52	.56	.60	.61	.54	.54																												
hc4	-.08	.05	.06	.49	.63	.63	.78	.76	.58																											
hjc1	.18	-.20	.15	.49	.39	.26	.27	.33	.49	.16																										
hjc2	.26	-.14	.06	.43	.42	.42	.45	.45	.38	.44	.52																									
hjc3	.26	.04	.16	.34	.33	.39	.43	.41	.31	.28	.57	.58																								
hjc4	.45	-.15	.00	.46	.43	.45	.42	.49	.40	.28	.65	.77	.71																							
kc1	.26	.04	.18	.25	.30	.39	.41	.40	.34	.31	.53	.60	.96	.69																						
kc2	.41	-.11	.06	.48	.49	.49	.47	.52	.46	.35	.64	.81	.70	.97	.73																					
kc3	.30	.24	.32	-.01	.16	.33	.47	.30	.04	.10	.01	.06	.18	.23	.18	.21																				
kc4	.22	-.32	.04	-.15	-.13	.02	-.11	.02	.28	.13	.32	.38	.05	.21	.21	.23	-.13																			
uhtc1	.16	.11	.18	.53	.62	.54	.45	.29	.52	.43	.36	.43	.14	.44	.19	.52	.27	.24																		
uhtc2	.03	.45	.08	.52	.67	.46	.42	.32	.29	.45	.20	.10	.23	.25	.26	.31	.29	-.06	.62																	
uhtc3	.10	-.02	.08	.45	.55	.61	.53	.42	.33	.44	.42	.35	.48	.52	.41	.47	.43	-.05	.45	.49																
uhtc4	.00	.10	.07	.41	.49	.39	.36	.42	.12	.33	.32	.42	.46	.46	.43	.40	.34	.12	.43	.48	.70															
rc1	.11	.03	.09	.49	.51	.22	.31	.30	.21	.29	.22	.35	.41	.50	.38	.56	.15	-.33	.33	.53	.30	.25														
rc2	.21	.16	.18	.43	.45	.43	.54	.46	.22	.31	.53	.40	.67	.63	.60	.61	.61	-.15	.34	.42	.65	.53	.50													
rc3	.34	-.11	.23	.30	.29	.31	.44	.47	.47	.44	.36	.50	.40	.60	.41	.58	.33	.16	.37	.11	.47	.33	.42	.63												
rc4	.06	.04	.25	.42	.42	.31	.48	.52	.26	.31	.39	.42	.64	.62	.64	.61	.40	.07	.32	.30	.50	.59	.43	.68	.62											
sc1	-.06	-.07	.18	.08	.19	.32	.58	.61	.29	.38	.28	.19	.47	.18	.49	.23	.45	.06	-.01	.05	.20	.24	.10	.40	.21	.38										
sc2	-.07	-.02	.08	.45	.58	.39	.45	.37	.30	.52	.17	.28	.31	.10	.32	.13	.26	.14	.21	.34	.34	.44	.18	.30	.12	.27	.61									
sc3	-.27	-.02	.21	.02	.13	.18	.48	.41	.12	.44	-.04	-.02	.26	-.17	.27	-.14	.31	.01	-.13	-.04	.07	.13	-.08	.26	.08	.33	.77	.64								
ohsc1	-.36	-.12	.14	.32	.43	.30	.40	.20	.18	.44	.17	.24	.04	.12	.02	.17	.26	-.09	.56	.40	.53	.44	.28	.29	.30	.19	.12	.28	.07							
ohsc2	-.13	.09	-.04	.49	.55	.37	.35	.27	.12	.43	.06	.37	.09	.35	.13	.40	.26	.04	.69	.62	.41	.40	.51	.31	.35	.48	-.12	.22	-.06	.53						
ohsc3	.12	.10	.11	.40	.56	.56	.42	.17	.29	.46	.06	.23	.03	.25	.04	.30	.52	-.04	.67	.67	.54	.30	.41	.46	.32	.13	.01	.38	-.02	.62	.64					
ohsc4	-.29	.15	.18	.35	.45	.18	.33	.11	.03	.35	.06	.08	-.17	-.05	-.17	.01	.40	-.05	.55	.53	.30	.30	.24	.35	.16	.22	.00	.33	.20	.72	.64	.72				
ohtc1	.34	.26	.06	.28	.40	.35	.52	.24	.45	.47	.19	.22	.45	.39	.47	.43	.15	.10	.48	.47	.39	.11	.22	.37	.35	.34	.06	.21	.13	.17	.35	.45	.18			
ohtc2	.25	.10	.15	.36	.48	.34	.44	.29	.43	.44	.18	.20	.23	.38	.22	.41	.19	-.06	.60	.53	.62	.25	.43	.33	.44	.31	-.12	.05	-.13	.43	.60	.53	.29	.69		
ohtc3	.03	.29	.06	.24	.33	.35	.34	.15	.17	.33	.23	.12	.30	.30	.29	.34	.15	-.15	.46	.61	.53	.21	.31	.43	.20	.22	-.24	-.20	-.19	.37	.49	.47	.36	.62	.74	
ohtc4	.15	.17	.18	.34	.44	.21	.35	.26	.32	.44	.19	.26	.29	.25	.30	.32	.10	-.05	.41	.34	.16	.22	.44	.49	.41	.24	.13	.31	.23	.19	.25	.34	.28	.43	.43	.35	

Linking Chapter 5 to Chapter 6

Chapter 5 highlighted the variation in mastery of skills at a behavioural component level for the first time amongst children with ID. The weaknesses presented across the FMS may indicate that children with ID are experiencing a 'proficiency barrier' that could hinder their involvement in lifelong sport and physical activity. This is the first time that this methodological approach has been used to examine children with ID while it has only been used five times amongst TDC. Future research should include a control group of children with ID who do not attend SO training in order to see the impact that the YA programme has on the motor skill development of participants. Additionally, a control group would be vital to investigate any further deficiencies in FMS proficiency that may exist for children with ID who do not participate in any sports or physical activity outside of school. It is hypothesised by Seefeldt (1986) that children may need to meet a certain mastery level in FMS in order to progress and acquire more complex skills e.g. TMS and SSS. Overcoming this proficiency barrier phenomenon is particularly important for children with ID in order for them to gain the health enhancing benefits from lifelong physical activity participation and improve their overall quality of life. The findings indicate the importance of coaching/teaching each individual skill component and presenting children with ID opportunities to repeat the movements multiple times in order to achieve skill mastery.

Chapter 6 acknowledges the gatekeeper role that coaches play in influencing a child's desire to participate in sport and PA, as well as having an impact on their overall development (MacDonald et al., 2016). For children with ID, sport and PA need to be a vehicle not only for the development of FMS but also a driver for developing independence and social skills (Downs et al., 2014). Due to the large role that coaches play in developing children's FMS, Chapter 6 investigates whether coaches can accurately report on children's actual MC (Liong et al., 2015). This research will provide insight for sports organisations to determine whether coaches can accurately report on the MC of children with ID and highlight where further coach education may be required.

Chapter 6: Can Special Olympics Coaches accurately report on the motor competence of children with intellectual disabilities?

Abstract

Participation in physical activity (PA) during childhood is recognised as a key factor in leading a healthy lifestyle. If children are not participating in PA, they will not be provided with opportunities to develop their motor competence (MC). Sports coaches play an integral role in motivating children with intellectual disabilities to continue engaging in sport and PA. Despite this, little research has been carried out investigating whether coaches can accurately report on MC levels of children with intellectual disabilities. This study examined the MC of children with intellectual disabilities (n = 100, mean age 7.5 ± 2 years) and coaches' perceptions of children's MC (n = 10, mean age 45.1 ± 8.3 years). Participants were assessed using TGMD-3 and balance subtest from BOT-2. Coaches completed an adapted version of the PMSC scale. The impact of children's PA level on their MC was assessed using a linear regression analysis. The predictive power of coaches perceived MC vs children's actual MC was assessed. Weak to moderate Pearson's correlations were found between the children's actual MC at the individual skill level and the coaches' perception of children's MC. The results of the POMP method indicate that coaches rate children's MC higher by 21.5% in locomotor subset and 33.8% higher in ball skills subset compared to the objective TGMD-3 assessment tool scores. The results presented will help to highlight the knowledge gap that exists for coaches and will act as a motivator for sports organisations to implement more coach education opportunities.

Keywords: Motor competence, Children with intellectual disabilities, Perception, Proxy assessments, Sports coaches, Special Olympics

Introduction

Participation in physical activity during the childhood years is recognised as a key factor in leading a healthy lifestyle, through to adulthood and beyond (World Health Organisation, 2019). In spite of this, children around the world are failing to meet the recommended physical activity (PA) guidelines of 60 minutes per day of moderate to vigorous intensity activity (Bull et al., 2020) which is a public health concern. Similarly, children with intellectual disabilities are not meeting the recommended PA guidelines and are even less active then their typically developing peers (Einarsson et al., 2015; Wouters et al., 2019). An intellectual disability is characterised by limitations in both intellectual functioning and adaptive behaviour, this disability is diagnosed before an individual reaches twenty two years of age (Boat and Wu, 2015). Overall, if children are not participating in PA, they will not be provided with sufficient opportunities to develop their motor competence (MC) meaning that as they age, they will not possess the prerequisite skills to be active (Stodden et al., 2008; Barnett et al., 2016a). Research outcomes clearly show that high levels of MC are associated with increased PA participation (Gallahue et al., 2012) and positive health outcomes for all children, including those with intellectual disabilities (Eugia, Capio and Simons, 2015).

MC is the ability to perform "goal directed human movements in a co-ordinated, accurate and relatively error free manner" (Downs et al., 2020, p1). Fundamental movement skills (FMS), also known as gross motor skills, involving large musculature in the arms, trunk and legs (Clark, 1994) are an integral component of MC. FMS encapsulates three categories of movements including locomotor (e.g., skipping, running), ball skills (e.g. throwing, catching) and balance (e.g. dynamic and static stability) (Logan et al., 2018; Barnett et al., 2016a). Despite the positive benefits associated with higher levels of MC, the literature frequently reports that children with intellectual disabilities consistently demonstrate low proficiency in FMS (Maïano et al., 2019; Kavanagh et al., 2023). This is concerning as Stodden et al. (2008, p. 297) describes a model in which children who demonstrate low MC have the potential to be drawn into a "negative spiral of disengagement" in which low FMS proficiency levels contribute to low self-perception of physical competence perpetuating lower levels of PA participation. This spiral results in an increased risk of developing obesity and other negative health outcomes (Stodden et al., 2008). Amongst children with intellectual disabilities, low MC has been shown to hinder their psychological, social and physical development (Westendorp et al., 2011). All of the aforementioned risks associated with low MC in children with intellectual disabilities have the potential to impact overall quality of life and future wellbeing, which extends far beyond childhood.

For children with intellectual disabilities, one of the key determinants of PA participation is the role and level of support of significant others, including their parents, teachers and coaches (McGarthy and Melville, 2018). Research has demonstrated that PA levels of children with intellectual disabilities are significantly correlated with parental behaviours and beliefs of PA (McGarthy et al., 2018). These findings are in line with research amongst typically developing children which emphasise parents as "gatekeepers" of PA participation and promotion (Peterson et al., 2020). In addition to parents, sports coaches play an integral role in influencing a child's desire to participate in sport and PA, as well as having an impact on their overall development (MacDonald et al., 2016). Research specific to the intellectual disabilities sporting context, found that coaches maintain a gatekeeper role in motivating people with intellectual disabilities to continue engaging in sport with Special Olympics (SO) (Farrell et al., 2004). For children with intellectual disabilities, sport and PA need to be a vehicle not only for the development of FMS but also a driver for developing independence and social skills (Downs et al., 2014).

Due to the large role that coaches play in developing children's FMS, an area of interest for researchers and practitioners is whether coaches can accurately report on children's actual MC (Liong et al., 2015). Previous research from Estevan et al. (2018) and Liong et al. (2015) demonstrated that parents and physical education (PE) teachers' perceptions of children's MC are significantly associated with children's actual MC scores. These results support the idea that both parents and teachers could potentially provide proxy reports of children's actual MC. Whilst a small number of studies have considered the perceptions of parents and teachers providing proxy reports on typically developing children's actual MC, to our knowledge no studies to date have examined the potential relationship between coaches' perceptions of children's MC and children's actual MC.

Sports coaches play an integral role in developing the MC of children with intellectual disabilities (MacDonald et al., 2016), despite this, little research has been carried out investigating whether coaches can accurately report on MC levels. The implementation and success of targeted FMS interventions to improve MC in this population is partially dependent on the quality of MC assessment (Hands and McIntyre, 2015). The main aim of this study was twofold: (1) to investigate the relationship between children's PA levels (as proxy reported by their parents) and their MC, (2) to compare coaches' perceptions of children's MC with their actual MC. A secondary aim of the study was (2.1) to evaluate whether coach gender and coaching experience influence coaches' perceptions of children's MC. This research will provide insight for sports organisations to determine whether coaches can accurately report on the MC of children with intellectual disabilities and highlight where further coach education may be required.

Materials and Methods

Participants

Cross-sectional data were collected as part of the *'SO Fun'* project with Special Olympics Ireland. Fifteen Special Olympics Young Athletes clubs were contacted with ten clubs agreeing to participate in the study. The eligibility criteria for participating in this study included children with intellectual disabilities who are registered with the Special Olympics Young Athletes programme, aged 4-12 years, who are fully mobile and can walk without the use of an aid. A sample of 100 children with intellectual disabilities were recruited from clubs across 8 counties in each of the four provinces of Ireland and Northern Ireland. 66% of the participants had Down Syndrome (DS), while the remaining participants reported their condition as an intellectual disability. The sample consisted of 60% boys with an age range of 4-12 years and a mean age of 7.5 ± 2. The Head Coaches, from the ten participating clubs, were then recruited to participate in the study to rate the children's motor competence of the group they coach. The coaches sample consisted of 50% females with a mean age of 45.1 ± 8.3 years. Their coaching experience delivering the Young Athletes programme ranged from 1.3 to 5.1 years (3.8 ± 0.97 years). Data were collected during the period of October 2021 to June 2022.

Ethical approval was obtained from Dublin City University, Research Ethics Committee (DCUREC/2021/100). The coaches of each of the participating clubs provided initial consent for the research team to visit the club, while parental consent and participant assent was also obtained and required in order for the children to partake in the study. Coaches recruited to partake in the study were contacted by the first author via email with a description of the study, their role and the plain language statement. Coaches were informed about the purpose of the study and confidentiality was assured. After agreeing to participate in the study, coaches were sent an informed consent form to complete. Anonymity was maintained with each participant (children and coaches) assigned a unique numerical code.

Measures

Children's demographics including age, gender and physical activity levels were collected through the consent forms and questionnaires completed by parents. Children's motor competence was assessed using a subset of the process-oriented fundamental movement skill (FMS) assessment battery, the Test of Gross Motor Development - 3rd Edition (TMGD3) (Ulrich, 2019). The TGMD-3 is an individually administered test that assesses two components of FMS, locomotor and ball skills (Ulrich, 2019). The subset of skills assessed for the purpose of this study included locomotor skills (run, skip, horizontal jump, hop) and ball skills (catch, kick, stationary dribble, overhand throw, underhand throw, one hand strike) (Ulrich, 2019). The TGMD-3 has established clinical validity (Pitchford and Webster, 2021; Temple and Foley, 2017), reliability ($\alpha = 0.81$) and instructional sensitivity (Staples, Pitchford and Ulrich, 2021) for children with intellectual disabilities in this age cohort (Magistro et al., 2018).

Coaches demographics including age, gender and coaching experience were provided from the Special Olympics Ireland database. Coaches rated the children's motor competence using an adapted version of the Pictorial Movement Skill Competence (PMSC) scale. The original PMSC scale is used with children to assess their perceived motor competence and is composed of twelve pictographic tasks corresponding to the FMS assessed using the TGMD-2nd Edition (Barnett, et al., 2016b). This original scale was transformed into a written survey, with each FMS named and supported with an accompanying image (Liong et al., 2015; Estevan et al., 2018). Both parents and PE teachers have used this survey to assess children's MC (Liong et al., 2015; Estevan et al., 2018). The rating scale in this adapted version of the PMSC is based on the same 4-point Likert scale that is used in the children's version, ie. a score of 1 means 'not good at' while a score of 4 means 'very good at'. The range of scores for the total scale and subscales was thus the same as in the children's version (Estevan et al., 2018). As detailed by Estevan et al. (2018), the 'gatekeepers' version of the scale demonstrated test-retest reliability (13.4 days) with 21 Australian parents of children aged 6.3 years and was found to be highly reliable (intra-class correlation $^1/_4$ 0.90, 95% CI 0.77e0.96).

Data Collection

Formal training was provided to all members of the research team to ensure an in-depth understanding of the TGMD-3 assessment battery, in addition to establishing consistency for the visual demonstration of the skills to each participant. The research team were provided with opportunities to practice skill demonstrations as well as marking assessments. Visual demonstrations of each skill followed Ulrich's (2019) protocol. The research team attended the children's Young Athletes club training session and individually administered the TGMD-3 assessment battery to each participant. A practice trial was provided to participants so they could become accustomed with each skill, followed by two opportunities to perform the skill. Participants received no verbal feedback or cues. The participants' performances were video recorded.

Retrospectively, a trained member of the research team assessed and scored each skill component. If the participant successfully performed the criteria a score of 1 was given while if the participant failed to meet the criteria, they received a score of 0. Participants' raw scores per skill were calculated by collating the scores from both trials. Once all skills were assessed, raw subtest scores for locomotor and ball skills were calculated.

After the research team assessed the children's actual motor competence, individual meetings were set up with each participating coach wherein they received an explanation and training on how to complete the survey. The coaches were asked to rate the children's motor competence using the adapted version of the PMSC during the weekly Young Athletes club training session. Assistance to coaches during this period was also provided by phone, email or video meeting platforms when required. Coaches completed the perceived motor competence survey for each child that participated in the actual motor competence assessment with the research team. The coaches returned the surveys for each participating child to the research team upon completion.

Data Analysis

All data was analysed using R (R Core Team, 2022). To describe the characteristics of the data, means and standard deviations on the variables of interest were computed (see Table 6.1).

The impact of children's PA level on their locomotor and ball skills scores was assessed using a simple linear regression analysis. The data of the children's actual motor competence (n = 100) was analysed and aligned with the coaches proxy reports (n =10). Pearson's correlation was performed to determine the relationship between the children's actual MC and the coaches perception of children's MC for each individual skill, locomotor and ball skills scores (see Table 6.2). Additionally, the Percent of the Maximum Possible (POMP) method (Cohen et al., 1999) was used to compare the children's actual motor competence scores to the coaches perception's proxy report scores. Using the POMP method, the score assigned to each participant is a percentage, reflecting the participants position on the scale as a "percent of the maximum possible score achievable on that scale" (Cohen et al., 1999). This enabled the researchers to determine whether the coaches were underestimating or overestimating the children's motor competence compared to the gold standard TGMD-3 assessment tool assessment of their motor competence.

In preparation for the mixed effects analysis, we tested the assumptions, normality residuals of the dependent variable in the mixed effects model by comparing the residuals to the fitted values. Based on the findings we ran the linear mixed effects model. Multilevel mixed-effects regression models were conducted to assess the predictive power of coaches' perceptions of the children's MC (i.e. locomotor and ball skills) on children's actual MC. Each model included the coach as a random effect and was adjusted for: coach gender and years of experience. Standard errors were calculated and model assumptions were checked with residual plots and histograms. To quantify the proportion of variance explained by the fixed effects model both determine the marginal R-squared (R^{2m}) and conditional R-squared (R^{2c}) was calculated. Furthermore, the multilevel mixed-effects models were compared using the Akaike's information criterion (AIC) and Bayesian information criterion (BIC). A smaller AIC and BIC value suggests a better model. Table 6.3 represents the results from the random intercept only model as this outperformed the random intercept and random slope model.

Table 6.1 Descriptive Statistics of Participants

	Means (±SD)			
	Children's MC Score	Score Range	Coaches Perceptions	Score Range[a]
Locomotor Subset	12.1 ± 7	0-30	9.9 ± 1	1-16
Run	5.6 ± 2.5	0-8	3.1 ± 1	1-4
Skip	0.8 ± 1.6	0-6	2 ± 0.9	1-4
Hop	2.3 ± 2.6	0-8	2.2 ± 1	1-4
Horizontal Jump	3.6 ± 2.8	0-8	2.6 ± 1	1-4
Ball Skills Subset	14.7 ± 9.6	0-44	16.2 ± 1	1-24
Dribble	1.7 ± 2.1	0-6	2.2 ± 1	1-4
Catch	3.0 ± 1.7	0-6	2.7 ± 0.9	1-4
Kick	3.9 ± 2.2	0-8	3 ± 1	1-4
Overhand Throw	1.3 ± 2.1	0-8	2.9 ± 1	1-4
Underhand Throw	3.3 ± 2.6	0-8	3.2 ± 0.9	1-4
Strike	1.5 ± 2.3	0-8	2.2 ± 1	1-4
POMP Scores				
Locomotor Subset	40%	0-100%	61.6 %	0-100%
Ball Skills Subset	33.3%	0-100%	67 %	0-100%
Physical Activity Levels				
No. Days per week active	4.34 ± 1.8			0-7
No. Days active in last 7 days	4.25 ± 1.9			0-7
Coaches Experience (years)			3.8 ± 0.97	
Age (years)	7.5 ± 2		45.1 ± 8.3	
Gender	60% M		50% M	

MC = Motor Competence ES = Cohen's d M = Males, POMP = Percent of the Maximum Possible (Coaches perceptions – Objective FMS scores = POMP (%)) [a] = 1 - Not too good at 2 - Sort of good at 3 – Pretty good at 4 – Really good at

Table 6.2 Pearson Correlation (Pearson) between Children's Actual MC and Coaches Perceptions of Children's MC

Actual vs. Perceived MC	Correlation Co-efficient	Strength of Correlation[a]
Locomotor Subtest		
Run	0.37	Weak
Skip	0.40	Moderate
Hop	0.50	Moderate
Horizontal Jump	0.33	Weak
Ball Skills Subtest		
Dribble	0.54	Moderate
Catch	0.25	Weak
Kick	0.20	Weak
Overhand Throw	0.20	Weak
Underhand Throw	0.30	Weak
Strike	0.32	Weak
Combined Scores		
Total Locomotor Subtest Score	0.59	Moderate
Total Ball Skills Subtest Score	0.47	Moderate

[a] = 0.00-0.19: Very weak correlation, 0.20-0.39: Weak correlation, 0.40-0.59: Moderate correlation, 0.60-0.79: Strong correlation, 0.80-1.00: Very strong correlation

Results

A simple linear regression was carried out to investigate whether MC (total locomotor and total ball skills scores) was a predictor of parents proxy reports on children's PA levels (Over a typical day, on how many days is your child physically active for a total of at least 60 minutes?). The model explained a small proportion of the variance in children's PA levels, with an R-squared value of .025. The regression coefficients showed that neither total locomotor ($\beta = .190$, SE = .032, $p = .125$) nor total ball skills ($\beta = -.086$, SE = .023, $p = .487$) were statistically significant predictors of children's PA levels. These results indicate that the relationship between children's MC and parent proxy reported PA levels are not significant in this sample. The correlation between total locomotor and total ball skills was examined and the variables were found to be moderately correlated (r = .577), suggesting the possibility of multicollinearity. The variance inflation factor (VIF) was used to detect multicollinearity. The VIF value for both total locomotor and total ball skills was 1.5, indicating a moderate correlation between children's MC and parent proxy reported PA levels. Therefore, the VIF value was not severe enough to require attention as it was below 5.

The results of the Pearson's correlations are presented in Table 6.2, determining the relationship between the children's actual MC at the individual skill level and the coaches' perception of children's MC, highlighting how strong or weak the associations between the two variables are. The results of the POMP method indicate that coaches rate children's MC higher by 21.5% in the locomotor subset and 33.8% higher in the ball skills subset compared to the objective TGMD-3 assessment tool scores.

A linear mixed-effect model was used to investigate the relationship between actual locomotor score of the children and coach's perceived performance rating, gender, and years of experience while controlling for the effect of individual coaches. The analysis revealed a significant association between the perceived locomotor score of coaches and the actual locomotor score of children ($\beta = 1.36$, SE = 0.16, $t(95.76) = 8.64$, $p < .001$). This indicates that an increase in coaches' perceived performance rating was linked to higher actual locomotor performance in children. However, the gender of the coach ($\beta = -1.12$, SE = 2.28, $t(7.49) = -0.49$, $p = .638$) and years of experience ($\beta = -0.0005$, SE = 0.003, $t(8.37) = -0.19$, $p = .853$) did not show a significant effect on the actual locomotor score. The model also revealed significant variance between coaches ($\sigma^2 = 1.36$, SD = 0.16, $p < .001$) and within-coach residuals ($\sigma^2 = 23.17$, SD = 4.81). The overall model fit for the mixed effects model was assessed using the conditional and marginal R-squared values. The conditional R-squared value was 0.58 indicating that approximately 58% of the variance in the outcome variable was explained by the fixed and random effects in the model. The marginal R-squared value was 0.40, indicating that approximately 40% of the variance in the outcome variable was explained by the fixed effects alone.

Similarly, a linear mixed-effect model was used to investigate the relationship between actual balls skills score of the children and coach's perceived performance rating, gender, and years of experience while controlling for the effect of individual coaches. The model showed a significant effect of coaches perceived ball skills score on children's actual ball skills score ($\beta = 1.13$, SE = 0.17, $t(72.09) = 6.60$, $p < .001$), indicating that an increase in coaches perceived performance rating was associated with higher actual ball skills performance. Similarly, there was a significant effect of coach gender ($\beta = - 7.74$, SE =

2.98, $t(5.12) = -3.46$, $p < .01$). There was no significant effect of years of experience ($\beta = -0.0005$), SE = 0.003, $t(8.37) = -0.19$, $p = .853$) on actual ball skills score. The model also revealed significant variance between coaches ($\sigma^2 = 1.13$, SD = 0.17, $p < .001$) and within-coach residuals ($\sigma^2 = 52.84$, SD = 7.27). The overall model fit for the mixed effects model was assessed using the conditional and marginal R-squared values. The conditional R-squared value was 0.42 indicating that approximately 42% of the variance in the outcome variable was explained by the fixed and random effects in the model. The marginal R-squared value was 0.37, indicating that approximately 37% of the variance in the outcome variable was explained by the fixed effects alone.

Table 6.3 Mixed effects model analyses for coaches' perception of children's motor competence predicting children's actual motor competence.

	n	*C*	Adj. coeff. 95% CI	SE	AIC ‖ BIC	χ2	D*f*	*p*	R^{2m}	R^{2c}
ATL (outcome)										
CP	100	10	1.36 [0.80, 1.44]	0.16	4619.93 ‖ 630.35	54.35	1	.001	0.40	0.58
ATBS (outcome)										
CP	100	10	1.13 [1.04, 1.66]	0.17	4704.43 ‖ 713.86	33.21	1	.001	0.37	0.42

ATL = Actual Total Locomotor; ATBS = Actual Total Ball Skills; CP = Coaches Perception; *C* = clusters; Adj. coeff. = Adjusted unstandardised coefficients; SE = standard error; D*f* = degree of freedom; $p < .001$ = significant difference; R^{2m} = marginal R squared; R^{2c} = conditional R squared. All mixed effects models were adjusted for coach gender and years of experience (results shown in text). AIC = Akaike's information criterion. BIC = Bayesian information criterion (smaller AIC and BIC values suggest a better model). Clusters = number of coaches involved. R^{2m} and R^{2c} represents the proportion of variance explained by the model.

Discussion

At a macroscopic level, this study investigates the relationship between PA participation and MC amongst children with intellectual disabilities. Furthermore, it demonstrates the importance of educating sports coaches on how to assess the MC levels of children with intellectual disabilities. If sports coaches receive adequate training and upskilling in the area of MC assessments, they can act as a first line of defence in identifying motor impairments (similar to PE teachers) (Logan et al., 2014) amongst children with intellectual disabilities, and have the ability to tailor FMS programmes to effectively target MC weaknesses for this population.

Firstly, the findings demonstrate that children with intellectual disabilities who participated in this study are not meeting (4.34 ± 1.8 days) the recommended PA guidelines, as proxy-reported by their parents. The World Health Organisation proposes that children participate in 60 minutes of moderate to vigorous intensity PA seven days per week (Bull et al., 2020), while the children in this study are only meeting this recommendation on average four out of the seven days. This finding is in line with previous research which indicates that children with intellectual disabilities are even less active than typically developing children of the same age (Einarsson et al., 2015; Wouters et al., 2019). It is important to note that compared to parent proxy reports of PA, objective measures like accelerometers, heart rate monitors and pedometers give more accurate results (Hands, Parker and Larkin, 2006). Marasso et al. (2021) advises researchers to use two methods when assessing PA in children, including one subjective report measure e.g. PA questionnaire and one objective measure e.g., accelerometer devices, to provide a comprehensive view of PA participation. Evidence suggests that there is a positive association between physical activity participation and the development of FMS for typically developing children, which has been discussed in numerous systematic reviews (Logan et al., 2015). The investigation of this relationship has not been as thorough for children with intellectual disabilities with fewer studies available (Maïano et al., 2019).

In this article, the authors examined the relationship between children's actual MC And PA participation (as proxy reported by their parents). Children's MC did not significantly affect their PA levels. Current research investigating the association between PA participation and MC amongst children with intellectual disabilities reports mixed findings (Westendorp et al., 2011, Eugia, Capio and Simons, 2015; Wang et al., 2022). Wang et al. (2022) found that the MC of children with intellectual disabilities is positively associated with time spent in moderate-vigorous intensity PA (MVPA) (accelerometer measurement). While Westendorp et al. (2011) and Eguia, Capio, Simons (2015) found that ball skill scores were a greater significant predictor of MVPA time compared to locomotor skills. examining the relationship between PA (daily step count) or sports participation (Yes vs. No) on MC. No significant relationship was found between sports participation and locomotor skill scores by Westendorp et al. (2011). Conversely, a positive relationship between overall PA levels and locomotor skill scores was found by Eugia et al. (2015). Further research with bigger sample sizes and standardised methods for assessing PA participation, is needed to determine the association between MC and PA levels for children with intellectual disabilities (Hinckson and Curtis, 2012).

On an individual skill level, the Pearson correlations highlighted weak to moderate associations between the children's actual MC and the coaches' perception of the children's MC. These findings are supported by those found by Estevan et al. (2018) who reported PE teachers provided moderate proxy report associations and parents provided weak-moderate proxy report associations compared to typically developing children's actual MC. Similarly, the results from the POMP indicate that coaches perceive the children's MC ability to be higher in the locomotor subset by 21.5% and in the ball skills subset by 33.8% compared to the assessments conducted by the research team using the objective TGMD-3 assessment tool. These combined results illustrate that sports coaches cannot accurately report on the MC of children with intellectual disabilities, as they are currently perceiving the children's ability to be higher than it actually is. While the results are not entirely surprising, as the sports coaches have not received any formal training on assessing children's MC, they are important for establishing a need for further coach education opportunities and to highlight the knowledge gap that exists for Young Athletes coaches within the Special Olympics Ireland programme.

Coaching children with intellectual disabilities who have mixed levels of MC requires specific training and expertise (Smits-Englesman et al., 2022). The results from the linear mixed-effects model demonstrated that an increase in coaches' perceived performance rating was associated with higher actual locomotor and ball skills performance and that all coaches demonstrated similar rating abilities. Years of coaching experience did not significantly influence coaches perceived MC scores, however coach gender significantly influenced coaches perceived ball skill scores. Comparable results in terms of model fit variability are seen in the study by Estevan et al. (2018) which demonstrated that PE teachers were more accurately able to assess the ball skill subset ($\eta 2 = 0.47$) then the locomotor subset ($\eta 2 = 0.24$). Similarly, our findings suggest that coaches are can more accurately recognise the ball skill subset (R2 = 0.58) rather than the locomotor subset (R2 = 0.42).

The ability to appropriately differentiate for various MC levels within a sports session is a core competency needed by sports coaches (Smits-Englesman et al., 2022). However, in order for coaches to develop this skill set, training needs to be provided by the National Governing Body of Sport to support the coaches' continuous professional development (CPD) and ensure that they have the skills required to enhance the development of FMS amongst children with intellectual disabilities. Previous research in school-based FMS interventions has shown physical education programmes that provide CPD opportunities for teachers in the areas of FMS instruction, session management, and session observations can increase the rate of MC development in children (Cohen et al., 2015). This form of CPD should be available to community sports coaches to provide them with a better understanding of the FMS and the importance of developing and reinforcing these skills with the children that they coach. Having coaches who are trained in delivering FMS would enhance the number of opportunities available to children with intellectual disabilities to practice, reinforce and learn these vital skills (Barnett et al., 2016a), which are a prerequisite for the development of sports specific skills and lifelong PA participation (Stodden et al., 2008).

Additionally, Bolger et al. (2018) recommended the introduction of annual formal assessments of FMS for children in primary schools to monitor MC over time, as seen in many countries across Europe. This idea could easily be implemented by trained coaches in community sports clubs, particularly for children with intellectual disabilities who have exceptionally low MC (Kavanagh et al., 2023). These assessments would provide encouragement to sports coaches to develop and improve the MC of children with intellectual disabilities, enable coaches to track the progress of each child in their session, as well as highlight to parents' particular skills which require continued work and development (Bolger et al., 2018). Such assessments also provide meaningful data to evaluate and review the impact and efficiency of the programmes. Overall, appropriately trained coaches can develop tailored FMS programmes to target specific skill weaknesses to address the low levels of MC seen in this population in a cost and time effective manner (Liong et al., 2015).

Limitations

Firstly, PA participation was measured using parent proxy reports detailing the number of days per week children were active for 60 minutes per day. This measure of PA participation is hard to compare to other studies as there is a dearth of valid and reliable research investigating the tools used to quantify PA participation in children with intellectual disabilities. Additionally, due to the time constraints presented to the researchers during data collection, the full battery of the TGMD-3 was not administered. Gallop and slide from the locomotor subset and two hand strike from the ball skills subtest were not included. As a consequence, these skills were also then omitted from the adapted PMSC scale. A final limitation important to note, is that the linear mixed-effects model demonstrated a significant effect of coach gender on coaches' perceived ball skills score performance rating. There is currently no evidence available in the literature discussing the cause of this relationship and further research is required in order to be able to hypothesise the association.

Perspective

Results of this study highlight the disconnect that exists between sport coaching and motor learning. Coaches are seen as gatekeepers to children's MC development. However, there is a lack of CPD opportunities available to coaches on the importance of FMS and best practices in teaching these skills. From the findings, it is clear that currently coaches rate the MC of children with intellectual disabilities higher compared to the objective TGMD-3 assessment tool scores. This has the potential to impact on their ability to develop and progress the FMS of the children they coach. The results presented will highlight the knowledge gap that exists for coaches and will act as a motivator for SO to implement more coach education opportunities. Further research should seek to reassess the coaches' ability once specific training has been implemented. This would enable researchers to get a clearer understanding whether gatekeepers can accurately report on the MC of children with intellectual disabilities. It is suspected that upskilling coaches on assessing MC of children with intellectual disabilities will have a positive impact on their ability to develop and tailor FMS programmes targeting specific weaknesses, in addition to assisting in tracking and progressing the overall MC levels of children with intellectual disabilities.

Linking Chapter 6 to Chapter 7

Chapter 6 identified that children with ID who participated in this study are not meeting the recommended PA guidelines of 60 minutes of moderate to vigorous intensity PA per day. On average children with ID participated in 4.34 ± 1.8 days of PA, as proxy reported by their parents. Additionally, the findings demonstrated that currently sports coaches cannot accurately assess the FMS performance of children with ID. Furthermore, these results highlighted the importance of educating sports coaches on how to assess the MC levels of children with ID. If sports coaches receive adequate training and upskilling in the area of MC assessments, they can act as a first line of defence in identifying motor impairments (similar to PE teachers) (Logan et al., 2014) amongst children with ID, and have the ability to tailor FMS programmes to effectively target MC weaknesses for this population. Annual formal FMS assessments could be implemented, as recommended by Bolger et al. (2018) to monitor children's MC over time.

Chapter 7 further acknowledges the importance of the role of the coach in delivering FMS interventions to children with ID. Special Olympics (SO) is the leading provider of sports and physical activity opportunities for children and adults with intellectual disabilities worldwide, delivered on the ground by millions of volunteers (Pochstein et al., 2023). Volunteer coaches play a pivotal role in the sports sector, particularly in disability sports (Carlin, 2019). As coaches play such an influential role in the lives of SO athletes (Farrell et al., 2004), it is important to take the coaches' perspectives and experiences of delivering a programme into account when evaluating it. Coaches are vital stakeholders in the delivery of the YA programme. Therefore, understanding their perspective is necessary for optimising the growth and expansion of the YA programme and coach development policies within the global SO organisation. However, to date, there is a lack of previous research investigating coaches' experiences of delivering the YA programme. Moreover, this topic is of particular relevance due to the publication of SOI's strategy (2021-2025) which looks to grow the programme as well as addressing current challenges. The study outlined in Chapter 7 aimed to explore the experiences of coaches who are involved in the YA programme, including their perceptions of the barriers and facilitators to implementing the programme.

Chapter 7: Coaching from the Heart: Experiences of Coaches delivering the Special Olympics Young Athletes programme

Abstract

Young Athletes (YA) is a fundamental movement skill programme for children with intellectual disabilities delivered through Special Olympics by volunteer sports coaches. There is a lack of research investigating coaches' experiences of delivering the programme. The aim of this study was to explore the experiences of coaches involved in YA programme, including their perceptions of barriers/facilitators to implementation. An interpretative phenomenological analysis (IPA) method was utilised involving data collection via focus groups with eight YA coaches (50% male). Data were analysed using reflexive thematic analysis. Four themes were identified: 1) Defining success in YA programme, 2) Key strengths of programme delivery, 3) Challenges experienced during programme delivery, 4) Coaches recommendations for the future of YA programme. Findings suggest that coaches have a positive experience of delivering the YA programme. However, coaches face challenges in programme delivery and identified aspects of the programme requiring improvements.

Keywords: Athletes with intellectual disabilities, Coaches experience, Special Olympics, Children

Introduction

Organised sport plays a significant role in all children's lives and can have a notable impact on their physical, social and psychological development (Côté and Fraser-Thomas, 2008; MacDonald et al., 2016). Participation in organised sports is associated with positive health benefits, personal development and skill acquisition for people with intellectual disabilities (MacDonald et al., 2016). Special Olympics (SO) is the leading provider of sports and physical activity opportunities for children and adults with intellectual disabilities worldwide (Pochstein et al., 2023). In Ireland, Special Olympics Ireland (SOI) is the primary sports organisation for children and adults with intellectual disabilities, providing sport and competition opportunities for athletes from four years old with no upper age limit (*Special Olympics Ireland*, 2019).

Children with intellectual disabilities entering the SOI organisation at four years of age begin their participation journey in the Young Athletes (YA) programme. The YA programme is "a play and sports activity programme for children aged 4-12 years with an intellectual disability" (*Young Athletes Programme | Special Olympics Ireland*, 2019, p1.). Other SO programmes deliver the YA programme to children from 2-7 years of age both with and without intellectual disabilities (*Young Athletes*, 2018). The aim, structure and delivery of the YA programme is similar across SO organisations around the world (*Young Athletes*, 2018).

A key focus of the programme is to provide young athletes with the baseline fundamental movement skills (FMS). FMS are described as the 'building blocks' required for lifelong participation in sport and physical activity (Behan et al., 2019). The skills taught to children with intellectual disabilities through the YA programme are closely linked to Clark and Metcalfe's (2002) 'mountain of motor development model', in particular to the FMS development period of this model (Favazza et al., 2013).

All sports programmes facilitated through the medium of SOI are delivered on the ground year round, by thousands of volunteers (n = 5,445), 855 of which are trained sports coaches and 13 of which are YA head coaches (data provided from SOI administrative records, May 2023). Volunteer coaches play a pivotal role in the sports sector, particularly in disability sports (Carlin, 2019). This sentiment is highlighted in the words of de Cruz (2005, p83) who stated "Take away volunteers… sport dies". Within youth sport, coaches are recognised as the second most influential adults (after parents) in children's lives (Petitpas et al., 2005). Research by Farrell et al. (2004) presented findings demonstrating that coaches play an important role in motivating athletes to continue participating in sports with SO. These findings suggest that coaches not only impact a person's desire to participate in sport but also influence the overall development of an individual (MacDonald et al., 2016; McConkey et al., 2019).

As coaches play such an influential role in the lives of SO athletes (Farrell et al., 2004), it is important to take the coaches' perspectives and experiences of delivering a programme into account when evaluating it. Additionally, Robinson et al. (2018) and Weiss et al. (2020) found that a strong contributor to athletes' continued participation in SO programming is attributed to the strong coach-athlete relationship that coaches build with the athletes they work with. Coaches are vital stakeholders in the delivery of the YA programme. Therefore understanding their perspective is necessary for optimising the growth and expansion of the YA programme and coach development policies within the global SO organisation. However, to date, there is a lack of previous research investigating coaches' experiences of delivering the YA programme. Moreover, this topic is of particular relevance due to the publication of SOI's strategy (2021-2025) which looks to grow the programme as well as addressing current challenges. The aim of this study was to explore the experiences of coaches who are involved in the YA programme, including their perceptions of the barriers and facilitators to implementing the programme.

Methods

Qualitative Framework

This study was guided by the author's pragmatic research philosophy and their aim to generate knowledge that is practically meaningful for both researchers and practitioners in the field. A pragmatic research philosophy is one that "emphasises practical solutions to applied research questions" (Giacobbi et al., 2005, p.19). Pragmatism encourages researchers to draw on their own 'real world' experiences during the research process (Kaushik and Walsh, 2019), therefore it is important to note that all authors have experience working with youth sports coaches and SO athletes. The authors positioning as both academics and practitioners who are familiar with the context of this study, enabled the authors to have innovative and novel insights into the data collected (Bryant, 2009). The author's pragmatist stance led them to employ an interpretative phenomenological analysis (IPA) methodology (Smith, 1996; Pringle et al., 2011).

IPA aims to understand how participants describe and share their lived experiences and the meaning of these experiences (Pringle et al., 2011; James, 2016). The IPA methodology is underpinned by the perspective that individuals make sense of, and shape, their experiences through interpretation and forming stories based on their experiences that make sense to them (Brocki and Wearden, 2006; James, 2016). The IPA approach was chosen not only because it aligned with the authors research paradigm but also for its methodological benefits (James, 2016; Healy et al., 2021). IPA allows for rich, detailed accounts of individuals experiences while also enabling the researcher to contextualise the participants perspective within the broader literature base to include cultural, social and theoretical vantage points (Larkin et al., 2006; Healy et al., 2021). Traditionally, IPA methodology employs the use of one-to-one interviews (Smith, 2004), however Smith et al. (2012) and Love et al. (2020) acknowledge that focus groups can be utilised with IPA. An important aspect of IPA is the ability to derive rich, detailed accounts of individuals experiences (Larkin et al., 2006; Healy et al., 2021) and as such, focus groups can enhance personal accounts by taking advantage of the rapport or synergy between participants as well as peer-to-peer interactions (Flowers et al., 2001). Additionally, a number of measures were undertaken to ensure all voices were heard in the focus groups including carefully constructing the design of the focus group to ensure participant numbers were 5 or less in each group which enabled participants to discuss their own experiences at a more in-depth level (Flowers et al., 2001; Githaiga, 2016). Larger numbers of participants in the focus groups could have weakened the idiographic commitment of the IPA approach and proven difficult to capture individuals accounts from the data during the analytical stage (Githaiga, 2016). The researcher played an important role in facilitating the focus groups particularly in the management of group dynamics, for example, redirecting questions and interjecting when required to ensure quieter participants were not overshadowed by more vocal participants (Love et al., 2020). This ensured each participant had the opportunity to voice their experiences and that there was an easy flow of conversation and discussion (Love et al., 2020).

A number of strategies were employed to minimise bias within the study. Researcher bias was minimised by 1) Meticulous record keeping which demonstrates the clear pathway of decisions made, ensuring interpretations of data are transparent and consistent (Sandelowski, 1993; Long and Johnson, 2000), 2) Including verbatim quotations that are rich in detail, from participants accounts to support findings (Slevin and Sines, 1999) and 3) Engaging with other members of the research team to reduce researcher bias

(Sandelowski, 1993). Participant bias was minimised by 1) Providing reassurance, encouraging participants who may be hesitant assuring them that there are no wrong opinions and asking them to speak freely (Bergen and Labonté, 2020), 2) Probing for further information, asking follow up questions and prompting participants (Krueger, 2014; Bergen and Labonté, 2020) and 3) Requesting stories or examples from participants own experiences which will help to illustrate their response (Krueger, 2014; Bergen and Labonté, 2020).

The author's pragmatic research approach, alongside the IPA methodology, has shaped this study in numerous ways. Firstly, the participant group selected for this study were the YA coaches, as they are the practitioners on the ground living and delivering the YA programme. It is therefore vital to ensure that their voices and experiences of delivering the programme are heard. This also influenced the research aim as it is practically focused, exploring coaches personal experiences of the YA programme and identifying any facilitators/barriers faced during implementation. Finally, the focus group questions were shaped by the research philosophy and IPA methodology as they included questions that were solution-oriented and practical in nature. This allowed for an in-depth exploration of the coaches' lived experiences of delivering the YA programme on the ground and will allow for SO to implement practical driven solutions to any challenges that the coaches may identify.

Participants

A recruitment email was sent to all Head Coaches within YA clubs in Ireland (n = 13). Eight coaches agreed to participate, all aged between 37-57 years (50% male; M = 46.4 years, SD = 7.7 years). IPA methodology is best used with small sample sizes of around 1-10 participants as this encourages the maintenance of an idiographic focus (James, 2016). Eligibility criteria included any individual who was a Head Coach of a YA club. All participants were recruited from across the four provinces of the Rep of Ireland and Northern Ireland. Their coaching experience delivering the YA programme ranged from 1.3 to 5 years (M = 3.78 years, SD = 0.97 years). Data were collected during the month of November 2022.

Ethical approval was obtained from Dublin City University, Research Ethics Committee (DCUREC/2022/181). Participants were contacted by the first author via email with a description of the study and inviting them to contact the PI if interested in learning more or participating. Consent from SOI was obtained to contact YA coaches. Participant confidentiality was assured with all participants assigned a pseudonym.

Data Collection

A focus group guide was developed using the interview protocol refinement (IPR) framework (Castillo-Montoya, 2016) and the authors knowledge and experiences of SO and the YA programme. This involved the following steps: (a) developing interview questions which aligned closely with the research questions, (b) refining the interview questions to ensure they were in a conversational style, (c) receiving feedback from two experts in the qualitative and coaching disability sports field, on the structure, writing style and content of the interview guide and (d) piloting the interview guide prior to data collection. Questions revolved around the coaches' experiences and perceptions of the overall quality of the YA programme and the barriers/facilitators to implementing it (i.e., Do you enjoy implementing the YA programme or not?, What do you think are the main benefits that athletes gain from your sessions, if any?, What are the most challenging parts of programme delivery, if any?, What helps you to implement the YA programme if anything?), with probes and prompts used to encourage participants to expand on specific points.

Two focus groups were conducted with the eight coaches by the first author. Focus groups were conducted electronically via Zoom video software (Zoom Video Communications, San Jose, California, USA) to enable coaches from across Rep of Ireland and Northern Ireland to participate. Conducting focus groups over Zoom allows for easier recruitment of participants as it eliminates the need for transport and reduces barriers associated with time constraints while allowing for increased flexibility (Santhosh, Rojas and Lyons, 2021). In addition, Gray et al. (2020) concluded that where face-to-face focus groups were not possible, Zoom electronic video groups provided an alternative method in which to gather rich data while also facilitating a positive experience for participants involved. Given the approach of RTA (Bruan and Clarke, 2019; 2021), focus groups were conducted with a flexible, fluid manner to facilitate and replicate a real-world group discussion which provided scope for the researcher to be responsive to the participants' unfolding accounts. This approach enabled the authors to gain an in-depth understanding of each participant’s experiences. Excluding an initial briefing and warm up questions, focus groups lasted between 80 and 90 minutes (M = 85 minutes, SD = 7.1 minutes) and were video and audio recorded for retrospective transcription and analysis. Focus groups were transcribed verbatim with the written transcription then re-checked against audio-recordings to confirm accuracy.

Data Analysis

Reflexive thematic analysis (RTA) (Braun and Clarke, 2019; 2021) was conducted to analyse the content of the focus groups. Braun and Clarke (2019, p.594) describe RTA as "the researchers reflective and thoughtful engagement with their data and their reflective and thoughtful engagement with the analytic process". In line with the interpretive nature of RTA, data analysis was undertaken primarily by the first author, therefore the results of the analysis reflect the first author's interpretation of the data.

Data was analysed using Braun and Clarke (2019; 2021) six-phased approach to RTA. To enable the author to fully immerse themselves in the data, each transcript was re-read several times with familiarisation notes taken to ensure further familiarity and understanding. Systematic coding of the data was then undertaken, followed by generation of initial themes from the codes. Potential themes were then developed and reviewed by all authors with further refinement of the themes based upon the content of the codes within each theme. The final phase of data analysis consisted of writing the report, however given the reflexive nature of RTA (Braun and Clarke, 2019; 2021), the report writing was embedded into the whole processes of the analysis.

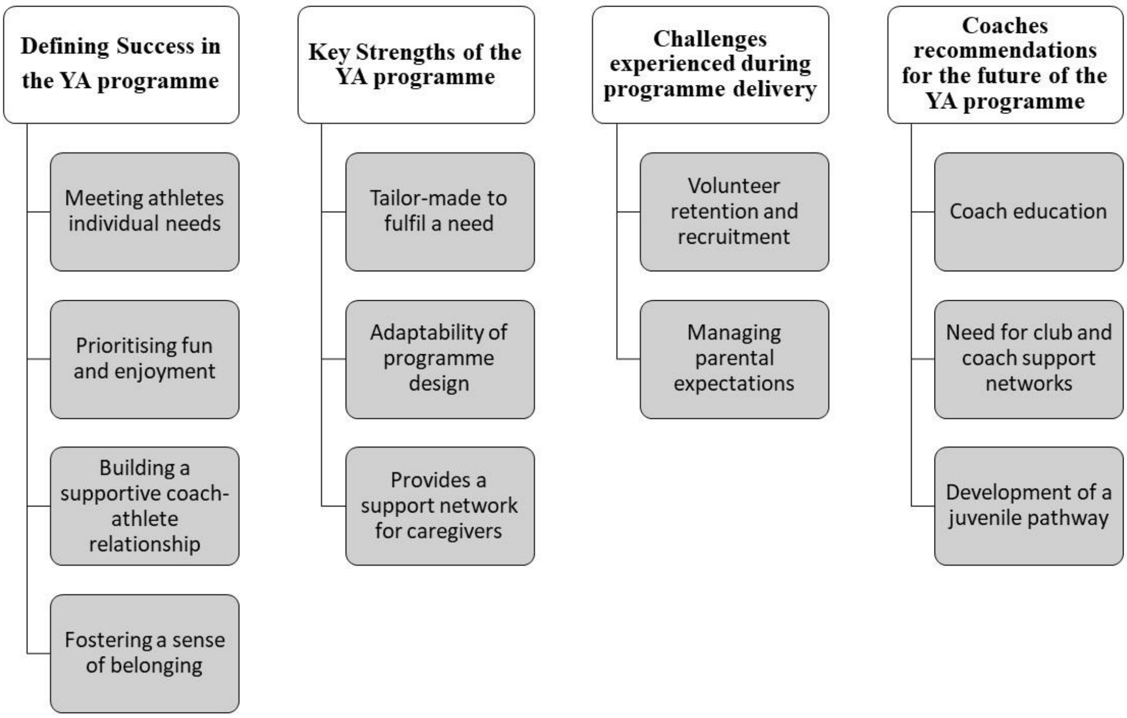
Trustworthiness

The first author was experienced in the youth disability sport environment which brought familiarity and awareness with participants on the topics being discussed within the focus groups. These factors enabled a level of trust and rapport to be built with the participants which facilitated the breadth and depth of the information provided. As previously discussed by Braun and Clarke (2013, p.36), qualitative researchers participate in subjective practice as they bring their "own histories, values, assumptions, perspectives, politics and mannerisms into research". Throughout data analysis, the first author kept a reflexive journal which they used to record their reflections and discoveries throughout data collection (Bruan and Clarke, 2021). Data analysis was mainly conducted by the first author, with additional authors monitoring the reflexive analytical process by sense-checking analysis and exploring alternative interpretations of data, due to the interpretive and reflexive nature of RTA (Byrne, 2022). Following this process promoted deeper reflexivity as the first author's construction of knowledge was challenged in a collaborative manner, allowing the development of richer interpretations of meaning (Braun and Clarke, 2019; Byrne, 2022).

Findings and Discussion

This study aimed to explore the experiences of coaches who are involved in the YA programme, including their perceptions of the barriers and facilitators to implementing the programme. Four main themes were developed by the authors from the data; each representing several subthemes (see Figure 7.1): (1) Defining success in the YA programme; (2) Key strengths of the YA programme, (3) Challenges experienced during programme delivery and (4) Can't Stop Now - Coaches recommendations for the future of the YA programme.

Figure 7.1 Themes and Subthemes Identified



Theme 1: Defining success in the YA programme

This theme explored the coaches' definition of what successful delivery of the YA programme looks like from the coaches' perspective. Coaches deemed training sessions to be successful if the athletes' individual needs were met during the session, if coaches were able to foster a supportive coach-athlete relationship, if the athletes had fun and enjoyed the training, and if the athletes experienced a sense of belonging. Coach Lorraine defined what a successful YA session means to her:

> *So for me, success is them [the athletes] coming to your class, success is them having fun, success is they're engaging in it. .... has everybody enjoyed your session and have*
> *they learned?* (Coach Lorraine, FG1; P1)

Meeting Athletes Individual Needs

Coaches expressed that in order for the YA programme to be delivered successfully, coaches must have the ability to adapt their delivery style to meet the needs of individual athletes during each training session (*"I think it boils down to each individual child and their own needs and their own state of development"*: Coach Brendan, FG1; P3). For many coaches, the key to ensuring all athletes benefit from the session is adapting the YA programme at an individual level (*"It's just that you have to work with your individual athletes to get the best out of them with the programme, that's all"*: Coach Samantha, FG1; P2). Similarly, McConkey et al. (2019) and Turgeon et al. (2022) describe how SO coaches develop a strong coach-athlete rapport by adapting their training sessions to cater for the individual needs of each athlete they work with. Through continuous interactions with athletes, coaches have the power to positively impact their athletes' growth (Conroy and Coatsworth, 2007) and motivation to remain engaged in sport and physical activity (Shapiro et al., 2003; Farrell et al., 2004; MacDonald et al., 2016).

The Special Olympics Coaching Guide (n.d) emphasises the importance of coaches designing training sessions that are developmentally appropriate for athletes, taking both their physical and intellectual capabilities into consideration. A known barrier to sports participation for people with intellectual disabilities is a lack of support from coaches or knowledge on how to tailor programmes that meet the athletes' individual needs (Darcy and Dowse, 2013). The ability and knowledge that YA coaches possess on adapting and tailoring sessions to meet the individual needs of athletes is a key factor they believe is required in order to successfully deliver the YA programme. One coach described how they adapt the delivery of the session to meet the individual needs of athletes:

> *We do a lot of repetition. So, we would do very similar drills you know, if we are doing say relays. They start in the same place every week … and use the same equipment every week. It's repetition… we just found that that works in our club.* (Coach Lauren; FG2; P8)

Indeed, these findings are also reflected in a study by Campbell and Stonebridge (2020) which indicated that when coaching athletes with intellectual disabilities, coaches should provide structured training sessions with frequent repetition of skills. In addition, coaches should break down FMS into more achievable sub-skills for athletes to master, while providing athletes with opportunities to practice and reinforce these new skills (Campbell and Stonebridge, 2020).

Building a supportive coach-athlete relationship

Coaches expressed the importance of building a supportive, positive relationship with the athletes they train. To the coaches, this relationship is a key facilitator to ensuring that the YA programme is delivered successfully. Coach Brendan (FG1; P3) noted: *"Engagement with the athletes, I think it's the critical thing…. If you can engage and if you get the kids to engage with you, I think…the whole programme becomes a lot easier."* In the same way Coach Samantha (FG1; P2) described how the YA programme "*lays the foundations for relationships to build between you and your athletes."* Across youth sport it has been recognised that second to parents, coaches are the most influential adults in children's lives (Petitpas et al., 2005). Coaches are the people with whom athletes most often look up to as a leader and the person whom they would mainly interact during training sessions (Camiré et al., 2011). Through a supportive coach-athlete relationship as well as their role modelling and behaviours, coaches can enable their athletes to obtain a variety of important sport and life skills (Bean et al., 2018) contributing to the individual development of each athlete (MacDonald et al., 2016). The coach-athlete relationship is key to helping SO athletes to develop life skills which they can use both on and off the sports field.

Additionally, research has demonstrated that a strong, supportive coach-athlete relationship contributes to athletes' continued participation in SO, sports and physical activity (Robinson et al., 2018; Weiss et al., 2020). A coach-athlete relationship which is caring and supportive is correlated with children having a positive experience in youth sport (Erickson and Côté, 2016; Gould, Flett, and Lauer, 2012), with similar findings found within disability sports programmes for youth athletes (Turnnidge, Vierimaa, & Côté, 2012; Turnnidge et al.,2014). SO creates a unique sports environment in which the coaches who volunteer their time are extremely supportive and dedicated to the athletes they coach (Robinson et al., 2018).

Prioritising Fun and Enjoyment

Coaches considered athlete enjoyment to be an important factor that contributes to a successful delivery of the YA programme. If coaches can ensure YA sessions are fun and engaging, they feel they have been successful in delivering the YA programme. Athlete enjoyment centred around the development of friendships and social connections that were made within the sports club (*"... it's a social thing where they meet their friends and the training is only a bi product… it's just fun for them"*: Coach Brendan, FG1; P3). As Coach Samantha (FG1; P2) noted, even athletes who are non-verbal demonstrate their excitement to attend the weekly training sessions *by "... running out the door when they hear the word Special Olympics and they're running in eagerly into the [sports] hall because they know they're going to see their friends."*

The key facilitators that determine the participation of children with intellectual disabilities in sport and physical activity are fun and enjoyment (Downs et al., 2013; Downs et al., 2014). The YA programme is a perfect example of such an activity. Children with ID will engage in physical activities that fulfil their need for enjoyment, the sense of skill mastery and achievement (Downs et al., 2013, Downs et al., 2014). These findings complement those found by Farrell et al. (2004) who investigated the motivation of 38 SO athletes from Canada for joining and participating in SO. Motivations included friendships (which coaches in our study repeatedly mention and associate with athlete enjoyment), learning new skills, fun and social approval, amongst others (Farrell et al., 2004). Similarly, Coach Lorraine (FG1; P1) described the relationships amongst athletes that have developed during their time in the YA programme *"... we've seen one friend come in and the other friend is in the other session and they're just running to each other and ...hugging each other..."*.

Fostering a Sense of Belonging

Coaches included fostering a sense of belonging as an important indicator to demonstrate successful delivery of the YA programme. Coaches explained how athletes experience a sense of belonging from participating in their training sessions, emphasising that the athletes use words like "my club" (*"...they [the athletes] think…this is my club, I like it. I'm having fun, I'm meeting my friends and we're playing games"*: Coach Lauren, FG2; P8). It appears that the feeling of being part of a group outside of the family network is important to athletes and the weekly training routine provides a sense of comfort and structure in their lives:

> *… a lot of parents tell us, we train on Sunday morning, so they say it helps going to bed easier on the Saturday night…so they know they are getting up and that means they are off to their club, not their siblings club. It's their club of a Sunday morning.* (Coach Paul, FG2; P5)

As demonstrated in the findings, participation on a sports team or in a sports club enables people with intellectual disabilities to develop a sense of identity as an important, valued member of a group in society (Darcy and Dowse, 2013; Hudson et al., 2018). Sports clubs create an environment to meet new people, develop friendships and provide an opportunity to enjoy the company of others which increases the sense of belonging amongst people with intellectual disabilities (Darcy and Dowse, 2013). As described by Hudson et al. (2018), people with intellectual disabilities who are members of a sports club define themselves as "athletes" and "team mates" as opposed to a person with an intellectual disability. This experience of having a shared identity with others and having a valued role and place within the sports club/team is a positive consequence of sport and physical activity participation for people with ID. This sense of belonging is fostered from a young age in the YA programme with children with intellectual disabilities as young as four years old being able to identify themselves as an 'athlete'. It is evident that the benefits that participation in SO has on people with intellectual disabilities extend far beyond those that are demonstrated on the sports field.

To summarise, while coaches recognise that the development of FMS is an important aspect of successful delivery of the YA programme, they have a more holistic definition of what successful delivery looks like to them in their role as a coach. The interpersonal relationships between the coaches and the athletes, as well as the friendships built between the athletes themselves are key to its success. Coaches believe that to successfully deliver the YA programme, the individual needs of each athlete must be met and that coaches need to have strong, supportive relationships with the athletes they coach to help them develop skills that are transferable both on and off the sports field. Additionally, coaches believe that athletes must be having fun and enjoying themselves and that fostering a sense of belonging is integral to providing athletes with a sense of identity.

Theme 2: Key Strengths of the YA programme

This theme captures the coaches' experiences of the quality of the YA programme. Predominantly, coaches identified the strengths of the programme that they experienced on the ground during implementation, which contributed to the overall quality. These key strengths are what makes the YA programme unique and demonstrates its importance for athletes with intellectual disabilities and their families.

Tailor-made to fulfil a need

The YA programme is unique in that globally, it is currently the only year-long sport and play programme available for children with intellectual disabilities that focuses on developing FMS and is delivered by a National Governing Body of Sport (*Young Athletes*, 2018). Additionally, this programme provides a gateway for children with intellectual disabilities to participate and compete in a variety of Olympic-style sports from eight years of age once they are ready to move on from the YA programme (*Young Athletes*, 2018). The coaches expressed that prior to the rollout of the YA programme that *"there was a massive void there"* (Coach John, FG2; P6). The need for this novel programme was evident with coaches discussing the huge "*waiting lists for [sports] clubs"* and how one club has *"children who are waiting to turn four so they can join".* These two reasons alone, as voiced by Coach Paul (FG2; P5) *"tell us the need for it [the YA programme]".*

Moreover, coaches relayed how important this programme is for children with intellectual disabilities which is evidenced by how far parents are willing to travel to ensure their child can participate (*"We have a lot of people travelling over an hour to* *come to our club for a 40-minute session. That kind of speaks a lot when you hear that said out loud"*: Coach Paul, FG2; P5).

These findings align with those found in the literature identifying the need for inclusive pathways which enable children with intellectual disabilities to develop the prerequisite FMS and social skills needed for successful participation in sport and PA (Anderson et al., 2005; Shields and Synott, 2016). It is commonly recognised that PA programmes for children with intellectual disabilities tend to run for shorter periods of time or may be 'one off' events including Come and Try Days with no further programming available (Shields and Synott, 2016). The novel nature of this programme and the fact that it runs on a year-long basis has filled a gap to ensure that children with intellectual disabilities have a platform to be involved in sport and physical activity from a younger age. This is a massive strength that is contributing to its success.

Adaptability of Programme Design

Aside from the demand for the programme, coaches discussed how they considered the design of the programme to be a significant strength *("It's an amazing resource."*: Sarah). The adaptable nature of the programme and how it can be delivered in a variety of surroundings appealed to the coaches:

> *The whole point of the YA Programme is that it is done in the sporting environment with a coach, it's done at home with the parents, and it's done at school with school teachers. And that it's adapted to be able to be in each of the environments...* (Coach Lorraine, FG1; P1)

Coaches favoured the simplistic manner in which the games, skills and drills were presented for them to implement*, "it's a simple programme to deliver…because it's all based around fun games, every game you can think of ticks a box for the fundamental movement skill. So I think it's very useful and I think it does work quite well"* (Coach Brendan, FG1; P3). Additionally, coaches enjoyed the variety of activities presented in the YA toolkit which is provided by SO to the clubs (*"everything that's provided with all the flashcards and stuff like that, you could be there for years, there's so much to do"*: Coach Samantha, FG1; P2).

When asked if coaches felt that delivering one session per week was sufficient for athletes to develop their FMS, Coach Lorraine noted:

Ideally you would love to do it more than once a week but I wouldn't have the time and most people wouldn't have the time because there is a lot involved, but it is meant to be programme in your club, in your home, in your school. (Coach Lorraine, FG1; P1)

A strength of the YA programme is that it can be delivered within the home and school setting. All coaches felt that athletes would benefit from more than one session per week but within their volunteer role they would not be able to facilitate this themselves. However, parents could practice aspects of the programme at home with their children. Coach John (FG2; P6) suggested that it would be possible for athletes to practice skills at home to enhance their FMS development if facilitated by parents, *"I would say maybe send them [the athletes] home with one skill to practice each week… focus on a specific skill this week and come back and show me how good you are next week."* Flexibility and transferability within sports are recognised as two key elements in increasing sports participation amongst people with intellectual disabilities as it allows the pattern of sport involvement to be embedded as part of a routine (Darcy and Dowse, 2013).

Provides a Support Network for Caregivers

A significant strength of the YA programme, voiced by the coaches, is the opportunity the programme provides to parents/caregivers to build connections with other families who also have a child with an intellectual disability. The YA programme enables parents/caregivers to build a strong support network of people who share a similar lived experience. Coach John (FG2; P6) noted:

I think the biggest thing that maybe that goes under the radar with the young athlete programme is the parents' connection and the parents' connection with each other. … it's a great resource for parents …

This support system of like-minded parents/families is something that parents of children with intellectual disabilities may never have experienced prior to joining SO. Coach Lauren (FG2; P5) shared how she has seen the programme impact athletes and their families:

I would just say this programme has made such a difference to a lot of athletes and families …it's made such a difference in so many people's lives and the athletes are doing stuff that their parents never thought they would do, and they *have made connections that they probably wouldn't have had because of this programme.*

It can be easy to forget that behind every SO athlete is a family member, guardian or caregiver who supports them and that each of these caregivers have their own narrative (Pickett, Williams and Damon, 2022). Goodwin et al. (2006) found that 43% of parents who had a child in SO valued the support they received as a family since joining, including no longer feeling alone, learning more about their child and being comforted by other parents. More recent research by Pickett, Williams and Damon (2022) suggests that SO provides a social outlet for caregivers and they experience a deep sense of belonging in the organisation. The YA programme can represent a lifeline for parents and caregivers to be connected to others who have a shared understanding and experience.

Findings from this study suggest that three key strengths of the YA programme is the platform to encourage children with intellectual disabilities to participate in sport and physical activity from a young age, the easily adaptable nature of the programme and the opportunity for parents/ caregivers to become part of a wider support network, all of which contribute to a high quality programme.

Theme 3: Challenges experienced during programme delivery

This theme captures the coaches' perceptions of the quality of the YA programme. It particularly highlights areas in which the coaches have experienced challenges on the ground during implementation, which negatively impact the overall quality. These identified challenges should be taken into consideration by SO in order to see how they can be overcome to improve programme quality.

Volunteer Retention and Recruitment

A main barrier to programme delivery recognised by the coaches is the difficulties in volunteer retention. Many of the participating coaches are struggling to recruit and retain volunteers within their clubs:

> *We had tonnes of volunteers at the very start. We have had to cancel sessions because we haven't had enough people to run them. It's literally the main thing*

that we come up against when it comes to not being able to run our sessions. (Coach Samantha, FG1; P2)

Stebbins (2004) defined volunteering as "uncoerced help offered either formally or informally with no or, at most, token pay done for the benefit of both other people and the volunteer" (p.5). Volunteers are the most important asset to not-for-profit organisations like SO (Long and Goldenberg, 2010). Coach Samantha (FG1; P2) noted, *"... at the end of the day, if you don't have the volunteers, you don't have a club. That's the only thing coming up against us at the moment."* Further research is required to identify the factors motivating people who volunteer with the YA programme, in order to try to recruit and retain more volunteers to enable this programme to run successfully.

Parents of the young athletes may potentially be an underutilised resource in many clubs. Parents can facilitate physical activity involvement for children with intellectual disabilities by modelling and getting involved in the activity themselves (Menear, 2007; Shields, Synott and Barr, 2012) (*"... they're standing beside their child and they're helping them do it [the skills/games]":* Coach Lorraine, FG1; P1). Many of the YA coaches wanted to provide parents with a short respite while their children participated in the session, however as there is a lack of volunteers in a lot of clubs, this may no longer be something coaches can facilitate as they need parents to get involved. Coach Samantha noted:

> *At the start when our club was so big and we had all these volunteers, the parents were able to just be there and watch and just enjoy the half an hour and engage with other parents. But now volunteers are scarce on the ground, our parents have to get involved or our session doesn't run.* (Coach Samantha, FG1, P2)

Similarly, Coach Brendan (FG; P3) shared that due to lack of volunteers his club "*may need to review... our approach and ...get more parents involved"*. Coaches and clubs require more support from SO to encourage parents to register as volunteers with the YA programme. An example of this support, as demonstrated in research by Long and Goldenberg (2010), could be a targeted marketing campaign by SO directed "at recruiting new parent volunteers by focusing on the outcomes that the parents and athletes receive" (p.20). Relying on parents as volunteers is not unique to disability youth sport, across all youth sport there is a reliance on parents to fulfil volunteer positions (Griffiths, 2012). The sustainability of youth sport is unattainable without the continued support from parents and youth sport organisations face an integral role in recruiting and retaining parent volunteers in both coach and support roles (Griffiths, 2012).

Managing Parental Expectations

Feeling pressure to help manage parental expectations in relation to their child's development and progression through the YA programme was identified as a challenge in programme delivery by coaches (*"Your biggest challenge is the parents' expectations and managing them. It's what is your parents, what is their idea of success?"*: Coach Lorraine, FG1; P1). The lack of understanding from parents about the importance of developing children's basic FMS is significant cause of stress for the coaches:

> *The sessions/ they do definitely deliver the ABC's but if the parents let us do it for long enough it takes much longer than they think it does.* (Coach Patrick, FG2; P4)
>
> *I got to the stage now when I'm doing a drill, I'm nearly explaining to the parents the reason why I'm doing this drill.* (Coach Lauren, FG2; P8)

Previous findings suggest that coaches may perceive parents as a source of significant stress emerging from their dearth of sport-specific understanding, demand for attention from coaches and lack of respect towards coaches' roles and responsibilities (Gould et al., 2016; O'Donnell, Elliott and Drummond, 2022). The findings indicate that parents may be unaware of the objective of the YA programme, which is to introduce children with intellectual disabilities aged 4-12 years to FMS in a supportive and fun environment (*Young Athletes Programme | Special Olympics Ireland*, 2019). A solution to these arising challenges faced by coaches is for SO to host education sessions for parents on the importance of providing children with intellectual disabilities opportunities to practice, reinforce and learn the FMS (Kavanagh et al., 2023).

To summarise, the two main challenges experienced by coaches during YA programme delivery is the struggle to retain volunteers to help deliver the programme and the pressure experienced by coaches to manage parental expectations. These challenges as identified by coaches are hindering the overall quality of programme delivery. SO should look to address these challenges in order to improve future programme quality.

Theme 4: Can't Stop Now - Coaches Recommendations for the Future of the YA programme.

This theme reflects the recommendations from the YA coaches on the improvements that need to be made in order to continue to grow and improve the YA programme for future athletes. The coaches have a strong desire to see the continued growth and improvement of the programme. This was evident in the words shared by Coach Paul:

> *..When I look at the slogan [SO recent campaign]... 'Can't stop now,' there's no reason why we can't drive it on and improve it [the Young Athletes programme].* (Coach Paul, FG2; P5)

The coaches shared their recommendations on the aspects of the YA programme that can be improved in order to bring the programme to the next level. These key areas include provision of coach education, need for coach and club support networks and transition planning for athletes. All coaches who participated in the focus groups believe that the YA programme is the future of Special Olympics (*"this here [the Young Athletes programme] will take Special Olympics to the next level, as in participation numbers and ... in coaching numbers, everything"* : Coach John, FG2; P6). However, the coaches are very keen that their recommendations be taken into consideration in order to improve the overall quality and effectiveness of the programme.

Coach Education

All coaches felt very strongly about the need for improved coach education and support from SO (*...it is a brilliant programme but I still think it needs a lot more coach education and huge amount of coach support for it*: Coach Lorraine, FG1, P1). Coaches believe that the current education model for coaches and volunteers delivering the YA programme is insufficient and is impacting the overall quality of programme delivery. The current education model for YA head coaches consists of the SOI 'Introduction to Coaching Practices' course, followed by the Sport Ireland Coaching Children workshops. Coach Samantha noted:

> *...it affects the programme and it affects the implementation of it because we get stale. …it definitely affects the running of the programme because our volunteers don't feel confident and knowledgeable enough to be able to step in and take over for when we're not there.* (Coach Samantha, FG1; P2)

Ultimately, coach education and upskilling should help to develop both practical skills and confidence levels amongst youth sport coaches (Cuskelly, Hoye and Auld, 2006). Coaches identified the main areas for improvement, centring largely on course content, delivery style and frequency in which the coach education opportunities are offered. The following suggestions were made by coaches for improving the coach education offerings:

1) *Practical Delivery Style.* Coaches understood the importance of the theory-based coach education content provided through the Sport Ireland, Coaching Children workshop. However, all coaches demonstrated concerns in relation to the content of the course and its delivery style. Coaches described the course as *"very top heavy"* with too much theory, (*"..it's nearly like a GCSE PE course*: Coach John, FG2; P6). Coaches feared that the course was 'too much' for general volunteers and would be of little benefit to them. YA coaches would like to see more practical based workshops on offer for both coaches and volunteers. Coach Patrick echoed these sentiments whilst sharing his opinion about the course:

> *I'm fully behind the theory but it needs to be more practically delivered…the course… It's not practical enough. It's too academic…there is a need to build the practical side of it.* (Coach Patrick, FG2; P4)

Research suggests that coach education should incorporate a problem-based learning approach for youth sport coaches in order to bridge the gap between theory and practice (Gilbert and Trudel, 2001; O'Connor and Bennie, 2006). Coaches pointed out a key flaw in the course, which was the lack of transferable skills to help them deliver a hands-on practical coaching session. Referring to the course content, Coach Paul noted:

> *I don't think [the course] addresses how we [Young Athletes coaches] actually do things. It tells them [the coaches] what the ABC's are, but it doesn't tell you how to do something properly. We don't train the coaches to do the drill properly.* (Coach Paul, FG2; P5)

Many coaches enquired about the possibility of offering practical workshops that enable them to gain 'hands-on' experience coaching the FMS and learning technically appropriate methods of demonstrating and improving FMS in children with intellectual disabilities *("it's being able to have a session that you go down to"*: Coach Samantha, FG1; P2). Such sessions would be delivered in person in order to facilitate connections between coaches which was sought after *("...you need the human contact, you need the peer to peer"*: Coach Lorraine, FG1; P1). Coaches believed that these practical sessions are the missing link to adequately preparing them to deliver the YA programme:

> *I think just that [the course] in itself maybe isn't enough. I think it is that link between the coaching children course and the actual putting it into practice. There's a little small bit missing there between that. It is just to see and just to have a bit of real time experience of seeing sessions in practice.* (Coach Brendan, FG1; P3)

2) Recurring Upskilling Opportunities Coaches unanimously expressed that the one-time training opportunity at the beginning of setting up their Young Athletes club was not adequate *("I did my training ... all back in 2018. It is 2022… nothing else has been done when it comes to Young Athletes"*: Coach Lorraine, FG1;P1). Recommendations included hosting coaching clinics throughout the year and continuous professional development workshops either online or in person. Coaches communicated their desire to be presented with opportunities to meet with other coaches and share ideas or tips on what has or has not worked for them. Previous research has shown that in sporting organisations where coaches feel valued and supported, coach retention levels are higher (O'Connor and Bennie, 2006). These upskilling opportunities will help to improve coaching-efficacy. Coaching efficacy is defined as a coaches' belief in their ability to positively influence the learning and performance of their athletes (Feltz et al., 2009; Kowalski and Kooiman, 2013). Opportunities to meet with other coaches and discuss their experiences would provide "reassurance" to less experienced YA coaches and give them confidence that they are successfully delivering the sessions:

> *... give people an idea of the challenges they would come up against and what's the suggested ways of handling that. And the reassurance that …there will be tough sessions and times things don't go to plan …but that's not a problem. Just that reassurance ... Particularly for the newer coaches and newer volunteers, I think that would be a very valuable resource for them.* (Coach Brendan, FG1; P3)

3) *Disability Specific Training Opportunities* In the future, coaches would like to see disability specific training materials incorporated into the coaches education model *("... you could… cover each of the [intellectual] disabilities, just to touch into it even"*: Coach Paul, FG2; P5). They felt that this aspect would be vitally important for new coaches and volunteers who have never worked with children with intellectual disabilities before. Particularly as the current course content does not cover this, the coaches expressed that it leaves people ill prepared *("for somebody coming in as a volunteer with no link to any child with special needs to do the course and then go into a hall with 20 or 25 kids, it must be mayhem for them"*: Coach Paul, FG2; P5). Furthermore, content teaching coaches how to communicate with children with intellectual disabilities, particularly children who are non-verbal was requested. Currently some coaches are finding their lack of knowledge and experience in this area to be challenging:

> *…we have quite a few children now with nonverbal autism in the club. And… we are struggling to communicate properly. And I feel like that's …not good enough for the kids because we are here for them.* (Coach Sarah, FG2: P7)

As discussed by Moran and Block (2010), educating and supporting youth sports coaches to work with children with disabilities is vital, in order to overcome participation barriers.

Need for Club and Coach Support Networks

An area for improvement as identified by the coaches is additional support from SO. Coaches would like assistance from SO to help them facilitate more interclub connections. Coaches felt that once their clubs had been established they were left to their own devices *("We have been pretty much standalone"*: Coach Brendan, FG1;P3). Coaches shared that in the beginning when they were originally setting up the clubs, the support was apparent from SO staff through advice and club visits. However, once they were up and running the supports were no longer present. Coach Lorraine (FG1, P1) noted, *"there's no follow up"* from SO staff. This has led to feelings of isolation and concern over whether coaches are correctly delivering the YA programme or not. Coach Brendan summarised what coaches would like to see:

> *…just more interconnection with other clubs, that we can feed off each other… particularly for new clubs, I think it's hugely important that that is there.* (Coach Brendan, FG1; P3)

Support networks for coaches have been identified in the literature as being a key driver in retaining youth sport coaches (Pendle, 1997). Particularly, organisation wide gatherings where club coaches can network, share ideas and experiences (OConnor and Bennie, 2006). Networking and increased opportunities for social interaction aid in the development of a support system for coaches which acts as an incentive in coach retention (O'Connor and Bennie, 2006).

Development of a Juvenile Pathway

The final area of improvement identified by the coaches which they felt requires immediate attention is the development of a juvenile pathway for athletes once they *"outgrow"* the YA programme. An objective of the programme is providing athletes with the FMS they need to progress into sports specific skills, however there is a lack of sports clubs available for athletes when they are ready to take this next step (*"…there is no point in having it if there's nothing to go to [afterwards]"*: Coach Paul, FG2; P5). Coach Sarah further emphasised:

> *…when they come to an age the clubs aren't there. There's not the variety or very few in the area. So, it [the Young Athletes programme] does help to… prepare the children. But I think there needs to be the sport there for them once they are ready to move on.* (Coach Sarah, FG2; P7)

Currently, a lot of the Young Athletes clubs that have been set up are 'stand-alone' clubs, meaning they are not connected to an existing sport specific SO club. Coaches believe that this is *"where the fall down is going to be in the next couple of years"*: Coach John (FG2; P6). The limitation to setting up standalone clubs is that, if there are no sports specific clubs available in the area for athletes to progress onto, coaches, parents and athletes will be faced with a difficult situation. Coach Lauren shared her experience:

> *We would have been in a difficult situation if I wasn't so keen in setting up basketball… We would have had nothing… So, we would have had …50 kids that had nothing to go to, only for we wanted to set up those sports and had people willing to step up and do that.* (Coach Lauren, FG2; P8)

Moving forward coaches unanimously suggested through the development of a juvenile pathway that clubs should be set up in areas where "feeder clubs" are available, so athletes are provided with a range of different sports that they can avail of, within their locality. Coach John summarised what all coaches would like to see implemented in the future:

> *...I think, the idea of young athletes being dropped in somewhere and then having two or three feeder clubs, so if somebody wants to go to basketball, ...soccer, ... athletics, ...swimming,...bocce, ...equestrian, they [the sports specific clubs] are there.* (Coach John, FG2; P6)

The benefits of sports participation are widely recognised for children with intellectual disabilities including improvements in cardiovascular and muscular fitness, bone health, reduction in symptoms of depression and anxiety, in addition to helping children maintain a healthy weight (World Health Organisation, 2010). At the environmental level, participation in sports and physical activity by children with intellectual disabilities is influenced by the lack of appropriate programmes available (Yu et al., 2022). In order for SO to retain young athletes and encourage lifelong participation in sports, development of a juvenile pathway is required to establish Young Athletes clubs in areas where sports specific programmes are available for athletes to transition into.

To summarise there are three key areas of the YA programme which require improvements in order to increase the longevity and sustainability of programme rollout, including coach education, development of club and coach support networks, as well as development of a juvenile pathway for athletes to progress from the YA programme into sports specific clubs.

Limitations

Although the results of the study are informative, there are some limitations that need to be acknowledged. It is a very heterogeneous sample of participants, for example coaches' experiences of working with people with intellectual disabilities prior to coaching on the YA programme was not taken into consideration. This has the potential to influence the coaches' experience as well as their view of barriers/facilitators to programme implementation due to their level of coaching efficacy and experience. Potentially, alternative methods of data collection such as observations, individual interviews and time use diaries, may have provided richer data. Finally, conducting focus groups with coaches of the YA programme presents methodological challenges, including acquiescence bias, which may have influenced participants' responses.

Conclusions and Future Directions

Findings from this study suggest that coaches have a positive experience of delivering the YA programme and they rate the quality of the programme quite highly, particularly the demand for the programme and the opportunity it provides to parents/caregivers to have a support network of individuals with a shared experience. However, in order to sustain and improve the programme's quality and satisfy coach needs, certain aspects of the programme require improvements. These include coach education, coach and club support networks, and development of a juvenile transition pathway. Additionally, coaches highlighted the barriers to programme implementation including challenges with volunteer retention and managing parents expectations. SO are encouraged to take the recommendations from the coaches on board in order to improve the YA programme and to retain both coaches and athletes within the SO organisation. Future research should look at providing solutions to the challenges experienced by coaches during programme delivery. As well as implementing the recommendations for programme improvements, particularly the development of the juvenile pathway.

Chapter 8: Conclusions and Future Directions

8.1 Overview of Thesis

FMS are defined as the ‘building blocks’ required for performing safe and efficient movements and activities (Barnett et al., 2016; Behan et al., 2019). It is widely recognised in the literature that in order to acquire sports specific skills needed for lifelong involvement in sport and PA, children must first develop their FMS (Seefeldt, 1986; Clark, 2005; Gallahue, Ozmun and Goodway, 2012). There is a trend of reporting low levels of FMS throughout the world for both TDC (Barnett et al., 2009; Lubans et al., 2010; Mukherjee et al., 2017; Behan et al., 2019) and children with ID (Wang and Ju, 2022; Alesi et al., 2018; Craig et al., 2018; Pitchford and Webster, 2021). In order to develop FMS, children need to be provided with opportunities to learn, practice and reinforce these vital skills (Barnett et al., 2016). PE teachers, parents and sports coaches are the gatekeepers to ensuring children are provided with these opportunities to develop their FMS (MacDonald et al., 2016). For children with ID, SO is one of the main organisations which would provide them with opportunities to engage in sport and physical activity, delivered by volunteer sports coaches. SO is the world’s largest sports organisation for children and adults with ID (Special Olympics, 2023). SO introduced the YA programme in 2006 in the United States, in order to tackle the motor challenges experienced by children with ID under eight years of age through a range of motor play activities (Favazza et al., 2013). The YA programme aims to develop the FMS of children with ID across the three categories of skills including locomotor skills (e.g., running, skipping, hopping), ball skills (e.g. catching, throwing, kicking) and stability skills (e.g. static, dynamic balance) (Favazza et al., 2013). SOI introduced the YA programme in 2016 and prior to undertaking this PhD, they had not begun to examine the motor competence of children with ID participating in the programme or gathered evidence-based feedback from coaches in relation to programme delivery. This thesis investigates the FMS performance of children with ID globally (Chapter 3) and in Ireland (Chapter 4 and 5). Additionally, the coaches' perceptions of delivering the YA programme and their ability to assess children’s motor competence are also examined (Chapter 6 and 7).

Given the substantial evidence linking FMS with future sport, PA participation (Barnett et al., 2009; Stodden et al., 2008; Jaakkola et al., 2019) and the health disparities faced by the ID population (Reichard et al., 2011; Recihard and Stolzle, 2011), it seems clear that efforts to increase the FMS proficiency of children with ID should be explored. There is, however, first a need to understand the magnitude of difference that exists in FMS proficiency levels between children with ID and their typically developing counterparts in order to determine if specific interventions are required to close the proficiency gap. There have been two systematic reviews (Gkotzia et al., 2017; Maïano et al. 2019a) published in the last decade, which aimed to provide researchers and practitioners with the answer to the proficiency deficiency question. Whilst these studies provided some valuable insights, there were limitations that needed to be addressed. The limitations included: low sample sizes, not comprehensively examining all three components of FMS and inconsistencies in FMS assessment tools used, which left readers faced with uncertainty in terms of interpreting results and deriving firm conclusions. Systematic reviews of a general nature (e.g. narrative reviews) often exhibit imprecision in their conclusions, stemming from results that lack a robust synthesis of the underlying data. This presented a clear need to ensure all studies comparing FMS proficiency levels between children with ID and TDC were synthesised and summarised using quantitative methods to give a precise estimate of the magnitude of difference between these two groups. The precise estimate of the magnitude of difference increases the accuracy of results and conclusions by increasing participant numbers, provides readers with an objective appraisal of the evidence and guides intervention development. This was the main objective of the study outlined in Chapter 3, which included 3,525 participants (TDC = 2,293, Children with ID = 1,232) aged 4-12 years from 26 global studies (Europe, n = 13; USA, n = 11; Asia, n = 2). The results of this meta-analysis give an accurate reflection of the difference in FMS proficiency between children with ID and TDC while also taking into consideration the moderators causing variability in the outcomes between studies. Generalisability of results would not have been previously possible due to the inconsistencies in FMS assessment tools used across studies in the field and the smaller participant sample sizes. The findings will provide sports coaches, PE teachers and policymakers with more reliable and valid evidence. Such findings will in turn influence the development and modification of current practices and policies in this domain. Similarly, the moderators between FMS proficiency and ID level have not been previously synthesised, which potentially has important implications for the design of FMS interventions for children with ID.

Additionally, for the purpose of improving the motor competence of children with ID in Ireland, it is first important to establish baseline measures in order to track and quantify the progress. Whilst there have been several studies undertaken in Ireland examining the FMS of TDC (Farmer et al., 2017; Bolger et al., 2018; Behan et al., 2019), the same cannot be said for children with ID. To our knowledge, prior to this PhD, no research investigating the FMS proficiency of children with ID has been conducted in Ireland. This presented a clear need for a large scale, representative sample to ascertain the levels of FMS proficiency including percentage mastery, in Irish primary school children with ID. This was the main objective of the studies outlined in chapter 4 and 5, with a large sample size of 100 children with ID aged 4-12 years from across the island of Ireland. Further to this point, only one other study to date has investigated the mastery/near levels of FMS amongst children with ID (described in Chapter 4) while no studies to the authors knowledge had examined FMS at a behavioural component level in this cohort (described in Chapter 5). It is for these reasons that the results presented in both of these chapters have meaningful implications for researchers and practitioners working with children with ID globally. The cross-sectional data provides an accurate representation of FMS proficiency levels, including percentage mastery, and analysis at the behavioural component level, of primary school children with ID. Overall, the findings indicate that although TDC are underperforming in FMS, children with ID are displaying even lower proficiencies than their typically developing peers. Additionally, at the individual skill level as demonstrated in Chapter 4, the highest mastery/near mastery for both groups was seen in the run, the catch, and the kick. For TDC, these relatively high levels of performance are to be expected, as Gallahue and Ozmun (2006) established that all of the basic FMS should be mastered by 8 years of age. As children with ID have been shown to experience motor skill delays of 5–6.5 years behind TDC (Rintala & Loovis, 2013), it is positive to see that there are similarities in the skills in which both groups of children score the highest levels of proficiency. These results also align with studies from Rintala and Loovis (2013) and Behan et al. (2019) who demonstrated that children with ID and TDC had relatively high mastery/ near mastery for the run and catch, respectively. As children get older, their FMS proficiency increases due to biological maturation, increased duration of practice, and receiving feedback (Charlesworth, 2016). The findings in Chapter 4 reinforce this concept with the results demonstrating that for TDC, FMS proficiency was significantly impacted by age with the higher scores favouring the older children. Previous research (Behan et al., 2019; Bolger et al.,2018; Jeong et al., 2017) also confirms these findings. However, the results did not demonstrate this pattern among children with ID, the gap in proficiency increasing as the participant's age increased. This result can be viewed through the lens of the developmental skill-learning gap hypothesis proposed by Wall (2004). This hypothesis indicates that as children who experience motor skill deficiencies get older, the skill-learning gap between them and TDC who have better skill proficiency continues to grow (Wall, 2004). This proficiency gap becomes evident across a range of settings including PE class, sports practice, and competition (Wall, 2004). The potential impact of this skill-learning gap is that TDC continue to participate in sports and physical activity which means they continue to increase their FMS proficiency levels, while CwID may withdraw from sports activities, thus limiting their opportunities for further FMS proficiency development (Bremer & Cairney, 2016).

Chapter 5 provides even more in-depth information on the motor competence of children with ID at the behavioural component level, in order to close the knowledge gap of studies who only report FMS proficiency at the aggregated level. As children with ID consistently demonstrate low FMS proficiency in the literature (Gkotzia et al., 2017; Maïano et al. 2019a; Kavanagh et al., 2023a,b), they are at risk of being significantly impacted by the proficiency barrier. The hypothetical 'proficiency barrier' as described by Seefeldt (1986) occurs when children fail to develop a sufficient proficiency in FMS, leading them to experience difficulties learning TMS and thus SSS. If children cannot skip, run, kick, throw, catch etc., they will be presented with limited opportunities to participate in physical activity as they get older because they will not possess the prerequisite skills to be active (Stodden et al., 2008). This conclusion is further confirmed in our findings which identified that children with ID who participated in the study are only at the initial stage of motor development (Gallahue and Goodway, 2012; Salehi et al., 2017) with 0% of the participants mastering all ten FMS. Furthermore, it was found that participants mastered less than one in ten skills, indicating extremely low skill execution among children with ID aged 4-12. These findings provide important information to researchers, coaches and teachers regarding the developmental characteristics of children with ID. Additionally, the results presented will support these gatekeepers to develop appropriate evidence-based strategies to address low FMS proficiency among children with ID by focusing on activities that aim to develop and improve weaker FMS at a behavioural component level. SO can take these findings on board in order to improve the current YA programme content and focus on areas in which children with ID are experiencing weaknesses to improve their overall FMS proficiency.

Sports coaches play an integral role in influencing a child's desire to participate in sport and PA, as well as having an impact on their overall development (MacDonald et al., 2016). Despite the important role that coaches play in the lives of children, the majority of the 7-9 million youth sports coaches in the EU hold no qualifications or have a lower-level coaching qualification (Lara-Bercial et al., 2017). Results of the study presented in Chapter 6 highlight the disconnect that exists between sport coaching and motor learning with weak to moderate associations found between children's actual MC and the coaches' perception of the children's MC. These findings are supported by those found by Estevan et al. (2018) who reported PE teachers provided moderate proxy report associations and parents provided weak-moderate proxy report associations compared to TDC's actual MC. Similarly, the results from the POMP indicate that coaches perceive the children's MC ability to be higher in the locomotor subset by 21.5% and in the ball skills subset by 33.8% compared to the assessments conducted by the research team using the objective TGMD-3 assessment tool. Previous research in school-based FMS interventions has shown PE programmes that provide CPD opportunities for teachers in the areas of FMS instruction, session management, and session observations can increase the rate of MC development in children (Cohen et al., 2015). This form of CPD should be available to community sports coaches to provide them with a better understanding of the FMS and the importance of developing and reinforcing these skills with the children that they coach. Having coaches who are trained in delivering FMS would enhance the number of opportunities available to children with ID to practice, reinforce and learn these vital skills (Barnett et al., 2016a), which are a prerequisite for the development of sports specific skills and lifelong PA participation (Stodden et al., 2008).

The majority of sports coaching literature centres around elite, competitive sport with limited studies available describing the experiences, context and practices of community sports coaches (Flett et al., 2012). Since coaches are the primary developers of youth in sport (Flett et al., 2012), it is important to take the coaches' perspectives and experiences of delivering a programme into account, as is the case in Chapter 7 of this thesis. Robinson et al. (2018) and Weiss et al. (2020) found that a strong contributor to athletes' continued participation in SO programming is attributed to the strong coach-athlete relationship that coaches build with the athletes they work with. Coaches are vital stakeholders in the delivery of the YA programme. Therefore, understanding their perspective is necessary for optimising the growth and expansion of the YA programme and coach development policies within the global SO organisation. Four main themes were developed by the authors from the data in Chapter 7; each representing several subthemes: (1) Defining success in the YA programme; (2) Key strengths of the YA programme, (3) Challenges experienced during programme delivery and (4) Can't Stop Now - Coaches recommendations for the future of the YA programme. Findings from this qualitative study identified areas for improvement within the YA programme which can be taken on board and evaluated as part of future research in this area. At a national and international level these findings are important for NGB's of sport to acknowledge the importance of including the coaches voice when designing coach education courses. A frequent downfall of coach education courses is that they are often designed by researchers with little input from coaches about what exactly they need training or upskilling on. When designing content for coach education courses, a collaborative approach between stakeholder needs, researchers and coaches seems to be a key ingredient for success.

To summarise, this thesis contributes to the field in several novel areas. The initial two studies give a definitive snapshot of the FMS proficiency levels of children with ID globally and in Ireland, highlighting the difference in proficiency between this cohort and their typically developing peers. The large sample size, as well as the wide range in age, will give researchers involved with FMS assessment in children with ID of all ages a new dataset to compare to their own. The third study provides the most in-depth examination of FMS at the behavioural component level, for the first time, amongst children with ID. The results highlighted some of the environmental and task constraints of FMS development that can be used by coaches/teachers to develop and tailor more specific, effective interventions within and across FMS that target the weaknesses demonstrated by children with ID. The remaining fourth and fifth studies focus on the sports coaches who deliver FMS programmes to children with ID. Study four pinpoints the need for more coach education opportunities to upskill coaches in assessing children's FMS performance in order to ensure that they have the skills required to enhance the development of FMS amongst children with ID. While study five discusses the coaches' experiences of delivering the YA programme and presents practically meaningful solutions from those on the ground, to improve the motor competence of children with ID and enhance the sustainability of the YA programme.

8.2 Research Strengths

This thesis introduces the reader to an array of concepts relating to children with ID of primary school age, namely SO, FMS proficiency levels, theories of childhood motor development, assessment of FMS by sports coaches, proxy reported PA levels and coaches perceptions and experiences of delivering the YA programme. The various strengths are as follows:

The study outlined in chapter 3 is the only meta-analysis to date that examines the differences in FMS proficiency between TDC and children with ID at a global level with a large sample size (n = 3,525). This study incorporates the latest state-of-the-art multivariate meta-analysis methods, and takes into meticulous consideration factors including ID categories, age, IQ and study quality.

The studies outlined in chapters 4-6 of this thesis provide an in-depth look at the motor competence of children with ID, using gold standard assessment tools. This approach was taken after recommendations from the literature on the best FMS assessments to assess children with ID in the field setting. Additionally, this data provides SOI with an in depth assessment of the baseline levels of the children attending their YA programme. No assessment of the children's skills has been carried out since the programme was rolled out in 2016.

A unique iPad application was utilised to capture the children's FMS performances on video as outlined in the various studies within this thesis. This enabled the researchers to retrospectively assess the children's skills while increasing the amount of time and attention the research team could give to the children during the data collection phase. When working with children with ID it is important to build a rapport and give them 1-1 attention to ensure they can complete the task to the best of their ability. As a result of using the app, the research team could be hands free during data collection.

The study in chapter 5 breaks down the FMS proficiency to the behavioural component level, displaying the connections that exist between different FMS and identifying the weakest areas within each skill. The results from this study are beneficial to sports coaches in order to identify which skill components they need to focus on in order to improve the overall FMS proficiency levels of the children they coach. To our knowledge, this is the first study of its kind to examine FMS at the behavioural component level for children with ID, with only five other comparable studies available assessing TDC.

This thesis also evaluated the relationship between children's actual MC and coaches' perceptions of children’s MC, in chapter 6. This evaluation allowed for a deeper understanding of the dynamic nature of the relationship and has added to the value to the existing literature. To date, the ability to rate the MC of children has only been investigated with teachers and parents but not sports coaches. Therefore, the results from this study not only give important knowledge to researchers, particularly those who are interested in conducting research with children with ID, it also highlights the need for more coach education. Knowing that currently, coaches only demonstrate a weak to moderate ability to assess the MC of children with ID will inform coach education practices and policies in sports organisations that cater for people with ID.

In Chapter 7 of this thesis, qualitative methodology was used to explore the experiences of the YA coaches delivering the programme, including any barriers or facilitators to programme delivery. This is another key strength as it is important to take into consideration the experiences of practitioners who are on the ground, year-round delivering a programme in order to identify any changes that need to be made to improve programme delivery.

Finally, a significant strength throughout the thesis is the statistical analyses employed throughout. The author believes that the most appropriate, relevant analyses were used for each study presented here, and the increasing rigour of analyses utilised as the thesis progresses mirrors the authors progression as a researcher.

8.3 Research Limitations

The samples used in the studies described in chapter 3-6, while large for this population, are cross-sectional, and as such cannot be used to confirm causal pathways. Future research should seek to be longitudinal in nature, to see if the results depicted here hold true over time.

The sample of children with ID only consisted of children who currently participate in the SO YA programme. In order to get a true picture of the FMS levels of this group, a control group of aged and gender matched children with ID who do not participate in any sport or PA outside of the school setting should be included. This would also highlight the potential benefit of the YA programme on FMS development.

During the FMS data collection, participants receive a correct demonstration of the skill being assessed by a trained member of the research team. There is the possibility that an individual's cognitive ability may have hindered their interpretation of the skill they were being asked to perform. Degree or level of ID was not taken into consideration as an inclusion or exclusion criterion in this project.

Parents provided proxy reports on children's PA levels, however future studies should consider adopting an objective measure of PA (e.g., using an accelerometer) in order to expand the breadth of the analyses put forward here.

Focus groups only focused on the YA coaches experiences of delivering the YA programme. Future research should investigate parents' perceptions of the programme and how it has benefited their children, to include their motives for enrolling their children in the programme and their views on registering as a volunteer with SO.

I was clear in outlining my philosophical position early in the thesis and it was also mentioned that my previous experiences could influence the interpretations outlined in the thesis. While this could have had a potential bias on the narrative, this was ameliorated through implementing strong rigour throughout the research design, particularly through the verification process provided by the supervision of three senior academics.

8.4 Major Contributions of this PhD

Research	This work has extended the current evidence- base by: • Providing researchers with a precise estimate of the magnitude of difference in FMS proficiency levels between children with ID and TDC, for the first time (Chapter 3) • Evaluating the differences in mastery/near mastery of FMS for children with ID and TDC from a large sample size, increasing statistical power and generalisability of results (Chapter 4) • Exploring age and gender differences in FMS performance within the ID population (Chapter 4-5) • Examining FMS at the behavioural component level for children with ID for the first time, highlighting where specific weaknesses exist for this population (Chapter 5) • Identifying the need to upskill sports coaches on how to assess FMS performance of children with ID (Chapter 6)
Practice	The practical implications from this work include: • Highlighting the need for developmentally appropriate FMS interventions for children with ID in the community setting to improve motor competence (Chapter 3-5) • Improving coach education that focuses on how to develop and progress children's FMS (Chapter 6-7) • Providing training for sports coaches on how to assess children's FMS performance and incorporate these assessments as a typical component of FMS programmes for children with ID (Chapter 6-7) • Importance of listening to the coaches and practitioners delivering FMS programmes in order to determine areas for improvement (Chapter 7)

Policy	This work has the potential to influence policy by: • Highlighting the need for a national strategy to target the development of FMS amongst all children not only in school settings but also in the community and at home • Prioritising the need to upskill teachers and sports coaches on standardised methods for improving and assessing children's FMS • Ensuring National Governing Bodies of Sport are working alongside researchers for evidence-based development of FMS interventions that can be easily implemented and are sustainable for the target groups

8.5 Future Directions and Recommendations

The findings from this PhD project propose a number of recommendations for improvements in order to increase the sustainability and growth of the YA programme and improve the FMS of all children with ID.

The primary recommendations are as follows:

Implementation of a multi-component intervention - As demonstrated in Chapter 3-5, children with ID demonstrate low FMS proficiency with 0% (n= 100) of participants mastering all 10 FMS, 1% (n = 1) mastering all 4 locomotor skills and 0% (n=100) mastering all ball skills (Chapter 5). On an individual skill level, the percentage of participants not achieving mastery in any one skill is 52% (n =52) (Chapter 5). Therefore, it is clear that a multicomponent intervention underpinned by relevant theoretical frameworks is needed to improve FMS development and progression amongst children with ID. Maïano et al. (2019b) systematically investigated the effectiveness of motor skill interventions on improving FMS amongst children and adolescents with ID. Their results recommended FMS interventions led by professionals that last at least 24 weeks in duration with a frequency of three sessions per week for 20-30 minutes in order to see improvements in overall FMS development. Furthermore, they describe the nature of these interventions as intensive motor skills training, therapeutic sensorimotor training or incorporated as part of PE sessions (Maïano et al., 2019b). The authors acknowledge that these recommendations should be taken with some caution as few studies included in the review were rated as high quality and only a small number of the studies focused on overall improvements in FMS, locomotor and ball skills (Maïano et al., 2019b). Currently, there are no gold standard FMS intervention guidelines to follow for improving FMS performance in children with ID.

Research focused on TDC has identified that the most successful FMS interventions were those led by trained teachers in group settings with multiple engagements per week and delivered in conjunction with parental involvement through 'at home' activities (Thompsett et al., 2017). Flynn et al. (2023) further supported the importance of parental involvement in FMS interventions presenting strategies including 1) education and empowerment of parents, 2) activities involving both parent and child participation and 3) providing parents with clear FMS guidance and structure. All of these strategies to involve parents in FMS interventions have positive influences on children's FMS development (Flynn et al., 2023). A multicomponent intervention for children with ID should be designed with recommendations from the literature taken into consideration and should include an aspect of parental involvement. More recently, O'Brien and colleagues (2023) explored the idea of applying the FITT (frequency, intensity, time and type) principle to FMS interventions in order to guide practitioners when designing and implementing interventions. The authors hope to equip movement practitioners with user-friendly and evidence-based recommendations for improving FMS development amongst children and adolescents (O'Brien et al., 2023). Their recommendations based on evidence from the literature are outlined in Table 8.1

Table 8.1 FITT Principle design for FMS interventions (O'Brien et al., 2023)

	Fundamental Movement Skills
F	**Frequency:** At a minimum 2 times per week
I	**Intensity:** Moderate-to-vigorous thresholds, with a priority towards object-control skills. Desired FMS intensities can be reached through direct and indirect instructional practice pedagogies.
T	**Time:** Aim for 30 to 60 minutes of FMS-related activities per week, striving for at least 600 minutes of total intervention or overall program dosage time.
T	**Type:** Avail of FMS teacher/coach expertise, supported by parents/guardians. Practice FMS regularly in structured (games, stations) and unstructured activities (free play).

Improved coach education - As highlighted within Chapter 2 and Chapter 7, there is an evident need for improved coach education for youth sports coaches. It is alarming that 7-9 million youth sports coaches within the EU have little to no coaching qualifications (Lara-Bercial et al., 2017) while over half of children worldwide participate in youth sports (Tremblay et al., 2016). How can we expect children to develop and progress their FMS if coaches are not adequately trained to coach these vital skills? In Chapter 7, coaches from the YA programme identified how a lack of coach education can have a detrimental effect on programme delivery:

> ...it affects the programme and it affects the implementation of it because we get stale. (Coach Samantha)

Increasing the amount of coach education opportunities for youth sports coaches will help to improve coaching-efficacy. Coaching efficacy is defined as a coaches' belief in their ability to positively influence the learning and performance of their athletes (Feltz et al., 2009; Kowalski and Kooiman, 2013). Opportunities to meet with other coaches and discuss their experiences would provide "reassurance" to less experienced coaches and give them confidence that they are successfully delivering the sessions. As stated by one YA programme coach:

> ... give people an idea of the challenges they would come up against and what's the suggested ways of handling that. And the reassurance that …there will be tough sessions and times things don't go to plan …but that's not a problem. Just that reassurance ... Particularly for the newer coaches and newer volunteers, I think that would be a very valuable resource for them. (Coach Brendan)

Further to this point, the findings from Chapter 6 indicate weak to moderate associations between children's actual FMS performance and the coaches assessment of the children's performance. Similarly, the results from the POMP indicate that coaches perceive the children's MC ability to be higher in the locomotor subset by 21.5% and in the ball skills subset by 33.8% compared to the assessments conducted by the research team using the objective TGMD-3 assessment tool. In addition to having coaches trained in delivering FMS which would enhance the number of opportunities available to children with intellectual disabilities to practice, reinforce and learn these vital skills (Barnett et al., 2016a), coaches should also receive training on what FMS are and how to assess children's MC. If coaches were trained to carry out frequent FMS assessments, it would provide encouragement to sports coaches to develop and improve the MC of children with ID, enable coaches to track the progress of each child in their session, as well as highlight to parents particular skills which require continued work and development (Bolger et al., 2018). Overall, appropriately trained coaches can develop tailored FMS programmes to target specific skill weaknesses to address the low levels of MC seen in this population in a cost and time effective manner (Liong et al., 2015).

Practically for SOI, this would entail modifying the 'Coaching Children' course content or creating a specific training course targeted at YA coaches and tailored to meet the needs of children with ID. Additionally, a stand alone CPD should be created to upskill coaches on how to assess the FMS performance of children with ID.

The secondary recommendations are as follows:

Upgrade of equipment - As identified through the study described in Chapter 7, the YA coaches believe that the equipment provided to them by SOI to deliver the YA programme is insufficient. This is particularly prominent for the skill of balance with sentiments echoed by the coaches such as ("There's nothing for balance. So you want me to teach balance but you're not going to even give me a beam?" : Coach Lorraine). Her comments were further supported by Coach John who remarked, "Yeah, the kit is good, but I think there is a few big omissions from it. Balance, I think is a big one." The coaches' claims are supported by quantitative evidence from Chapter 4 in which 0% of the children tested who attend the YA programme have mastered the skill of balance. This balance deficit exhibited by CwID is a cause for concern as this group gets older, particularly as balance proficiency is an important indicator for risk of falls (Enkelaar et al., 2012; Patikas, 2015; Maïano et al., 2018). Compared to typically developing youth, the incidence rate of falls among young people with ID is higher, often resulting in injury (e.g. fractured bones) (Sherrard et al., 2001; Maïano et al., 2018). In addition, improving the balance proficiency of CwID is a critical issue as it also improves overall FMS proficiency encouraging CwID to participate in lifelong sport and physical activity (Maïano et al., 2018). Additionally, Chapter 4 and 5 provide significant detail at the individual skill level as to which FMS the children with ID are failing to master and how the skill components overlap with each other. The recommendation is to create specific equipment packs that target weaker skills e.g. balance kit, which clubs can loan out from the Regional Offices for a set period of time. The type of equipment most suitable for developing FMS amongst children is not discussed in any detail within the literature. Future research should seek to determine what equipment is the most appropriate for developing and progressing children's FMS.

Development of a Juvenile pathway - While the main objective of the YA programme is to provide children with ID with the FMS they need to progress into sports specific skills, there is currently a lack of sports clubs available for athletes when they are ready to take this next step. This topic is discussed in detail in Chapter 7. Currently, a lot of the Young Athletes YA clubs that have been set up are 'stand-alone' clubs, meaning they are not connected to an existing sport specific SO club. The limitation to setting up standalone clubs is that, if there are no sports specific clubs available in the area for athletes to progress onto, coaches, parents and athletes will be faced with a difficult situation. Lack of available community programmes is an environmental factor which prevents children with ID participating in sport and PA programmes (Barr and Shields, 2011; Yu et al., 2022). In order to retain athletes within the SO programmes and encourage lifelong participation in sports, an indepth needs analysis needs to be conducted to determine where the sports clubs are located in comparison to the existing YA clubs. Development of a juvenile pathway is required to establish Young Athletes clubs in areas where sports specific programmes are available for athletes to transition into.

Experiences of families - It can be easy to forget that behind every SO athlete is a family member, guardian or caregiver who supports them and that each of these caregivers have their own narrative (Pickett, Williams and Damon, 2022). An area of interest to SOI is the experiences of family members and caregivers of children who participate in the YA programme. Unfortunately, this was outside of the scope of the current project, however future research should seek to investigate how parents or caregivers have benefited from their child being involved in the YA programme and if their involvement has changed their perception of their child. Additionally, this research could seek to determine the factors associated with parents registering as volunteers with SO. As highlighted in Chapter 7 of this thesis, parents may be an underutilised resource for clubs struggling to recruit and retain volunteers.

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Appendices

Appendix A: Ethical Approval for studies described in Chapters 3-6

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

DCU

Ms. Hayley Kavanagh
School of Health & Human Performance

Dr. Johann Issartel
School of Health & Human Performance

14th June 2021

REC Reference:	**DCUREC/2021/100**
Proposal Title:	**Comparing the Motor Proficiency Skills of Children with Intellectual Disabilities and Typically Developing Children**
Applicant(s):	**Ms. Hayley Kavanagh and Dr. Johann Issartel**

Dear Colleagues,

Further to full committee review, the DCU Research Ethics Committee approves this research proposal.

Materials used to recruit participants should note that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee.

Should substantial modifications to the research protocol be required at a later stage, a further amendment submission should be made to the REC.

Yours sincerely,

Dr Geraldine Scanlon
Chairperson
DCU Research Ethics Committee

DCU Research & Innovation

Taighde & Nuálaíocht Tacaíocht
Ollscoil Chathair Bhaile Átha Cliath,
Baile Átha Cliath, Éire

Research & Innovation Support
Dublin City University,
Dublin 9, Ireland

T +353 1 700 8000
F +353 1 700 8002
E research@dcu.ie
www.dcu.ie

Appendix B: Ethical Approval for studies described in Chapter 7

Oilscoil Chathair Bhaile Átha Cliath
Dublin City University

Ms. Hayley Kavanagh
School of Health & Human Performance

Dr. Johann Issartel
School of Health & Human Performance

14th June 2021

REC Reference:	**DCUREC/2021/100**
Proposal Title:	**Comparing the Motor Proficiency Skills of Children with Intellectual Disabilities and Typically Developing Children**
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Further to full committee review, the DCU Research Ethics Committee approves this research proposal.

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Yours sincerely,

Dr Geraldine Scanlon
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DCU Research Ethics Committee

DCU Research & Innovation

Taighde & Nuálaíocht Tacaíocht
Oilscoil Chathair Bhaile Átha Cliath,
Baile Átha Cliath, Éire

Research & Innovation Support
Dublin City University,
Dublin 9, Ireland

T +353 1 700 8000
F +353 1 700 8002
E research@dcu.ie
www.dcu.ie

Appendix C: Focus Groups Interview Refinement Protocol Framework

Phase 1: Ensuring interview questions align with research questions

The first phase focuses on the alignment between interview questions and research questions. To check the alignment of questions, the following matrix maps interview questions onto research questions.

	Question	**RQ 1.** How do coaches perceive the overall quality of the Young Athletes programme (YAP) ?	**RQ 2.** What are the barriers and facilitators to implementing the YAP?
1. i	Do you enjoy implementing the YAP or not? Why?	X	
1. ii.	Do athletes regularly attend the weekly sessions or not? Why?	X	
1. iii.	What do you think are the main benefits that athletes gain from your sessions, if any?	X	
1. iv.	Do you think that the YAP does or does not provide children with baseline skills required for progressing into a specific sport? What are these skills? Why do you think this?	X	
1. v.	What motivates you to coach in the YAP?	X	
2. i.	What are the barriers to implementing the YAP, if any?		X
2. ii.	What are the most challenging parts of programme delivery, if any?		X
2. iii.	What aspects of the programme currently do not work well, if any?		X
2. iv.	What are the area's for improvement in the programme, if any?		X
2. v.	What helps you to implement the YAP, if anything?		X
2. vi.	What aspects of the programme currently work well, if any?		X

Follow up questions: Structure of YAP			
3. i.	Do you think the frequency of sessions (no. per week) is sufficient or not? Why?	X	
3. ii.	Do you feel athletes would benefit from carrying out the programme at home aswell as in your session on a weekly basis or not? Why?	X	
3. iii.	Do you think it would be feasible to ask parents to implement the YAP at home in addition to your session or not? Why?	X	
3. iv.	Do you think the starting age of 4 years old for athletes attending the YAP is appropriate or not? Do you think athletes should be younger/older?		X
3. v.	Do you feel the length of the each session (45-60mins) is sufficient or not?	X	
3. vi.	Do you feel the season length (September – June) is appropriate for this group or not? Why ?	X	
3. vii.	Do you feel that athletes maintain the skills they learnt over the summer break or not?	X	
3. vii.	Is the number of athletes in your sessions appropriate or not? Why? (Too many, too little?)		X
3. ix.	Do you feel the age range of the athletes in your session impacts session delivery or not? Why?		X
Follow up questions: Personnel			
4. i.	Is the training provided to you by SOI for delivering and implementing the YAP adequate or not? Why?	X	
4. ii.	Do you feel knowledgeable about fundamental movement skills or not?		X
4. iii.	Can you name the three domains of fundamental movement skills? Can you	X	

	name 2-3 examples of skills from each domain?		
4. iv.	Do you feel confident in knowing how SOI would like you to deliver the YAP or not?	X	
4. v.	Do you feel confident implementing the YAP or not? Why	X	
4. vi.	Do you feel confident in progressing different fundamental movement skills to adapt to the needs of the athlete or not?	X	
4. vii.	Do you feel confident in regressing different fundamental movement skills to adapt to the needs of the athlete or not?	X	
4. viii.	Do you feel that you can accurately assess the motor skill proficiency levels of athletes in your club or not? Why?	X	
4. ix.	Do you feel confident in knowing when to recommend that an athlete moves onto a specific sport after completing the YAP?	X	
4. x.	Do you let parents participate in your session or not? Why?		X
4. xi.	Are volunteers confident in assisting you to deliver the YAP or not? Why?		X
4. xii.	Do you think that volunteers are provided with adequate training on how to assist in delivery of YAP or not?		X
Follow up questions: Equipment			
5. i.	Is the equipment provided sufficient for delivering the YAP or not? Why?	X	
5.ii.	From the toolkit what equipment do you use most of? (Have a picture of the equipment to remind coaches) Why do you use this equipment the most?	X	

5.iii.	From the toolkit what equipment do you use least of? Why do you use this equipment the least?	X	
5. iv	What equipment would you like to see included in the toolkit? What equipment do you feel is missing from the toolkit, if any?		X
5. v	Have you added any additional equipment to the toolkit or not? Why?		x

Appendix D: Letter to SOI introducing the project

Letter to Special Olympics Ireland

Background: Dr. Johann Issartel and Ms. Hayley Kavanagh from the School of Health and Human Performance in Dublin City University are collaborating with Special Olympics Ireland and Re-Think Ireland to carry out a research project investigating and comparing the Motor Skills Proficiency levels of children with intellectual disabilities in Young Athletes™ clubs and Special Education schools to typically developing children across Ireland.

Project Rationale: Fundamental movement skills (FMS) (for example jumping, throwing, catching, skipping, running) represent the 'building blocks' of specific movement skills necessary for being physically active, participating in games or participating in sports. Children with intellectual disabilities (ID) have delays in achieving FMS with significant lower locomotor skills, object control skills as well as balance, compared with typically developing children. Irish research has measured FMS in adolescents (O'Brien, Belton & Issartel, 2014), and found that only 11% could perform the required movement patterns adequately. A lack of motor skill proficiency levels hinders children with ID's social, psychological and physical development and negative health outcomes (Frey et al., 2006; Westendorp et al. 2011). This is alarming, considering that FMS mastery can be developed by the age of 6. This project will assess the fundamental movement skills of both children with intellectual disabilities with a view to better understand how we can tailor interventions to improve the motor skills proficiency levels of those children.

What will happen during the research project?

- Before any testing commences the **Young Athletes™ clubs will be contacted** to see if they are interested in taking part in this project.
- **Parents of the Young Athletes™ will then be contacted** with a plain language statement and an informed consent form to be signed.
- Fundamental movement skills such as run, gallop, hop, jump, catch throw, balance, etc... will be measured; alongside their height, weight and waist circumference.

Project Timeline: We hope to start visiting the Young Athletes™ clubs in the coming months to begin the testing process.

Data Protection: All information gathered will be treated in the strictest of confidence. To ensure this, Young Athletes™ names will be removed from all data and replaced with an ID number. Only the researcher will know the Young Athletes™ ID number, and only the researchers will have access to the information.

COVID-19: The research team have completed the 'Sport Ireland COVID-19 Return to Sport Course' and attended the 'Special Olympics Ireland – Return to Activities' webinar.

Primary Investigators and Contact Details:

TITLE	SURNAME	FIRST NAME	PHONE	EMAIL
Dr	Issartel	Johann	01-7007461	Johann.issartel@dcu.ie
Ms	Kavanagh	Hayley	0871961220	Hayley.kavanagh4@mail.dcu.ie

Appendix E: Pictorial Scale of Perceived Movement Skill Competence for children (Boys)

Athlete's Name and Surname .... Sex: male female

Club Name .... Coach Name ....

Pictorial Scale of Perceived Movement Skill Competence for children (boys)

We want to know what is your perception of each Young Athlete's motor competence. Please complete a separate questionnaire for each athlete. Below are a series of physical activities, please mark from 1 to 4, 1 being "not very good" and 4 being "very good", of how well the athlete performs these tasks:

Remember:

1. There are no good or bad answers.
2. Please answer the questions as **honestly** as possible. This is very important.

A. Jumping forwards with the feet together (Horizontal Jump)

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O

B. Catching a ball

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O

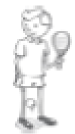
C. Kicking

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O

D. Bouncing a ball (Dribble)

Not too good at	Sort of good at	Pretty good at	Really good a
1	2	3	4
O	O	O	O

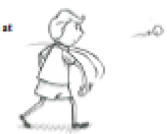
E. Hitting a ball with one hand on the racquet (Strike)



Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O

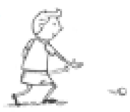
F. Overhand throwing

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O

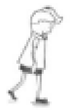


G. Rolling a ball

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O



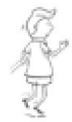
H. Running



Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O

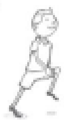
I. Hopping on one leg

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O



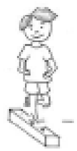
J. Skipping

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O

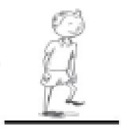


K. Single leg Beam Balance

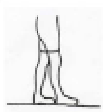
Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O



L. Walking heel to toe on the line



Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
O	O	O	O



Appendix F: Pictorial Scale of Perceived Movement Skill Competence for children (Girls)

Athlete's Name and Surname .... Sex: male female

Club Name .... Coach Name ....

Pictorial Scale of Perceived Movement Skill Competence for children (boys)

We want to know what is your perception of each Young Athlete's motor competence. Please complete a separate questionnaire for each athlete. Below are a series of physical activities, please mark from 1 to 4, 1 being "not very good" and 4 being "very good", of how well the athlete performs these tasks:

Remember:

1. There are no good or bad answers.
2. Please answer the questions as honestly as possible. This is very important.

A. Jumping forwards with the feet together (Horizontal Jump)

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○

B. Catching a ball

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○

C. Kicking

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○

D. Bouncing a ball (Dribble)

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○

E. Hitting a ball with one hand on the racquet (Strike)

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○

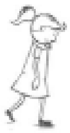
F. Overhand throwing

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○

G. Rolling a ball

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○

H. Running

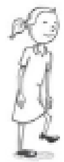


Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○

I. Hopping on one leg

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○

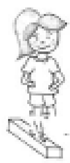
J. Skipping



Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○

K. Single leg Beam Balance

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○



L. Walking heel to toe on the line

Not too good at	Sort of good at	Pretty good at	Really good at
1	2	3	4
○	○	○	○