Fundamental Movement Skill Proficiency Status of Girls Aged 9-to-12 Years from Previously Disadvantaged Communities in Nelson Mandela Bay

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Submitted in fulfilment of the requirements for the degree of MAGISTER ARTIUM
In the Faculty of Health Sciences at the Nelson Mandela Metropolitan University

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2014
DECLARATION

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ACKNOWLEDGEMENTS

I would like to extend my utmost gratitude to my supervisor, Professor Rosa du Randt, for her continuous facilitation and patience throughout the process of writing up each chapter of my master’s dissertation. With this valuable guidance and input, completing this research process was a learning experience which I am truly thankful for and will carry forth into my future research endeavours.

I would also like to thank my family and friends for their continuous support and understanding during the process and conclusion of this study. For their love and support I am forever grateful.

This masters project would not have been possible without the blessings from the principals and teachers from each school. Additionally without the eagerness of the children who participated in this study, this research endeavour would not have transpired. Consequently, thanking these critical role players is of utmost importance to me.

Lastly I would like to acknowledge and thank the Nelson Mandela Metropolitan University Research Capacity and Development Department and the National Research Foundation for their fund allocation to this project. Without the funding, this research project would not have been a possibility. It should be noted that, other than supplying the monetary support, the NRF had no influence on the research conducted, the results obtained and the conclusions drawn.
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ABSTRACT

Problem Statement
A lack of fundamental movement skill (FMS) proficiency in children can contribute to decreased physical activity (PA) levels, increased adiposity and poor acquisition of specialised sport specific movement skills. To prevent the latter, the identification of FMS status in early and middle childhood years is needed for targeted and specific interventions. Against the backdrop of physical education being omitted from the South African school curriculum, the presence of a patriarchal society, gender sporting stereotyping, high levels of unemployment and low education levels; the assessment of FMS status is particularly warranted.

Aim of Study
The primary aim of this study was to assess the FMS proficiency of girls aged 9-to-12 years from previously disadvantaged communities within Nelson Mandela Bay.

Methodology
A descriptive-exploratory-contextual study design, employing quantitative assessment techniques, was utilized. The sample comprised of 227 girls. Convenience sampling was employed. Testing consisted of FMS proficiency tests in the 20m and 40m sprint, standing long jump, throwing for distance, catching, static balance and throwing for accuracy. FMS process scores were assessed with the body component (BC) and Test of Gross Motor Development II (TGMD II) approaches. Anthropometric measurements of the standing and seated height, mass, arm span and leg length were additionally measured.

Microsoft Excel® and Statistica® were used for descriptive and inferential statistical analysis. In the case of significant ANOVA results, the Scheffe post hoc test was used for pairwise comparisons. Statistical significance was set at p<.05 and practical significance (Cohen’s d) was set at d>.2. Pearson Correlation Coefficient identified statistical and practical correlations between two variables and chi square was applied to indicate differences in frequency distribution tables. Cramer’s V values were applied to determine practical significance in the case where statistical significant differences were identified between sets of frequency distributions.
Results
The BC approach indicated that most participants could not proficiently perform the run for speed (94.71%), standing long jump (96.9%) or throw for distance (83.56%). Only the catch was performed proficiently (91.19%). TGMD II results for the present study indicated that participants’ run for speed (100%) and catch (96.92%) were performed proficiently and their standing long jump (93.78%) and throw for distance (83.56%) process scores were performed least proficiently. Only the catch composite BC scores had a statistically (df=1.31; f=3.24; p=.024) and practically significant (d=0.82) improvement in the BC scores between the age groups 9 and 12 years. Only the standing long jump, throw for distance and throw for accuracy product scores improved statically and practically significantly with aging (p<.05; d>.2). Hence the further participants jumped, the faster they ran. Standing and seated height, weight and arm span improved statistically and practically significantly with age (p<.05; d>.2). All anthropometric variables, except for leg length, had a positive medium correlation (r=.335 to r=.439) with balance errors and this was only in 12 year olds. The throw for distance product scores had a medium correlation to seated height (r=.32) and arm span (r=.33). The run for speed had a medium correlation (r=.313) with mass. According to the IOTF classifications 24.67% of children were overweight and 7.49% of children were obese. Statistically significant differences were found for the run for speed (df=224; f=27.07; p=2.9E-11) and standing long jump (df=224; f=15.68; p=4.2E-07) when comparing product scores to normal weight, overweight and obese participants. These differences were furthermore found to be of medium to large practical significance between the normal and obese participants for the run for speed (d=0.61 to d=1.77) and Standing Long Jump (d=0.40 to d=1.33). On average 50% and 55% of participants partook 60 minutes or more of PA after school on week days and on weekend’s respectively. This PA consisted mostly of running and ball games. Only 10% of participants had commenced with menarche.
Conclusion
Findings have highlighted the need for specifically targeted FMS interventions at an early age in female learners from previously disadvantaged communities. Both a product and process FMS assessment is warranted as this facilitates deductions about movement proficiency levels. A FMS proficiency assessment protocol is needed for South African children which is internationally comparable. Childhood overweight and obesity impacts FMS proficiency and should be addressed in future research. Cultural norms, gender stereotypes and sport management structures at primary school level seem to be affecting FMS proficiency and should be addressed in future research.

Keywords: fundamental movement skills, movement proficiency, female learners, TGMD II, Body Component Approach, lower socio-economic, previously disadvantaged.
CHAPTER 1: RESEARCH PROBLEM

1.1 INTRODUCTION

FMS are defined as the basic foundational and precursor movements required by children in order to attain specialised movement skills for recreational and sport specific endeavours (O’Keeffe, Harrison & Smyth, 2007). Research indicates that possessing proficient FMS can increase children’s enjoyment levels whilst participating in PA endeavours (Wrotniak, Leonard, Epstein, Dorn, Jones, & Kondilis, 2006:e1759; Barnett, Van Beurden, Organ, Brooks & Beard, 2008) and furthermore decrease their likelihood of becoming overweight and obese (Marchall & Bouffard, 1997; D’Hondt, Deforche, Gentier, De Bourdeaudhuij, Vaeyens, Philippaerts & Lenoir, 2013). The negative correlation to overweight and obesity levels is possibly due to the fact that the children who possess proficient FMS enjoy PA endeavours more and are more confident in their ability to participate and hence are more likely to engage in higher energy expenditures physical activities. It is consequently not surprising that researchers have furthermore illustrated the positive contribution proficient FMS have on a child’s social, physical and mental development (Lubans, Morgan, Dylan, Cliff, Barnett, Okely, 2010:1023-1030).

Empirical research and contemporary theories imply that FMS cannot automatically be learnt during early and middle childhood (Newell, 1991; Thelen, 2000). That is, proficient FMS are not inevitably achieved by children during periods of motor development when they are innately highly active such as in early and middle childhood and or when children participate in numerous physical activity (PA) endeavours at home and or at school between the ages of 2-to-12 years (Cronin & Mandich, 2005:178, 209). Instead, according to literature the environment and FMS interventions put in place have to be optimised for children to develop proficiency in FMS. Newell’s constraint theory on variables which affect motor learning illustrates that the environment, personal structural and functional traits of the individual and task constraints that are imposed on the individual whilst performing a motor skill affect the ability of the individual to attain proficiency in the motor skill (Newell, 1991). In addition to these aforementioned variables, Malina (2004:50-66) and Gallahue
(2010:17) believe that children necessitate practice and adequate instruction to attain proficient motor skills. In accordance with Malina’s and Gallahue’s beliefs, the contemporary dynamic systems theory proposes that movement transpires naturally if the opportunity for movement discovery is provided for an attractor movement state to emerge (Heriza, 1991; Thelen, 2000; Bakhtiar, 2013). Consequently by assessing the FMS status of children it can be deduced as to whether the constraints proposed by Newell (Newell, 1991) and the FMS interventions in place are optimised for the attainment of FMS proficiency in children.

Studies investigating the FMS status of children and adolescents have been found to be mostly conducted in Australia, Brazil, Hong Kong and the United States of America (USA) (Booth, Okely, McLellan, Phonsgavan, Macaskill, Patterson, Wright & Holland, 1999:93-105; Ulrich, 2000; van Beurden, Zask, Barnett & Dietrich, 2002:244-252; Okely & Booth, 2004; Pang & Fong, 2009; Hardy, Reinten-Reynolds, Espinel, Zask & Okely, 2012; Spessato, Gabbard, Valentini & Rudisill, 2013). Most of these studies have indicated that the status of FMS proficiency levels in these population groups are at a poor proficiency level. As it has been found that on average FMS proficiency status is poor internationally and children are hence not benefiting from its positive contributions to their holistic development, whether a similar situation prevails in the South African context necessitates further investigation.

Within the South African context, there are limited studies on the FMS status of children. Hence closer examination of the current and past South African physical education system, and consequently movement interventions, and the status of Newell's constraints transpiring within the South African environment may provide evidence for the need for FMS assessments. Physical education was omitted from the South African curriculum in 1995 and re-introduced in the year 2005 without the support of qualified physical education teachers or the correct management thereof (Van Deventer, 2004:107-121). According to Van Deventer (2004, 2009, 2012) previously disadvantaged communities and minority ethnic groups received less infrastructural and human resource support for physical education, particularly during the apartheid regime. Consequently, depending on the school children and adolescents attended, learning FMS proficiently may not have transpired. This reality
has persevered since apartheid commenced in 1948 to 1994 with minimal improvement in the service delivery of physical education at schools presenting in the 21st century (Amusa & Toriola, 2006; Van Deventer, 2004, 2009, 2012). Consequently generations of individuals’ holistic FMS proficiency development may have been affected.

In terms of Newell’s environmental constraint and when referring to socio-economic status (SES) and social norms within South Africa, the possible negative effect of the lack of physical education within schools is augmented by the large percent of the South African population being unemployed and uneducated (Banerjee, Galiani, Levinsohn, McLaren & Woolard, 2007:8). This reality is even more prevalent in the Eastern Cape, which has been found to have the highest unemployment and low education rates (Makiwane & Dan, 2011). An additional environmental constraint within South Africa is its historically patriarchal society consisting of many recreational and sporting gender stereotypes (Shehu, 2010:125-134). In terms of Newell’s personal structural constraint this would refer to being male or female. Literature findings support the notion that there are motor learning differences between males and females but additionally indicate that minimal differences would materialize if equal opportunity to practice and participate in all types of PA endeavours were encouraged for both genders (Thomas & French, 1985; Teixeira & Gasparetto, 2002; Barnett et al., 2008:2137–2144; Spessato et al., 2013:916-923). Although the South African government has made an effort to eradicate gender inequalities by sponsoring female sport, cultural and gender stereotyping persevere and may negatively be impacting the holistic motor learning of female learners.

The proposed window of opportunity for FMS proficiency attainment is estimated at being between the ages of 2-to-7 years (Malina, Bar-Or & Bouchard, 2004:202; Ford, De Ste Croix, Lloyd, Meyers, Moosavi, Oliver, Till & Williams, 2011:392-393). That is, within the motor development spectrum, FMS optimisation occurs once bipedal motion is achieved in early childhood and progresses along the FMS proficiency levels from initial to mature movement patterns during middle and late childhood (Wickstrom, 1983:7-9). Within the South African school curriculum, this equates to optimising FMS motor learning in the foundation phase within the primary school years (English Life Skills, 2011). Consequently, literature directs research initiatives
to investigating the FMS status of female South African learners, particularly in previously disadvantaged communities, within primary schools.

In this introductory section, the background literature and theory discussed have provided motivation for and has assisted with the formulation of the present study’s focus. The empirical and theoretical findings discussed thus far encourage research efforts to answer the question of ‘what is the FMS proficiency status of girls from previously disadvantaged communities in general’. In order to elaborate on how the primary research question was defined and subsequently answered, the following sections identify the specific aim and objectives of the research. It also depicts the significance and scope of this study as well as explains key terms deemed important to ensure a common understanding thereof.

1.2 RESEARCH AIM AND OBJECTIVES

Based on the verification through literature of the importance of proficient FMS, the identification of the lack of South African based research on FMS proficiency status and the fact that girls in particular tend to not possess proficient FMS; the following aim and objectives were formulated for this study.

Aim:
The aim of this study was to identify the FMS proficiency status of 9-to-12 year old girls from previously disadvantaged communities in Nelson Mandela Bay.

Objectives:
In alignment with the problem statement and research question and aim, the following objectives guided the study:

1. To determine and compare the FMS proficiencies of 9-to-12 year old girls in respect of the run for speed, throw for distance, standing long jump, catch, balance and throw for accuracy qualitatively and quantitatively.
2. To describe and compare anthropometric measurements such as weight, height (standing and sitting), body mass index (BMI), arm span and leg length in respect of 9-to-12 year old girls as well as to determine the effect thereof on FMS proficiency.
3. To describe and compare extra-mural PA participation status of 9-to-12 year old girls as well as to determine the associations thereof with FMS proficiency.

4. To identify whether menarche has begun, consequently identifying the level of maturation and its association with FMS proficiency.

1.3 SIGNIFICANCE OF STUDY

The absence of research on FMS proficiency of South African youth, particularly in the Eastern Cape which has been identified as one of the provinces with the highest unemployment and poorest education levels, indicates that there is a need for investigation into the FMS of children. Therefore by conducting a study on the FMS proficiency status of girls aged 9-to-12 years from lower SES communities within the Nelson Mandela Bay, the following significance was envisioned:

- Evidence for the need for future FMS interventions.
- Baseline data to assess the effectiveness of future FMS interventions.

In order to understand the delimitation of the study to the particular age group, gender and movement skills under investigation, the scope and limitations of the study necessitate further elaboration.

1.4 SCOPE AND LIMITATIONS OF THE STUDY

In order to contextualise the problem statement and the fact that this study was delimited to healthy female learners aged 9-to-12 years from previously disadvantaged communities within Nelson Mandela Bay, the scope of this study necessitates addressing. In so doing the limitations are additionally discussed.

Newell’s constraint and the dynamic systems theory of motor development formed the theoretical framework of this study. Based on literature findings and Newell’s constraint theory, the environmental constraints were accounted for by focusing primarily on children from lower SES communities and schools placed within a quintile 1 to 3 ratings (refer to chapter 3 for a thorough review of the quintile ratings). In so doing the sample was narrowed to only represent the selected lower SES
female learners to account for the possible lack of infrastructure and or limited utilisation of qualified physical education teachers and the effect it may have had on their FMS proficiency levels. An additional environmental constraint taken into account was South Africa’s historically patriarchal society and gender stereotyping and empirical research findings indicating that males tend to perform FMS more proficiently than females. Consequently the results only represent the selected female learners and not their male peers.

To account for personal structural constraints and their possible influence on motor proficiency, researchers tend to measure and assess anthropometric changes in children as they grow, mature and develop (Balyi & Way, 2005:5; Eunice, 2008). Consequently the anthropometric measurements association with FMS was assessed statistically. However, due to the cross-sectional nature of this study the result are specific to the group of individuals assessed at the particular time of testing and not of any individual assessed longitudinally. Additionally, due to practicality purposes, convenience sampling was employed and hence results are specific to the selected schools and population under investigation and not a representative sample of the South African female population aged 9-to-12 years. The limitation of the cross-sectional nature of the study and use of convenience sampling extends to identifying menarche as longitudinal assessments are required for more precise data collection.

Newell’s constraint theory illustrates that task constraints affect the motor ability of individuals and consequently the selection of the test battery employed to assess FMS proficiency was based on age appropriate and valid, reliable and standardised protocols. However, the test battery was limited to the specific FMS under investigation and not an array of FMS which may have contributed to a more holistic movement investigation. Due to time and resource constraints, an array of FMS could not be included in the test battery and consequently the results obtained are limited to the FMS assessed.

Personal functional characteristics such as motivational levels and the amount of movement experience an individual is exposed to can contribute to the attainment of motor skills (Haywood & Getchell, 2009:264). Although research findings illustrate
that motivation is necessary to facilitate the participation in movement experiences (Allender, Cowburn & Foster, 2006; Biber, Czech, Harris & Melton, 2013), to stay within the scope of this study which is descriptive and quantitative in nature, this qualitative paradigm of motor development was not included in the test battery of this study.

As PA endeavours are confounding variables which could have affected the results obtained in this study, the PA levels of the participants during the week and on weekends were assessed with the aid of a questionnaire in order to gain insight into the types and duration of PA participants in this study partook in. As the primary aim of this study was to describe the status of FMS, direct PA assessments (employing pedometers, energy expending devices and so forth) and the quality of movement experiences provided by physical education teachers were not directly assessed.

In terms of the dynamic systems theory and the importance placed on practice to facilitate movement attainment, this theory was employed to motivate the need for FMS assessment and to investigate whether adequate FMS interventions and practice are being put in place at schools. Hence as previously mentioned; the qualifications of teachers, the types of physical education classes provided and the amount of practice children received was not directly investigated within the schools assessed in this study. Hence an in depth investigation into the implementation of physical education classes into schools and the qualifications of teachers to teach physical education, for example as was calculated by Van Deventer (2004; 2009), fell outside the scope of this study.
1.5 **TERMINOLOGY**

The following section clarifies key terms pertaining to this study so as to ensure a clear understanding of how the terms were used and understood within the context of the present study.

1.5.1 Early and Middle Childhood

Within the lifespan an individual will develop through specific phases. That is, the prenatal (before birth, for a duration of approximately 9 months) and infancy (birth- to 12- months old), early (12 months- to 6- years old) and middle childhood (7 years old to the onset of puberty), adolescents (onset of puberty to 18 years old), adulthood (18- to 65- years) and elderly (65 years and above) (Cronin & Mandich, 2005:177-329). The phases which are of particular interest to this study are the motor development in early and middle childhood. That is, the motor development in children between the ages of 2-to-12 years old.

1.5.2 Motor Development

Motor development is the continuous attainment of motor skills (or loss thereof) across the lifespan and is divided into phases and stages (Malina, 2004:50). Within these phases and stages, the FMS phase and associated stages are the primary focus of this study.

1.5.3 Fundamental Movement Phase and Stages

The FMS phase consists of an initial, elementary and mature stage of FMS proficiency stage which should transpire between 2-to-7 years (Gallahue & Cleland Donnelly, 2003:63; Gallahue, 2010:18).
1.5.4 Fundamental Movement Skills

According to Burton and Miller (1998:215) FMS are the ‘locomotor and object-control skills performed in an upright or bipedal position that are used by persons in all cultures of the world’. Gallahue and Cleland-Donnelly (2003:63) define FMS as locomotor, manipulative and stability skills. For the purpose of this study FMS were defined as locomotor, non-locomotor and object control skills which children from all cultural groups should master so as to form the foundation of movements necessary for future holistic PA participation.

1.5.5 Locomotor Skills

Locomotor skills are FMS which encompass the body moving through space and include movements such as walking, running, jumping for distance, sliding, galloping and skipping (Winnick, 2011:380-381).

1.5.6 Non-locomotor or Stability Skills

Non-locomotor or stability skills are FMS that encompass the body parts being moved and include pushing, pulling, bending, balancing and twisting from a stationary position or during minimal movement (Lubans et al., 2010:1021).

1.5.7 Object-control Skills

Object-control skills are FMS that involve an object and include skills such as rolling, throwing, kicking, punting, striking, dribbling, trapping, stopping and catching an object (Winnick, 2011:380-389). The term ‘manipulative skills’ has additionally been used by authors to refer to movements which involve an object but for the purposes of this study, these skills will be referred to as object-control skills.

Locomotor, non-locomotor and object-control FMS are assessed according to the proficiency with which they are performed. That is these skills are rated according to their FMS proficiency stage which is either classified as an initial, elementary or mature FMS proficiency stage.
1.5.8 Fundamental Movement Skill Proficiency

Motor skill proficiency refers to the effectiveness, accuracy and precision with which a movement skill or more specifically a motor development sequence is performed (Gallahue & Cleland Donnelly, 2003:63; Barnett et al., 2137-2138). FMS proficiency hence refers to the effectiveness, accuracy and precision with which the FMS is qualitatively performed and can be divided into stages of FMS proficiency (Gallahue & Cleland Donnelly, 2003:63).

FMS proficiency is scored qualitatively, which is also referred to as the process score for a specified FMS. This qualitative or process score depicts whether the movement was performed at an initial, elementary and mature motor development stage.

1.5.9 Process or Qualitative Assessments

According to Gallahue (2010:17) the process characteristics of a movement refer to the ‘how’ of a movement and hence the underlying mechanisms which cause the movement. That is the influence of genetics and the environment on motor skill acquisition and the theories governing motor development. Conversely and according to Malina et al. (2004:197) and Williams (1983:210) when assessing the process of a movement pattern, specific body mechanical elements are assessed for their movement proficiency levels. In the present study the process and or qualitative assessment referred to the movement characteristics and proficiency thereof and not the underlying mechanisms causing the movement. The words process and qualitative assessment can be used interchangeably as both refer to the essence of the movement characteristic (Greig, Taylor & MacKay, 2007:135).

As mentioned, when analysing movement qualitatively a motor development sequence or stage is used to categorise the proficiency level of the movement. As movement proficiency is divided into proficiency stages, these are known as the process scores of the FMS under investigation.
1.5.10 Motor Developmental Sequence or Stage

According to Roberton and Langendorfer (1980:270-271) a developmental sequence or stage refers to the type of movement features which characterise a specific developmental age and can be divided into progressive stages or steps based on literature findings indicating when these movements appeared during the process of motor learning. Hence all children will go through the same developmental sequence to eventually reach a proficient level of performance. Movement proficiency in a development sequence or stage can be divided into initial (immature), elementary or mature developmental stages (McClenaghan & Gallahue, 1978:68; Gallahue, 2010:18). Each motor developmental sequence or stage is unique in terms of the movement incorporated to achieve the motor skill at hand. As an individual advances through each developmental stage a more efficient movement pattern is employed to achieve the task at hand.

The initial, elementary and mature movement stages are used to describe movement when the body component (BC) approach is being employed to assess movement (McClenaghan & Gallahue, 1978:79; Burton & Miller, 1998:223).

1.5.11 Initial Movement Stage

An Initial movement pattern is defined as the inability to prepare and follow through with a movement task. That is a child seems uncoordinated, variable in performance with mostly no presence of a mature movement pattern and actions which are inefficient to achieve the motor task at hand (McClenaghan & Gallahue, 1978:79; Gallahue & Cleland Donnelly, 2003:63). Degrees of freedom are frozen so as to assist in executing the motor skill at hand. Hence the initial movement pattern would refer to the least effective movement repertoire employed to execute a given FMS.
1.5.12 Elementary Movement Stage

An elementary movement pattern is characterized by less variability of performance but a lack of the most efficient movement pattern. More mature movement component parts are present but they are sub-optimal (McClenaghan & Gallahue, 1978; Gallahue & Cleland Donnelly, 2003:63).

1.5.13 Mature Movement Stage

A mature movement pattern can be thought of as achieving motor skill mastery in a specific skill (Gallahue & Cleland Donnelly, 2003:63). According to McClenaghan & Gallahue (1978:79) a mature stage of movement can be defined ‘the integration of all the component movements into a well-coordinated, purposeful act. The movement resembles the motor pattern of a skilled adult’. O’ Conner (2000:11-13) goes further to state that achieving motor skill mastery for any given skill is defined as ‘a test score of greater than 80% of skill component competency’. Hence for the purposes of this review a mature movement stage was deemed as achieving 80% or more of the BC variables being assessed in the FMS under investigation when using the BC approach.

When the total body configuration or BC approaches are not being employed to assess FMS proficiency levels and instead the Test of Gross Motor Development (TGMD) is being used, movement is characterised as either being at a near mastery or mastery pattern (Ulrich, 2000).

1.5.14 Near Mastery and Mastery Pattern

In addition to placing participants into Initial, elementary or mature stages of FMS proficiency levels, participants can be classified as being at a near mastery or mastery level. According to Ulrich (2000) near mastery is defined as possessing all but one BC variable in a FMS whereas mastery is defined as possessing all BC variables.
It is important to note that FMS proficiency can be assessed both qualitatively (process scores) and quantitatively (product scores). It is important to define both concepts as these are the primary assessment techniques employed within this study.

1.5.15 Product or Quantitative Assessments

Gallahue (2010:17) refers to the product assessment of motor development being the 'what' of motor development in terms of the stages and phases, age of onset and duration of the phase and or stage and what is normal and abnormal motor development. However for the purposes of this study the product assessment was understood as the quantitative assessment of motor skills. More specifically Malina et al. (2004:197) and Williams (1983:208-209) definition of the product assessment refers to for example the distance a child can jump, how fast a child can run and how long a child can balance.

In accordance with quantitative data, it is important to note a child’s chronological and biological age as both influence the level of FMS proficiency in children and adolescents.

1.5.16 Chronological versus Biological Age

Children may be the same chronological age but differ in biological age due to the process of growth, maturation and development. Chronological age refers to an individual’s age in years and days that he or she has been alive since birth (Balyi, Cardinal, Higgs, Norris, & Way, 2005:23). Biological age refers to an individual’s level of bodily maturation and growth in years (Malina et al., 2004:7). In terms of this study, it was deemed important to consider both through taking into account children’s dates of birth to determine their chronological age and assess their anthropometric measurements and whether menarche has begun to account for their biological age.
1.5.17 Menarche

Menarche is the attainment of sexual maturity in girls. It is characterized by breast budding, hair in the axillary and pubic regions and the onset of menstrual bleeding, which is indicative of the ovaries being able to secrete sufficient amounts of steroid hormones (Jones, Griffiths, Norris, Pettifor & Cameron, 2008).

In addition to growth, maturation and developments’ effect on FMS proficiency, it is important to define PA as this is an additional confounding variable which can affect the FMS proficiency scores attained.

1.5.18 Physical Activity

According to Malina et al. (2004:6) PA is ‘any body movement produced by the skeletal muscles that results in a substantial increase over the resting energy expenditure’. More specifically PA consists of ‘free play, house chores, exercise, school physical education, and organized sport’ (Malina et al., 2004:6). For the purposes of this study, the only PA accounted for was the amount of extra-mural participation in the main sports provided through the mass participation program (Mass participation program, 2010) and the amount of time spent running, playing ball games, riding bicycle and or swimming after school on week days and weekends.
1.6 SUMMARY

In summary FMS acquisition is a necessity for future optimal physical, social and cognitive development, possible increases in PA and or decreases in overweight and obesity levels and improved performance in sport specific PA endeavours in children. Based on the literature reviewed and the theoretical framework of this study; environmental, personal and task constraints and the quality of movement interventions should be considered when evaluating the status of movement proficiency. In terms of the South African context, when taking into consideration these aforementioned constraints the need for FMS status investigation was demonstrated. Additionally by illustrating the importance of age appropriate movement interventions through the dynamic systems theory and literature findings, the lack of quality movement interventions within the South African school curriculum was established.

The first chapter of the study provided justification for the study as well as clarified the aim, objectives, scope and limitations and important concepts used in the study. To follow is chapter 2 which focuses on FMS holistically and the literature findings on the status, the theory and the factors affecting the acquisition thereof. Chapter 3 emphasises each FMS under investigation in this study; namely the run for speed, standing long jump, throw for distance, balancing statically and throwing for accuracy. Chapter 4 focuses on the methods and procedures employed to validly and reliably answer the research question and achieve the specific research objectives set. Chapter 5 reflects the findings of the research and chapter 6 provides a discussion, concluding comments and the recommendations for future research.
CHAPTER 2: FUNDAMENTAL MOVEMENT SKILLS AND MOTOR DEVELOPMENT

2.1 INTRODUCTION

The primary aim of this study was to identify the FMS proficiency status of girls’ aged 9-to-12 years from previously disadvantaged communities within the Nelson Mandela Bay. This chapter entails a thorough discussion of the literature findings and theories on motor development to facilitate the optimal understanding and conceptualisation of the problem statement. For organisational purposes and ease of reading, the literature study was divided into two chapters.

This chapter focuses on defining FMS and FMS proficiency, discussing where FMS acquisition occurs within the motor development spectrum, deliberating the evidence in literature on the importance of possessing proficient FMS and the theories that govern motor development and consequently FMS proficiency attainment. Lastly the evidence through literature on the factors which affect FMS acquisition are discussed. This chapter is concluded with a summary.

2.2 THE ACQUISITION AND IMPORTANCE OF PROFICIENT FUNDAMENTAL MOVEMENT SKILLS

As illustrated in chapter 1 of this report, literature findings demonstrated that proficient FMS acquisition forms an integral part of development, positively correlates to increased PA levels and is a precursor to specialised movement skills (O’Conner, 2000; Wrotniak et al., 2006; O’Keeffe et al., 2007; Lubans et al., 2010). However, regardless of the positive effects noted, literature indicates that children possess poor FMS proficiency levels (Booth et al., 1999:93-105; Ulrich, 2000; van Beurden et al., 2002:244-252; Okely & Booth, 2004; SPAN, 2004; Spessato et al., 2012:1-8). Consequently, further investigation into the literature relevant to FMS is warranted.
2.2.1 Fundamental Movement Skills within Motor Development

In order to adequately conceptualise FMS a formal definition and explanation of FMS and FMS proficiency is warranted. FMS are foundational movements; namely locomotor, non-locomotor and object-control skills which should be performed at a proficient level by all normally developing children (Burton and Miller, 1998:215). The differentiation between locomotor, non-locomotor (stability) and object-control skills (projection and reception of objects) can be denoted in table 1. As literature indicates that balancing additionally forms part of the non-locomotor FMS domain and has been found to positively correlate to FMS proficiency (Overlock, 2004), table 1 has been adapted and the non-locomotor skill, the stalk-stand (static balancing on one leg), has been added. Wickstrom (1986:44) and Haywood and Getchell (2009:114-116) indicated that the inability to balance is indicative of an abducted arm position in many FMS and is hence frequently a rate limiter to achieving mastery in a given FMS.

Table 1: Categories of Fundamental Movement Skills

<table>
<thead>
<tr>
<th>Locomotor</th>
<th>Non-Locomotor</th>
<th>Projection and Reception of Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk</td>
<td>Skip</td>
<td>Swing</td>
</tr>
<tr>
<td>Run</td>
<td>Roll</td>
<td>Sway</td>
</tr>
<tr>
<td>Leap</td>
<td>Stop</td>
<td>Roll</td>
</tr>
<tr>
<td>Jump</td>
<td>Start</td>
<td>Stretch</td>
</tr>
<tr>
<td>Gallop</td>
<td>Bounce</td>
<td>Curl</td>
</tr>
<tr>
<td>Slide</td>
<td>Fall</td>
<td>Twist</td>
</tr>
<tr>
<td>Hop</td>
<td>Dodge</td>
<td>Stalk stand</td>
</tr>
</tbody>
</table>

Source: Seefeldt, Reuschlein and Vogel (1972 In O’Conner, 2000:32)

According to Delaney, Donnelley, News and Haughey (2008:2) FMS form part of physical literacy, which is ‘the ability to use body management, locomotor and object-control skills in a competent manner, with the capacity to apply them with confidence in settings which may lead to sustained involvement in sport and physical recreation’. Hence by ensuring for proficient FMS, an individual’s ability to employ a
repertoire of basic movement skills to accomplish PA challenges may ensure for sustained PA participation. It is hence not surprising that literature findings support the notion that children with proficient FMS tend to fall within the normal weight BMI classification as opposed to overweight or obese as these individuals have more PA alternatives to participate in (D’Hondt et al., 2009; Lubans et al., 2010).

Motor development is the continuous attainment (or loss thereof) of motor skills within the lifespan and is affected by environmental, personal structural and functional and task constraints (Newell, 1986; Malina, 2004:50-51; Bakhtiar, 2013:106). To understand the acquisition of FMS it is important to recognise where FMS acquisition commences and progresses within the motor development spectrum and within early and middle childhood. Motor development is divided into phases and stages. The phases of motor development are the reflexive, rudimentary, FMS and specialised movement phase (Gallahue & Cleland-Donnelly, 2003:62). These phases can further be divided into stages, which describe the characteristic movements of each phase. Table 2 identifies the stages and phases of motor development within the lifespan.

Table 2: Phases and stages of motor development

<table>
<thead>
<tr>
<th>Movement Phase</th>
<th>Typical Age of Development</th>
<th>Movement Characteristic of Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflexive</td>
<td>In Utero to 4 months</td>
<td>Information encoding stage</td>
</tr>
<tr>
<td></td>
<td>4 months to 1 year</td>
<td>Information decoding stage</td>
</tr>
<tr>
<td>Rudimentary</td>
<td>Birth to 1 year</td>
<td>Pre-control stage</td>
</tr>
<tr>
<td></td>
<td>1 – 2 years</td>
<td>Reflex- inhibition stage</td>
</tr>
<tr>
<td>Fundamental</td>
<td>2 – 3 years</td>
<td>Initial stage</td>
</tr>
<tr>
<td></td>
<td>4 – 5 years</td>
<td>Elementary stage</td>
</tr>
<tr>
<td></td>
<td>6 – 7 years</td>
<td>Mature stage</td>
</tr>
<tr>
<td>Specialized</td>
<td>7 – 10 years</td>
<td>Transition stage</td>
</tr>
<tr>
<td></td>
<td>11 – 13 years</td>
<td>Application stage</td>
</tr>
<tr>
<td></td>
<td>14 years</td>
<td>Lifelong utilization stage</td>
</tr>
</tbody>
</table>

Source: Gallahue & Cleland-Donnelly, 2003:62
Before the onset of FMS can occur children first undergo the reflexive and rudimentary phase of motor development. The reflexive movement phase is characterized by uncoordinated and involuntary reflexive movements. Some reflexes remain permanent and are incorporated into motor programs (for example the blink and postural reflexes remain) whereas most reflexes (moro and Babinski reflex) disappear by the age of 9 months (Piek, 2006). The presence of reflexes have a protective and survival function for the infant, however, certain reflexes that remain (or do not emerge during infancy) after the age of 1 years are considered a warning sign for developmental problems (Mercuri, Ricci, Pane & Baranello, 2005:947-956).

The rudimentary movement phase consists of the first signs of voluntary movements and omission of reflex actions (Gallahue, 2010:17). That is, the pre-control and reflex inhibition stages. In this phase movement milestones such as sitting, standing, grabbing, crawling, grasping and releasing, gaining control of the head, neck and trunk predominate. The rudimentary phase spans the period from birth-to-2 years old and is characterised by a child gaining control over their posture and locomotion (Malina, 2004:52). One of the most important movement milestones to attain is walking as it initiates the commencement of bipedal motion (Wickstrom, 1983:25). More specifically, once bipedal motion is initiated children can start exploring their surroundings and commence the next phase which is the FMS phase.

In the FMS phase children progress in movement proficiency (which refers to the effectiveness, accuracy and precision with which a movement skill is performed) from an initial to elementary and eventually mature movement stage (McClenaghan & Gallahue, 1978:78; Gallahue & Cleland-Donnelly, 2003:62). An Initial movement stage is defined as the inability of an individual to prepare and follow through with a movement task. Hence during the movement execution the individual would seem uncoordinated, incorporate actions which are inefficient to achieve the motor task at hand and exhibit variability in performance (McClenaghan & Gallahue, 1978:85; Gallahue & Cleland-Donnelly, 2003:62). An intermediate movement stage is characterized by less variability of performance but a lack of utilising the most efficient movement pattern (Gallahue & Cleland-Donnelly, 2003:62). Lastly a mature movement stage can be thought of as achieving motor skill mastery in a specific skill by effectively executing the most efficient movement pattern to complete the motor
task at hand (O’ Conner, 2000:12-13). These aforementioned initial, elementary and mature movement stages classifications are used to describe FMS when the BC assessment approach is being employed to assess FMS acquisition qualitatively (to be discussed in detail within the ‘theory of motor development’) (McGlenaghan & Gallahue, 1978:78; Burton & Miller, 1998:222).

According to Gallahue (2010:19-20) there may be between-pattern differences (mature in one FMS and at an initial development pattern in another), within pattern differences (at an initial pattern in one body element and mature in another) and between child differences present when evaluating FMS proficiency levels. Hence, as depicted in table 2, the recommended age of 2-to-7 years in which FMS are meant to develop to a mature level of proficiency is an estimate. The fact that empirical research indicates that children and adolescents have not mastered FMS by 7 years old (Booth et al., 1999:93-105; Ulrich, 2000; van Beurden et al., 2002:244-252; Okely & Booth, 2004; SPAN, 2004; Spessato et al., 2012:1-8), that there is conflicting literature recommendations for when FMS proficiency should be attained and literature indicating that the proposed window of opportunity for FMS acquisition has limited supporting empirical research (Ford et al., 2013) confirms the need for further investigation into the status of FMS and the critical windows of opportunity for FMS acquisition.

Within the South African context, when considering the aforementioned literature on the proposed age span for FMS acquisition and the fact that the school environment is one of the ideal environments for PA interventions (Walter, 2011:781), the age span for optimising FMS acquisition within the South African school curriculum translates to obtaining FMS proficiency in pre-primary school (3-to-5 years) and between grade R-to-3 (5-to-8 years). The South African Department of Education defines the grade R-to-3 age span within the school curriculum as the foundation phase (Foundation Phase Curriculum, 2012). As mentioned in chapter 1 of this study, the omission of physical education from the South African school curriculum and re-introduction thereof without the support of qualified physical education teachers may have not optimised on this window of opportunity in the foundation phase (Amusa & Toriola, 2006; Van Deventer, 2004, 2009, 2012).
It is important to note the phase within the motor development spectrum which successes the FMS phase. More specifically, only once FMS are at a proficient level can the specialised movement skill (attainment of sport specific movements) transpire. Based on table 2, this should occur between the ages of 7-to-14 years. Empirical research supports the fact that focusing on obtaining proficiency in FMS before endeavouring to participate in sport specific skills can optimise the attainment of specialised movement skills (O'Conner, 2000; O'Keeffe et al., 2007); however, further empirical research is required to establish the exact age span for specialised movement skill attainment. As specialised movement skills are not the focus of this study, the emphasis of this literature review will be shifted to whether or not the proposed window of opportunity for FMS has been optimised through investigating national and international studies which identify the status of children’s FMS proficiency levels.

2.2.2 Status of Fundamental Movement Skills

As established in chapter 1 and in this review of literature thus far, FMS proficiency is positively correlated to social, cognitive and physical development (Lubans et al., 2010), increased PA (Wrontiak et al., 2006) and a decrease in overweight and obesity levels (D'Hondt et al., 2013). Hence investigating the current empirical literature on the status of FMS within the South African context and internationally is warranted.

2.2.2.1 South Africa

Whilst reviewing South African literature on FMS it becomes evident that there is an absence of empirical research focusing specifically on the FMS proficiency status of children. More specifically, most studies investigating FMS either directly or indirectly assessed FMS by identifying normative data on the physical fitness levels of South African children (Armstrong, Lambert and Lambert, 2011), researching the effect of an intervention on the motor skill proficiency or expressive movement status of children (Baard, 1998) or the effect of age, gender and PA on running, balance, bilateral and upper-limb coordination (Portela, 2007), correlating overweight and obesity’s levels to motor skill proficiency (Du Toit & Pienaar, 2003) or assessing the
effect of an intervention on FMS status in either children with Attention Deficit Disorder (Pienaar, 2006) or Human Immune Deficiency Virus (Botha & Pienaar, 2008). Consequently, studies incorporating some form of FMS investigation were indirectly assessing FMS and not primarily focusing on the FMS proficiency status of children. It should furthermore be noted that many of the South African studies reviewed tended to assess FMS using different quantitative and or qualitative assessment protocols, hence indicating that if these studies were focusing on the similar aims, comparisons between studies would be challenging (Baard, 1998; Pienaar, 2006; Portela, 2007; Botha & Pienaar, 2008, Armstrong et al., 2011; Afrika & Kidd, 2013). More specifically either the Eurofit fitness test (Armstrong et al., 2011), Bruininks-Oseretsky (BOMPT) assessment protocol (Portela, 2007), Peabody Developmental Scales (PDMS) (Botha & Pienaar, 2008), perceptually based assessment battery (Baard, 1998) or the TGMD (Africa & Kidd, 2013) were utilised in studies either directly or indirectly assessing FMS. Furthermore, empirical research on the motor skills of children, although noteworthy and relevant, tended to be dated (Katzenellenbogen, 1976; Baard, 1998) or focusing on identifying the impact of FMS on indigenous games (Lyoka, 2011) or validating a FMS assessment protocol within a group of adolescents (Africa & Kidd, 2013). Lastly, many studies on FMS were based on pre-primary school children with a lack of investigation into the FMS of primary school children (Pienaar, 2006, Botha & Pienaar, 2008; Du Toit & Pienaar, 2013).

Hence based on the aforementioned empirical findings, limited information on the FMS proficiency status of South African children is available. However, what can be denoted from these studies are the implications to take into account when assessing movement within the South African domain. For example Armstrong’s et al. (2011) investigation into the physical fitness levels of 10295 (5611 boys and 4684 girls) South African children aged 6-to-13 years illustrated the need to control for confounding variables such as ethnicity, anthropometry and SES when evaluating motor skills. An additional element noted as being important to consider was the incorporation of qualitative assessments when investigating motor skill. More specifically; the standing long jump, sprint and the throw for distance were quantitatively assessed employing the EUROFIT testing protocol. Hence no deduction as to the qualitative movement proficiency differences within and between
ethnic and gender groups was presented. Regardless of the lack of FMS proficiency qualitative assessment, on average these studies’ product scores indicated that there is a need for the reintroduction of formal physical education into South African schools, particularly in schools in which black children predominate.

In accordance with Armstrong’s et al. (2011) South African investigation, Portela (2007) assessed the motor skill ability of 366 South African foundation phase male and female learners aged 8 years. The primary implication noted within this study was the need for further investigation into the gender differences in movement skill proficiency between girls and boys. An additional implication noted was to investigate the possible bias in PA children are exposed to as boys tended to perform better in running and jumping type activities and girls tended to perform better in balance and coordinative type activities.

Based on the literature review produced within the South African context, it can be concluded that empirical research which focuses on FMS proficiency process and product score statuses of South African primary school aged children is lacking. Hence due to the dearth of literature nationally, an investigation into international studies on the FMS proficiency levels of children is justified.

2.2.2.2 Internationally

Similar search limitations as noted in the South African literature were illustrated in the international literature searches. More specifically, although there was an abundance of literature on the FMS, many researchers focused on the effect of interventions on FMS proficiency of children (Logan, Robinson, Wilson & Lucus, 2011), FMS status in overweight and obese children (Cliff, Okely, Smith, & McKeen, 2009), FMS status in special population groups (Staple & Rade, 2010), correlation studies (McKenzie, Sallis, Broyles, Zive, Nader, Berry & Brennan, 2002) and or the FMS in pre-primary school children (Hardy, King, Farrell & Macniven, 2010; Logan, Robinson, Webster & Barber, 2013), adolescents (Okely & Booth, 2001) or adults (Stodden, True, Langendorfer & Gao, 2013). Lastly, studies tended to focus on validating the TGMD with children from a different nationality or creating normative data from the TGMD assessments (Wong & Cheung, 2010).
Nevertheless, in comparison to the lack of research on FMS proficiency within South Africa, FMS status studies on children have been conducted internationally in the USA (Ulrich, 2000), Hong Kong (Pang & Fong, 2009), New Zealand (Cowley, Hamlin, Grimley, Hargreaves & Price, 2010), Australia (Booth et al., 1999; van Beurden et al., 2002; Okely & Booth, 2004; Hardy et al., 2012) and Brazil (Spessato et al., 2012; Valentini, 2012). When comparing these aforementioned international studies depicting FMS status results; variations were noted in the methodological approaches employed when assessing FMS, sampling method utilised, population groups investigated, and the use or non-use of video footage to examine FMS qualitatively. Additionally within each country, the emphasis placed on the specificity of FMS training and the importance placed on FMS proficiency within the physical education curriculum was dissimilar. Lastly, as noted in Booth et al. (1999), Hardy et al. (2012) and Spessato et al. (2012) in which the results of 5-to-16, 9-to-16 and 3-to-10 year old FMS proficiency scores where collated respectively, results could have been biased either towards the younger participants (who may not have had the necessary strength, balance and co-ordination to perform FMS proficiently) or the older children FMS scores.

Regardless of the aforementioned variability present between studies, an important consistency to note was that results were reported in percentage values, hence providing a means of comparison between studies whilst taking into consideration the aforementioned variations noted. Additionally, children were deemed as performing a FMS at a near mastery level when all but one of the body component (BC) variables being assessed for a particular FMS was present. An additional important similarity to take note of between these studies is that, irrespective of the variations between studies, on average the FMS proficiency status of children was found to be at a poor level of proficiency.

Low FMS proficiency levels were illustrated in a study conducted in the Porto Algere, a metropolitan city in Brazil. In this study Spessato et al. (2012) assessed the FMS status and gender differences in 1248 participants aged 3-to-10 year old from selected public schools and day-care centres. Participants’ FMS were assessed with the TGMD II. Results indicated that the participants under investigation performed below average when compared to the TGMD II USA norms. More specifically only
8% and 3% of boys and girls respectively performed above average and 23% and 15% of boys and girls respectively performed averagely. Overall 69% and 82% of boys and girls performed below average indicating an overall low level of FMS proficiency (Spessato et al., 2012:4).

Low FMS proficiency levels were demonstrated by Booth’s et al. (1999) New South Wales (NSW) School Physical Activity and Nutrition (SPAN) Survey in 1997. A proportional stratified randomly selected sample of 5518 students aged 9-to-16 years (year 4, 6, 8 and 10) were assessed on their body composition, health-related fitness components, FMS proficiency, self-reported PA and the time spent participating in sedentary behaviour and physical education classes. The FMS assessed were the run, vertical jump, catch, overhand throw, forehand strike and kick. The Manual for Classroom Teachers, which is a criterion referenced assessment protocol, was employed to evaluate the motor skills (Walkley, Holland, Treloar & O’Conner, 1999). Participants who possessed all body components deemed critical to the proficient performance of the FMS, except for one, where classified as possessing the skill. Overall near mastery or mastery was found to be at or below 40% for boys and girls in all the age groups assessed, indicating that on average a low level of proficiency prevailed in the participants assessed.

The follow-up to the NSW 1997 SPAN survey was the 2004 SPAN survey (Okely & Booth, 2004:359). Skills were assessed with an updated manual which additionally employed criterion cut-offs to determine FMS proficiency levels (Davy, Davis, Doorn & Atkins, 2000). Random selection of schools did not take place and instead schools were selected based on the number of children enrolled. More specifically special need schools or those with less than 180 enrolled children were excluded from the study. Randomization was only employed when children in years 1 to 3 were selected. Overall 18 schools participated in the study and 1288 girls and boys aged 6-to-8 years old (years 1 to 3) took part. The FMS assessed were as follows: ‘hop, skip, side gallop, overarm throw, kick (stationary ball) and leap (Year 1); leap, kick, two hand strike, dodge, sprint run, and catch (Year 2); static balance, sprint run, vertical jump, catch, kick (stationary ball), and overarm throw (Year 3)’ (Okely & Booth, 2004:360). The same near mastery and mastery definition as employed in the 1997 NSW survey was used to analyse FMS. Overall, only 35% of the sample
investigated displayed mastery or near mastery levels. This was slightly lower than the FMS proficiency level in the NSW 1997 survey.

The follow-up to the 2004 SPAN study was conducted in 2010 (SPAN, 2010; Hardy et al., 2012). A total number of 101 schools were invited to participate in the study. In response to the invitation by the SPAN project and in terms of the students who were included in the FMS assessments, 60% and 52.2% of elementary and high school children volunteered respectively. The eventual sample size was 6197 students aged 7-to-15 years old in year 2, 4, 6, 8 and 10 ( Hardy et al., 2012:e392). Results indicated that by the age of 9 years (year 4) just over half of girls and boys assessed had mastered the investigated FMS. More specifically only 40.6%, 32.6%, 68.1%, 26.6%, 8%, 10.6% and 43.3% of girls could sprint, vertically jump, side gallop, leap, kick and over-arm throw and catch respectively at an advanced level (SPAN, 2010: 6-11; 168-203). When reviewing the percent of boys who performed the sprint, vertically jump, side gallop, leap, kick and over-arm throw and catch at an advanced level only 43.9%, 33%, 61.7%, 13.2%, 42.5%, 44% and 63.8% respectively could perform these FMS at an advance level. When averaging these scores only 32.8% and 43.15% of girls and boys aged 9 years could perform the aforementioned FMS at a proficient level. The low prevalence of FMS mastery continued in the female population up until year ten (15 years old) with only 53.8% of female adolescents exhibiting advanced FMS. Males improved significantly with 69.3% male adolescents exhibiting advanced FMS. These results indicate that since 1997 and up until the year 2010 minimal improvements in FMS proficiency transpired in the Australia children investigated. This statement was validated by Hardy, Barnett, Espinel and Okely (2013) who conducted a secondary analysis of these aforementioned Australian studies (SPAN conducted in 1997, 2004 and 2010). According to Hardy et al. (2013) the slight improvement in FMS after the year 2004 was due to policy change in the teaching of FMS, however, the lack of overall improvement may have been due to the fact that FMS programs were not strongly positioned within the school curriculum.

An additional study conducted in Australia in the year 2000 was the Move It Groove It survey (van Beurden et al., 2002). The study employed a quasi-experimental design with 9 schools as the control group and 9 schools as the intervention sample
to evaluate the effect of an intervention on the FMS proficiency levels of participants. Static balance, sprint, vertical jump, kick, hop, catch, overhand throw and side gallop were the FMS assessed with the use of the manual for classroom teachers (Walkley et al., 1999). Overall 515 participants aged 9 years (year 3 students) and 530 participants aged ten years (year 4 students) participated in the investigation. Baseline results were found to be as equally low as that of the 1997 NSW SPAN survey and when compared to the NSW 2004 and 2010 SPAN surveys similarly low levels of FMS proficiency can be denoted. More specifically, only 47% of the boys and girls assessed achieved near mastery and mastery scores for the FMS investigated. After the yearlong intervention the baseline results did not improve dramatically. The authors’ arguments as to the poor improvements in motor skill ability were that more than a year is necessary to improve FMS proficiency levels. More specifically, and as denoted in Hardy et al. (2013), interventions should be incorporated into school structures from pre- to primary- schools for results to be positive.

In addition to Van Beurden’s et al. (2002) and Hardy’s et al. (2013) rendition that FMS interventions should be incorporated into the school curriculum Cowley et al. (2010) adds that the focus should be placed on the teaching and coaching programs implemented and not only the incorporation of FMS training into school curriculums. Cowley et al. (2010) deducted this conclusion after assessing 5-to-8 year olds FMS proficiency levels (in which only 4% of children were found to perform all locomotor skills at a proficient level) and subsequently putting in place a 5 year intervention with results hereafter indicating that even after the intervention most children could not perform all locomotor FMS at a proficient level.

The effects of a long term FMS intervention in schools was demonstrated in a study by Pang and Fong (2009). The research was conducted on 76 females and 91 males (M=7.6 years) Hong Kong participants from 6 local primary schools. The TGMD II composite scores for locomotor and object-control skills were used to assess FMS. Results indicated that most participants performed proficiently in the FMS under investigation. Only 2% of participants scored below average, 47% were average and 60% were rated as above average. Hence in comparison to the Brazilian, Australian and USA participants, Chinese children performed superiorly. According to the
authors, excellence in proficiency was observed in the run, gallop, leap, slide, catch and throw. The skills in which most participants struggled to perform certain BC variables proficiently was in the standing long jump, hopping, dribbling a ball and kicking. The high levels of proficiency were attributed to physical education being identified as a key learning area in Hong Kong. Additionally FMS were essential learning activities that took place in these physical education classes. It should be noted that the primary limitation within the Hong Kong study was a small sample when compared to the larger representative sample group assessed by the Australian and Brazilian studies, which could have biased results. However, regardless of this limitation the study illustrated that by ensuring for age appropriate FMS training programs in the school curriculum the window of opportunity for FMS acquisition can be optimised.

In summary it can be noted that internationally children’s FMS proficiency scores are poor. Based on the recommendations from authors within the studies investigated, physical education which focuses on FMS interventions has to be a stand-alone subject within the school curriculum and the teaching method in which the FMS interventions are implemented necessitated scrutiny in order for the FMS proficiency status of children to improve. Without putting in place strategies to improve FMS proficiency status of children numerous physical, social and health benefits associated with improved FMS proficiency will not transpire. Hence the lack of FMS proficiency status internationally should raise concern both within the South African context (which lacks empirical research on FMS status assessments) and internationally.
2.2.3 Proficient Fundamental Movement Skills

2.2.3.1 Proficient motor skills and their correlation to physical activity

Studies focusing on interventions to decrease the level of obesity in children have fixated on a combination of dietary interventions, incorporating communities and family engagement in increasing PA levels and or decreasing sedentary behaviour (Goron, Reynolds & Lindquist, 1999; Jimenez-Pavon, Kelly & Reilly, 2010; Leung, Agaronov, Grytsenko & Yeh, 2012). Although these investigations have shown favourable results, the emphasis on motor skill competency as an intervention for lifelong participation in PA endeavours necessitates inclusion. Stodden, Goodway, Langendorfer, Roberton, Rudisill, Garcia and Garcia (2008:290) stated that ‘previous research has failed to consider the dynamic and synergetic role that motor skill competence plays in the initiation, maintenance, or decline of physical activity’. According to the authors, research has focused on the act of being PA instead of the skills underlying the PA. Stodden et al. (2008) created a model for increased PA based on literature findings and hypothesised that improved actual and perceived motor skill competence and physical fitness will intern increase PA participation. Subsequently by optimising these variables decreases in the level of obesity rates in children, adolescence and adults can be expected.

In accordance with Stodden’s et al. (2008) viewpoint that increased motor skill competencies result in improved PA participation; Wrotniak’s et al. (2006:e1759) study illustrated the positive role of proficient movement skills on PA levels. In their investigation of 65 males and females aged 8-to-10 years; motor ability in running speed and agility, balance, bilateral co-ordination, upper limb co-ordination and fine motor development was positively correlated to increased PA levels. Additionally participants with higher BMI’s tended to possess poorer motor skill abilities and participate in more sedentary behaviour, further illustrating the possibility that proficient skills can result in increased participation in PA which in turn may result in decreased BMI values in children. Another finding which illustrated the importance of motor competency in FMS was that the standing long jump and the run for speed were highly correlated with increased levels of PA, leading authors to infer that these skills may be fundamental to building strength and endurance and hence should be
incorporated into interventions and or test batteries to ensure for proficiency in their performance (Wrotniak et al., 2006:e1762).

The positive correlation between improved motor skills and PA was additionally illustrated in Barnett’s et al. (2008) longitudinal study in which participants found to be more skilful in object-control skills tended to demonstrate increased levels of cardiovascular fitness in adolescents. The study was based on an original sample of children aged 7.9-to-11.9 years. Six years later the original sample was sourced and retested. Object-control skills were found to be more positively related to cardiovascular fitness and explained 26% of the variance experienced in cardiovascular fitness whereas locomotor skills were not correlated. Authors concluded that the relationship between object-control skills and cardiovascular fitness was positive due to the high intensity nature of sports that require object-control skills. For example, boys partook in object-control skill dominant sports both in winter and summer (soccer, rugby, cricket, basketball and squash). Girls’ winter sports consisted of football, netball, soccer, and hockey. Only 13% of their winter related sports were dance and aerobics related endeavours. Regardless of the participation by girls in numerous ball related sports, only 20% of girls had achieved mature object-control skills in throwing and kicking. Additionally another surprising finding was that girls’ locomotor skills were better than boys. No specific reason other than a retention rate of 29.7% and a limited sample size could explain these findings.

Further support for the role that proficient motor skills have on PA was established in a study by Mckenzie et al. (2004). The study’s primary aim was to identify whether childhood movement skills predict PA levels in Anglo American and Mexican American adolescents. The longitudinal study was conducted on participants aged 4, 5 and 6 years and then subsequently on the same participants when they turned 11 and 12 years old. The original sample consisted of 351 participants and when participants were retested at 11 and 12 years old there was a 58% retention rate. Results indicated that the motor skill ability of participants could explain the variances between participants in PA levels; however, motor skill proficiency did not correlate to being more PA at an older age (Mckenzie et al., 2004:242). The lack of longitudinal correlation in Mckenzie and colleagues’ study was thought to be due to
the product scores which inappropriately represented the participants’ ability to perform motor skills. An additional limitation noted was the use of a Physical Activity Recall Questionnaire (PARQ) (which although a valid assessment tool, inherent bias is present), a small sample size, a large dropout rate, the lack of inclusion of more diverse FMS and the use of a product scoring system which limited the representation of the motor abilities. There was no assessment of the movement sequence itself through qualitative observations and hence the effects of maturation and learning were not considered. Additionally confounding variables such as motivation to participate in sport, especially in the adolescent years, was not included in this longitudinal investigation.

In the Cliff et al. (2009:446-448) study it was additionally noted that the assessment tool employed to evaluate FMS proficiency was limiting and hence resulted in bias. More specifically in the Cliff et al. (2009:446-448) study it was found that a significant relationship between increased PA and FMS proficiency in pre-school children exists. However, this relationship was more prevalent in boys than girls. According to the authors the use of the TGMD did not focus on balance and rhythm, which have been shown to be more strongly related to girls PA endeavours. The authors recommended that longitudinal research on FMS proficiency and gender disparities and their link to PA should be conducted with the utilisation of assessment tools which cover a larger array of movement skills to account for the gender disparities noted.

Based on the literature reviewed it can be surmised that a positive relationship does exist between increased PA levels and proficient FMS and consequently increased energy expenditure. However, each study’s methodological procedures should be considered when discussing these results.
2.2.3.2 Link to overweight and obesity

Lubans’ et al. (2010:1019-1035) conducted a meta-analytic systematic study on the importance of FMS from a physical, psychological and behavioural point of view in children aged 3-to-18 years old. Cross-sectional, longitudinal and experimental studies were quantitatively analysed. Only published journals were accepted from 6 electronic databases. In addition 18 experts in the field were contacted and sourced for relevant manuscripts. Only studies focusing on gross motor skills, qualitative and quantitative assessment techniques, cross-sectional designs and normally developing children were sourced; that is no studies were included which investigated children who were classified as overweight or obese or with developmental coordination conditions. The main finding was a positive relationship between PA and cardiorespiratory fitness and an inverse relationship between FMS and weight status, consequently indicating that individuals with proficient FMS tend to possess acceptable BMI values correlated to optimised health.

The lack of motor skill proficiency in obese children was additionally verified in the Marshall and Bouffard (1997) study in which the differences in motor skill ability in 100 obese participants and 100 aged matched non-obese peers was investigated. The TGMD was employed to assess locomotor skill ability in 7 skills; namely the run, hop, gallop, leap, horizontal jump, skip and slide and non-locomotor skills such as the two-handed strike, stationary ball bounce, catch, kick, and the overarm throw. These skills were videotaped and assessed by trained facilitators. Furthermore aerobic fitness was assessed with the use of the 20m shuttle run test and correlated to motor ability. Findings indicated that non-obese males and females were significantly more proficient in movement skills than their obese matched peers. Additionally non-obese males were found to be significantly better in movement skills than the non-obese females. Lastly non-obese participants were found to be physically fitter than their obese peers (Marshall & Bouffard, 1997:230-232).

A similar study was conducted by D’Hondt et al. (2009) who investigated the relationship between BMI and motor skill ability in 117 male and female participants aged 5-to-10 years (M:8.5 years+1.4 years). Correspondingly to Marshall and Bouffard’s (1997) study, convenience sampling was employed to gain access to
participants; however the Movement Assessment Battery for Children (MABC) was utilised to assess motor skill ability. The MABC assessment did not include locomotor skill proficiency and focused on manual dexterity, ball skills, and static and dynamic balance. PA was assessed with an accelerometer for a minimum of 3 days. Results indicated that non-obese participants performed ball, static balance and manual dexterity skills more proficiently than their obese counterparts.

In terms of the Marshall and Bouffard’s (1997), D’Hondt’s et al. (2009) and Luban’s et al. (2010:1019-1035) studies, the negative link between FMS proficiency and overweight and obesity was established. Contrary results were found in the Riddiford-Harland, Steele and Bar’s (2006:42-49) study in which product as opposed to process scores were assessed. That is as opposed to employing the MABC and TGMD assessment tools as in the Marshall and Bouffard (1997) and D’hont et al. (2009) studies respectively, to judge motor skill performance only the product scores were assessed to determine the effect of obesity on children’s upper and lower limb functionality. The Riddiford-Harland et al. (2006) study assessed upper limb motor ability via an arm push/pull test and basketball throw for distance. Lower body functionality was assessed with a vertical and standing long jump and a sit-to-stand test. As opposed to the Marshall and Boufford (1997) and D’ Hondt et al. (2009) findings, obese participants performed better in the upper body tasks when compared to their non-obese matched peers. The authors inferred that this was due to obese participants being larger and taller than their age matched peers and hence the additional mass provided these individuals with a definite advantage in terms of force production. Furthermore, according to the authors, research has indicated that obese children have larger muscle mass when compared to their non-obese peers, providing them with an added advantage. Comparable results were found in a cross-sectional South African study in which product scores were assessed through the use of the Fitnessgram and BOTMP on 280 Potchefstroom males and females aged 9-to-12 years (grade 4, 5 and 6) (Truter, Pienaar & Du Toit, 2010). Upper body skills such as fine manual control, manual co-ordination and body co-ordination had the lowest correlation to BMI whereas skills that required speed and agility (lower body functionality) decreased significantly in performance with increases in BMI. Balance ability was additionally affected by obesity levels. These were limited to standing on one leg with eyes closed and walking on a balance beam.
The difference noted in the obesity studies above possibly indicates that the ability to perform the developmental sequence (process scores) of locomotor FMS is compromised in obese children whereas the increased weight positively affects upper body power exertion and hence the product scores of obese children. The lack of being able to perform a skill proficiently (process score) may be due to the lack of participation in PA endeavours or the effect that the body mass has on the limbs ability to perform a motor skill adequately (D’Hondt et al., 2009:32). Regardless of the fact that upper body power was found to be better in obese children as opposed to their non-obese peers in the Riddiford-Harland et al. (2006) study, findings specified that cardiovascular fitness and lower body functionality were compromised in the obese children investigated. Based on these results it would hence seem as though investigating both product and process scores of FMS proficiency levels in children and comparing them to BMI results would provide more comprehensive data for analysis purposes.

In addition to FMS facilitating increased sport and recreational participation and consequently increasing energy expenditure and possibly contributing to the maintenance of the health through decreasing overweight and obesity rates, it facilitates the development of specialised movement skills. That is, in order to attain sport specific movement skills, FMS have to be at a proficient level. The following section illustrates the evidence from literature which substantiates this point.
2.2.3.3 Precursor to specialised skills

The O’Keeffe et al. (2007) study investigated the transfer and specificity of movement skills in physical education classes in adolescents aged 16 years. Adolescents were divided into a FMS overarm throw, badminton, javelin throw and a control group. Each group only participated in the aforementioned activity with the control group receiving no instruction. Results illustrated that the FMS overarm throw group showed significant learning effects in all 3 activities (the overarm throw, javelin and badminton) whereas transfer from javelin to badminton and vice versa were not as successful. The authors concluded that there is transfer between FMS to sport specific skills, practicing the overarm throw improves performance in the skill itself and the overarm throw should be the primary focus in early PA classes before sport specific skills are attempted.

Further validation of the link between FMS and specialized movement skills can be seen in the O’Conner (2000:1-407) study. Of particular interest was the effect of a ten week overarm throw and side-arm strike intervention on the performance of the skills themselves and related sports; namely javelin throw, baseball pitch, badminton clear, lacrosse pass, tennis serve, gridiron pass and volleyball serve. These aforementioned sports were included based on a thorough literature study, wherein the primary aim was to find sports which have the same component characteristics of the overarm throw and side arm strike. To test the effect of the ten week intervention O’Conner (2000:3) employed one secondary and two primary schools from Melbourne. Schools were chosen based on convenience with regard to accessibility, proximity, timetabling and class size. School A consisted of children aged 149 months on average, school B had children aged 144 months on average and school C had 107 months on average. One school received instruction on the overarm throw and two-hand side arm strike for 10 weeks and the second school (control group) received instruction on unrelated sports, namely the ball bounce and kick. The third school (control group) received daily physical education classes with no emphasis on learning any FMS. Results indicated that the group who received instruction had significant improvement in performance of the overarm throw and side arm strike together with the sports identified through the literature study. It should be noted that even though there was an improvement in performance, the
FMS level before and after testing was generally low. The author concluded that more time is required to learn FMS, there is a transfer from FMS to sport specific skills and practicing a FMS can improve sport specific skills and the skill itself.

The Gallahue and Cleland-Donnelly (2003:62) stages and phases of motor development indicate that FMS proficiency is required before specialised movement skills can be attained. These authors additionally add that there is a proficiency barrier which is based on the premise that future sports performance is dependent on an individual's FMS foundation. In addition to the Gallahue and Cleland-Donnelly (2003) theoretical model on motor development, Balyi and Hamilton (2004) proposed a Long Term Participant Development (LTPD) model. The LTPD model is a 7 stage Canadian Model which allows for the creation of periodization plans based on the individual's biological and training age. It is based on an individual's level of maturation and not chronological age and considers an individual's physical, mental, emotional, and cognitive development; consequently resulting in age-appropriate physical education and or sport specific programs. Peak height velocity (PHV), the maximum rate of growth in stature during the growth spurt, is one of the fundamental growth measurements incorporated to identify the child's level of maturation. In accordance with Gallahue & Cleland-Donnelly (2003:62) sentiments that FMS have to be trained before specialised sport specific skills can be acquired, the LTPD model includes an Active Start and Fundamental Movement stage which occur before the specialised sport specific LTPD stages transpire. Ford's et al. (2013:393) investigation into the empirical evidence supporting the proposed windows of opportunities and stages presented within the LTPD model indicates that there is physiological evidence to suggest that FMS acquisition should occur within childhood. However, more empirical research is required to support whether optimising FMS development in early childhood will transpire into supporting the sport specific stages following in the LTPD model.

Regardless of the proposed lack of empirical research to support Gallahue and Cleland-Donnelly’s (2003) phases and stages of motor development and the LTPD model (Balyi & Hamilton, 2004), based on the empirical evidence identified within this study focusing on FMS before the sport specific skills within early childhood is warranted.
2.2.3.4 Link to perception of motor ability

A positive correlation between motor skill proficiency levels, individuals’ perception of their movement ability and the amount of PA participated in was established in the systematic review of literature by Stodden et al. (2008:295-297). In Stodden’s et al. (2008) study it was established that by middle childhood children have higher cognitive function and can therefore perceive their motor function and compare themselves to peers. Hence there is a possible stronger link between their perception of their movement ability and the amount of PA participated in. Consequently middle childhood is a vulnerable time for children as their lower motor skill competence and perception of their movement ability may negatively affect their levels of PA participation. As empirical research proved these aforementioned sentiments, Stodden et al. (2008) stated that it is imperative that children learn proficient movement skills and improve their perceived motor skill competence during early and middle childhood.

The Barnett et al. (2008) empirical study supports the literature findings by Stodden et al. (2008:296). In this study perceived motor proficiency in childhood was assessed for its predictive ability for adolescent PA and fitness levels. A physical self-perception measurement was used to assess participants perceived sports competence. Each item in the questionnaire was scored between 1 (low self-perception) to 4 (high self-perception). According to the authors the reliability and validity of the questionnaire had been established. Results indicated that perceived sport competence in adolescence was significantly related to object-control skills in childhood. This positive correlation extended to time spent being physically active. Consequently the authors concluded that children who have higher perceptions of their ability to perform object-control skills were more likely to participate in PA. It is therefore important to provide children with positive movement experiences which foster FMS development to a level of proficiency which would be associated with success during recreational and future sporting endeavours.
2.3 THEORY OF MOTOR DEVELOPMENT

Thus far FMS and FMS proficiency have been defined and their emergence within the motor development spectrum conveyed. Empirical research on the FMS status within South Africa and internationally has been discussed and the empirical research supporting the positive contribution proficient FMS have on social, cognitive and physical development deliberated. Before discussing the empirical evidence on the variables which affect FMS proficiency, it is important to review the theoretical underpinnings which led to the inclusion of the specific confounding variables which affect motor skill acquisition and consequently the confounding variables accounted for in the methods and procedures employed whilst studying the FMS proficiency status of the population group under investigation.

2.3.1 Brief Discussion on the History of Motor Development

The motor development paradigm has a rich history dating back to the 1800’s with the first theoretical contributions to motor development commencing with Darwin’s autobiography of his son’s movement (Thelen, 2000:385). To many theorists of motor development this was the groundwork from which future motor development theories spawned. The persistent effort invested in observing infants and children’s motor behaviour was continued by guru’s in the field such as Harverlson, Shirley, McGraw, Gessell and Bayley to name but a few (Heriza et al., 1991:99). These observations of infants and children led to developmental norms which are still in use today. Gessell and McGraw were the pioneers in developing these developmental norms and were additionally advocates for the effect that Central Nervous System (CNS) maturation and genetic contributions to motor development (Heriza et al., 1991:99; Thelen, 2000:385; Malina, 2004:58). Their tedious observations of twins resulted in the premise that until children are developmentally ready in terms of CNS maturation, no amount of movement intervention will facilitate motor learning. Consequently during this period of motor development history it was believed that the environment did not stimulate movement progression but that the maturation of the CNS and genetics dictated the functional capacity produced by a child (Heriza et
Hence this era of motor development was governed by the Neuromaturational theory.

Research in the motor development arena has progressed due to contemporary literature findings supporting new schools of thought on how movement transpires and technological advances which have permitted modern investigations (Thelen, 2000:388). Contrasting the traditional views by McGraw and Gessell, contemporary theories support the notion that the task at hand, interactions between bodily systems and the environment effect the production of movement as opposed to primarily CNS maturation (Kam, Thelen & Jensen, 1990:768-773; Thelen, 2000:388; Malina, 2004: 57-58; Bakhtiar, 2013). That is, theories such as the dynamic system and Newell's constraint theory support the notion that the environment, genetics and the CNS, and the bodily systems affect motor learning. Consequently by employing the dynamic system and Newell's constraint theory as the theoretical framework of this study, confounding variables to consider that may affect FMS proficiency status are the types of movement interventions and the environment a child is exposed to. In order to understand this aforementioned viewpoint, it is important to discuss the dynamic systems theory in more depth and its opposing theory, the traditional Generalised Motor Program (GMP). Additionally, discussing Newell's constraint theory in terms of the current South African situation will provide the theoretical basis utilised to explain the FMS proficiency status results of this study.

2.3.2 Dynamic Systems and Schmidt's Generalised Motor Program

The premise of the dynamic system is that the body organises itself into an attractor state. An attractor state is the most efficient and effective movement sequence required to execute the motor task at hand and is created by the self-organisation of body segments and systems in response to an external stimulus (Thelen, 2000; Heriza et al., 2001; Malina, 2004; Cronin & Mandich, 2005:7). There is hence an interaction between the person, the environment and the task constraints which cause the body's systems and degrees of freedom to self-organise in such a way as to meet the demands of the motor task with a stable motor performance called an attractor state. In order for the person to discover an attractor state, practice and variability in movement experiences are required for the body to 'find' the most stable
movement pattern (Thelen, 2000:390; Malina, 2004:57-58). This process is governed by control parameters, which according to Cronin and Mandich (2005:8) ‘are the conditions in existence at the time the task is executed’. In other words it is a variable which will cause an attractor state to change. A good example of the dynamic systems theory was provided by O’Conner (2000:54-58) through explaining the transition of walking to running. When walking, the general pattern does not change until a critical speed (control parameter) is reached, then a new attractor state (running) will transpire so that the movement is more efficient. According to Cronin and Mandich (2005:7) pain is another example of a control parameter that can alter a movement pattern once a specific threshold is met so that a more efficient or less painful movement is established. A FMS example of how the body self-organises itself is in the act of throwing. In order to hit a target with an overarm throw the elbow would have to flex and then extend as the movement is executed. As the elbow is a hinge joint, anatomically only flexion and extension of the elbow joint in the sagittal plane can occur. More specifically during the throwing motion extension of the elbow joint occurs passively as the movement ‘naturally’ follows the path dictated by the anatomical structure of the elbow joint. According to Thelen (2000), when considering motor skills, balance and strength tend to be control parameters which affect the transition of movement from one attractor state to another.

A criticism by researchers of the dynamic systems theory is that it does not take into consideration mental representations of a movement (Malina, 2004:58). Hence it only hypothesises that movement naturally transpires as the body experiences situations that stimulates a movement response. A theory which supports the premise that there must be some form of brain activity involved in the production of movement was that proposed by Richard Schmidt’s (Schmidt, 2003:366). That is, the GMP and the schema theory which was first presented in 1974. According to this theory movement is generated by a GMP which houses and controls a unique sequence of bodily patterns to achieve a given motor goal. For example, if the CNS is stimulated by an external stimulus to initiate a throwing movement then the GMP for a throw will be collected and initiated. However, in order for the environment to be taken into account and the different demands required by the body to meet different movement goals, Schmidt (2003:366) stated that the GMP necessitates a recall and
the recognition schema (Schmidt, 2003:366). More specifically the recall schema refers to the parameters governing the movement and the outcome such as the ‘where, what, how fast, how hard’ of the movement (Keetch, Schmidt, Lee & Young, 2005:971). The recognition schema houses the sensory experience associated with the movement (Schmidt, 2003:367). That is what it feels, looks and hears like when initiating and performing the movement. Hence when a stimulus brings about the need to initiate a movement, the GMP is retrieved, the recall schema feeds into it by providing information on the parameters of the movements and the recognition schema assist by providing continuous feedback on the muscle force, coordination and directional changes needed to meet the movement goal. To generate a GMP, recall and recognition schema practicing and experiencing movement with a particular goal is a necessity.

Researchers have indicated that the primary limitation of the GMP and schema theory is that there is not enough processing ability in the brain or storage capacity to account for the many degrees of freedom in complex movement skills and the integration of all bodily systems to achieve a motor skill goal and hence there cannot be only one GMP governing a movement (Newell, 1991:221). It is for this reason that the dynamic systems theory has been so alluring to most researchers. According to O’Conner (2000:59-61) the dynamic and centralists approach should be merged and then perhaps a better understanding of the way individuals learn motor skills will emerge. As both theories support the need for practice, this factor should be considered when assessing the status of FMS proficiency.

As mentioned within chapter 1 of this study, within the South African context, physical education was omitted from the school curriculum and re-instated without support from qualified instructors (Amusa & Toriola, 2006; van Deventer, 2004, 2009, 2012). Consequently, and in terms of the dynamic systems theory, adequate practice and a stimulating motor learning environment for an attractor state to emerge may not have transpired.

Bakhtiar’s (2013:108) discussion on the implementation of the dynamic system into physical education supported the notion that an age appropriate movement intervention conducted by a trained facilitator is needed for motor learning to
transpire. That is, the physical educator’s primary goal should be to provide a variety of age appropriate movement experiences within an environment that is conducive to motor learning for an individual to find an attractor state.

In addition reviewing the FMS interventions put in place to facilitate motor learning, the environment an individual is exposed to is an important factor to consider when reviewing the FMS proficiency of a child. That is, Newell’s constraint theory states that an individual’s personal, task and environmental constraints should be considered.

2.3.3 Newell’s Constraint Theory

Newell’s constraint theory implies that movement attainment is affected by environmental, task and personal constraints; as depicted in figure 1. According to O’Conner (2000) one variable that Newell’s constraint model does not consider is the role that instruction plays in skill acquisition. Hence, by employing a multi-theoretical framework, movement acquisition can be explained through the dynamic system and Newell’s constraint theory.

![Newell's Constraint Model](Haywood & Getchell, 2009:6-7)

As depicted in Haywood and Getchell (2009:6-7) Newell’s constraint theory illustrates that when evaluating the motor proficiency levels of an individual it is important to pay attention to the environmental constraints in which movement
transpired; be it the cultural, the physical, political, SES and so forth. Additionally personal constraints such as structural (body structural changes through growth, maturation and development and being male or female) and functional (behavioural characteristics such as motivation, movement experience and so forth) constraints should be considered. Furthermore the task constraint such as the type of movement being performed, the rules under which the movement is to be performed and or the movement goal to be achieved should be deliberated as each can affect the quality of the movement produced.

On further elaboration of and in congruence with Newell’s environmental constraints; Greig et al. (2007:38) state that the environment is made up of a microsystem, mesosystem, exosystem and macrosystem; all of which can affect motor learning. The microsystem is the immediate environment or setting that the individual is in contact with (for example the physical space and or people present), the mesosystem is the relationship between settings (for example the school, home and or playground), the exosystem is a system without the individual but which influences his or her life (social networks and or employment rates) and the macrosystem refers to the culture and subculture variables indirectly affecting the individual (neighbourhood, ethnicity and the presence or absence of poverty).

As the dynamic system and Newell’s constraint theory provided the theoretical basis from which the confounding variables, deemed important to consider when assessing FMS proficiency status of children, were established; the following section discusses the empirical research findings on each proposed confounding variable within Newell’s constraint theory within both the South African and international context.
2.4 VARIABLES AFFECTING FMS ACQUISITION

Based on the premise that the status of physical education (dynamic systems theory) and personal structural (anthropometric variables, gender and growth, maturation and development) and functional (motivation), environmental (the micro-, exco-, meso- and macro- system) and the task (types of FMS interventions) constraints affect FMS proficiency it is necessary to discuss the empirical research supporting or disputing these claims.

2.4.1 Overweight and Obesity

As previously illustrated within section 2.2.3.2 (‘link to overweight and obesity’, page 31) of the literature review of this study, the effect that proficient FMS has on decreasing the level of obesity due to their positive influence on increasing PA levels was exemplified in the studies by Marchall and Bouffard (1997), Riddiford-Harland et al. (2006:42-49), D'Hondt et al. (2009), Lubans et al. (2010) and Truter et al. (2010:227-233). Additionally the negative effects of possessing a high BMI on participants FMS proficiency levels and activities of daily living (ADL) was demonstrated in these studies. To reiterate what was discussed previously these studies indicated that increased body mass may have a positive effect on upper body power and a negative effect on activities which necessitate propelling the body through the air such as running or jumping activities. Consequently this section expands on the positive effects proficient FMS may have on contributing to decreasing overweight and obesity levels in children by focusing on BMI’s effect on movement proficiency and the status of overweight and obesity nationally and globally. Hence through discussing empirical research on BMI and its effect on motor abilities, the need to account for BMI values in children due to its possible confounding effect on FMS proficiency status results is justified.
2.4.1.1 Overweight and obesity effect on motor skills

In terms of Newell’s constraint theory (Newell, 1987), overweight and obesity are encompassed within the personal structural constraint and consequently may have an effect on the motor learning of individuals. Within the national and international context a growing concern highlighted by researchers is the escalations in the body of evidence signifying the rise in overweight and obesity rates in children in developing and developed countries (Kelishadi, 2007:62). The increase in overweight and obesity rates are furthermore of concern as literature findings suggest that overweight and obesity track from childhood to adolescence and into adulthood (Gunnell, Frankel, Nanchahal, Peters & Smith, 1998:1117-1118; Guo & Chumlea, 1999:147S; Venn, Thomson, Schmidt, Cleland, Curry, Gennat & Dwyer, 2007:458), possibly further hindering motor learning and participation in PA energy expenditure activities and escalating the health complications associated with obesity. The latter being that child obesity can have severe consequences on health and wellbeing of the individual by causing complications such as hypertension, depression, low self-esteem, sleep apnea, asthma and diabetes to name but a few (Ebbeling, Pawlak & Ludwig, 2002:475).

Studies have found that children with lower motor skill ability have a tendency to be overweight and obese (D’Hondt et al., 2009). As a result researchers have focused on what the effects of proficient motor skills are on PA levels. Children who perform FMS more skillfully generally tend to be more active and more motivated to participate in recreational activities and organized sport (Wrotniak et al., 2006:e1759; Stodden et al., 2008:290-306).

In accordance with the findings above in the Okely, Booth and Chey (2004) study the correlation between BMI and waist circumference with FMS proficiency levels in 4363 males and females from data gathered in the 1997 NSW Schools Fitness and Physical Activity Survey was assessed. Results indicated that children and adolescents who were non-overweight were 2-to-3 times more likely to possess proficient FMS. However, similarly to the Riddiford-Harland et al. (2006) study’s results, the relationship between weight status and motor proficiency was more significant in locomotor as opposed to object-control skills.
Contrary to the above studies Hume, Okely, Bagley, Telford, Booth, Crawford and Salmon (2008) did not find a correlation between weight status and FMS proficiency levels. This is a surprising finding as the FMS assessed were lower body dominant (kick, run and vertical jump) and based on the literature study thus far discussed lower body dominant motor skills correlate negatively with increased body weight. Contrary to the lack of correlation between FMS and weight status, participants with higher FMS proficiency levels were found to be more active. A plausible reason for the lack of correlation between FMS and weight status in the Hume et al. (2008) study could be explained by the cross-sectional nature of the study, the small sample size and or not enough days spent monitoring PA levels to allow for potential statistically significant findings.

With empirical literature and the theoretical perspectives from Newell’s constraint and the dynamic systems theory clearly indicating the negative affect that overweight and obesity levels have on FMS proficiency levels, BMI is an important variable to control for due to its possible confounding effect on FMS proficiency scores. Identifying the current overweight and obesity status within South Africa and internationally and elaborating on how BMI is assessed is hence important to discuss further.

2.4.1.2 Overweight and obesity status in children

In accordance with the Kelishadi (2007:62) study results, the South African study by Armstrong et al. (2006) on children aged 6-to-13 years concluded that the same tendencies in overweight and obesity being exhibited in developed countries are being exhibited in South Africa, a developing country. More specifically Armstrong et al. (2006:57) established that 3.2% and 4.9% of South African boys and girls respectively had prevalence for obesity. Furthermore 14% and 17.9% of South African boys and girls were overweight respectively. The de Onis and Blissner (2000:1033-1034) investigation into the prevalence of obesity and overweight in 160 nationally representative surveys from 94 developing countries further confirmed the need for interventions to counteract the increased weight gain tendency among South Africans. More specifically South Africa ranked second for the highest
prevalence of overweight levels within pre-primary school children. This was on par with Rossouw, Grant and Viljoen’s (2012:3-7) systematic study on the overweight and obesity rates in South African adolescents. More specifically according to the authors high levels of overweight and obesity are present in South African children and adolescent and this is even more prevalent in the female population. Research has indicated that the adolescent years are usually the time span where youth eat most unhealthy (Berk, 2012:198). To add to this girls in particular tend to put on weight due to the onset of puberty and the associated hormonal changes and development of secondary sex characteristics (Freedman, Khan, Serdula, Dietz, Srinivasan & Berenson, 2003:2). Furthermore, literature indicates that when girls reach puberty they tend to decrease in their PA levels, consequently contributing to increased weight gain (Barnett et al., 2008: 2137–2144; Rossouw et al., 2012:2).

International studies in Australia, Spain and Canada are illustrating similarly high levels of overweight and obesity levels in children. Tremblay and Willms (2000) investigation into 7-to-13 year old Canadian boys and girls prevalence for overweight and obesity levels from the year 1981 to 1996 indicated much higher prevalence for overweight and obesity rates than those indicated by the South African studies. A disturbing trend was established in that the occurrence of overweight levels increased from 15% to 28.8% and 23% to 23.6% for boys and girls respectively. Obesity increased from 5% to 13.5% in boys and 5% to 11.8% in girls. Similar findings were found in other international developed countries such as Australia and Spain. In the Hume et al. (2008) study on Australian children indicated that 33% of girls aged 9-to-12 years were classified as overweight and or obese. Furthermore according to the NSW survey conducted in the year 2004 ‘almost a quarter of students aged 5-16 years were overweight or obese’ and ‘boys and girls aged 9-12 (years 4 and 6) had some of the highest rates – up to 33%’ (SPAN, 2004:3-4). Ara, Moreno, Leiva, Guita and Casajus (2007) cross-sectional study on 1068 Spanish male and female participants aged 7-to-12 years adiposity levels indicated that 31% and 6% of participants were overweight and obese respectively. Hence based on the literature findings on overweight and obesity levels in developing and developed countries an upward trend in this epidemic is evident.
Although overweight and obesity levels are on the rise throughout the world, wasting in African and Asian countries have been found to be 2.5 to 3.5 times higher than overweight rates (de Onis & Blissner, 2000:1033-1034). Consequently assessing for overweight, obesity and wasting is a recommendation. Wasting suggests the presence of acute shortage of food or acute infection, requiring immediate short term intervention such as food supplementation or treatment of the underlying disease (Solarch & Goga, 2003/2004:117). Stunting suggests the presence of severe undernutrition, which requires more of an aggressive approach such as adequate nutrition and preventing chronic illness for future generations (Solarch & Goga, 2003/2004:117).

Jinabhai, Taylor and Sullivan (2003:358-365) conducted a cross-sectional descriptive randomized controlled trial in Kwazulu – Natal to explore the relationship between stunting and overweight children using different BMI definitions, namely the World Health Organization (WHO) and International Obesity Task Force (IOTF) to measure nutritional status. Schools were randomly selected and all children in grades 1 and 2 from the randomly selected school were included in the study. The primary data source was the 1995 rural Kwazulu-Natal community based survey. Eight-hundred-and-two (802) children were included in this study. The secondary data source was from the South African National Primary School (SANPS) survey conducted in 1994. The participants included 24 391 primary school children aged 8-to-11 years (Jinabhai et al., 2003:360). Both population groups were said to be representative of the area. Height and weight were measured on calibrated equipment. Health professionals were trained by the research team and the national fieldworkers were trained by the National Department of Health. Results showed that for the national and provincial stunting the prevalence of mild stunting was 45% to 72%. In the rural district the prevalence of mild stunting was 31% to 100% for the age groups tested. In the severe stunting category the prevalence was 4.9% nationally, 4.5% provincially and 0.6% rurally. The number of children studied in the Vulamehlo district was too small to draw a conclusion. The prevalence of overweight according to the WHO criteria was 0.4 to 13.3%. When utilizing the IOTF criteria overweight was 0.4% to 11.9%. Females had higher levels of overweight and obesity than males in all age ranges and geographical regions. As can be noted the prevalence of being overweight and obese was not as high as the stunting rates.
rurally, provincially or nationally. Overweight and obesity varied on a district, provincial and national level and were found to be low. The authors attributed this low prevalence to the fact that lower SES children had a lack of access to basic infrastructure, health care and sporting opportunities.

From the information provided above it can be concluded that BMI is an important measure to take into account when assessing youth within South Africa as it can assist in identifying the need for intervention for under- or over- nutrition. This is particularly essential when female participants are being reviewed as the aforementioned studies have indicated that overweight and obesity are more prevalent in the female group. Different BMI cut-offs are available to categorise children, however, each has advantages and disadvantages which will be further investigated in the next section.

2.4.1.3 Measuring overweight and obesity rates

BMI is a calculation which takes height (meters) and weight (kilograms) into consideration \((\text{BMI} = \frac{\text{weight}}{\text{kg}^2})\) to identify nutritional status in terms of wasting or stunting, underweight, normal weight, overweight or the obesity level in individuals (Cole, Bellizzi, Flegal & Dietz, 2000). The development of BMI cut-offs for children are more tedious than in adults as growth, maturation and development and early and late maturing have an effect on the cut-offs created (Cole \textit{et al.}, 2000). Consequently to account for inter-individual differences BMI cut-offs have to be specific to gender and age. Currently the most commonly used BMI cut-offs are from the IOTF, Centre of Disease Control (CDC), World Health Organisation (WHO) and England’s 1990 growth reference curves (UK 90) (Dinsdale, Ridler & Ells, 2011). Each BMI cut-off is based on a different population group and hence comparisons are difficult. Table 3 summarises the BMI cut-offs and the population sample from which each was calculated (Cole, Freeman & Preece, 1995; Cole \textit{et al.}, 2000; Cole, Flegal, Nicholls & Jackson, 2007; De Onis, Onyango, Borghi, Siyam, Nishida & Siekmann, 2007; Freedman & Sherry, 2009; Dinsdale \textit{et al.}, 2011).
As noted in table 3 above, the UK 90 and CDC cut-offs represent UK and USA populations respectively. Hence employing the BMI cut-offs to categories South African youth’s nutritional status may result in an incorrect reflection of the overweight and obesity levels due to the dataset being outdated and a representative sample of developed Westernised countries. Similarly incorrect results may be obtained by employing the WHO cut-offs as they are based on data from 1977 from Westernised countries.

The most contemporary cut-offs are the IOTF BMI cut-offs as calculations are based on data from 1988 to 1994. The IOTF cut-off’s normative data is based on the most
recent and internationally representative data sets. There are however disadvantages when employing the IOTF cut-offs. They are based on averaging centile curves that are reported as BMI values and not BMI centiles (Cole et al., 2000). Additionally authors noted that whilst averaging the curves large variations were present when curves were transposed. It was furthermore surmised that this was due to the heterogeneous sample from which the dataset was obtained. The data set excludes African and Asian countries and hence conclusions drawn from the comparisons from these countries may be misleading (Cole et al., 2000:1-6). However, regardless of these shortcomings, many South African studies have employed the IOTF BMI cut-offs (Armstrong et al., 2006; Truter et al., 2010; Rossouw et al., 2012).

Chen, Lin, Peng, Li, Wu, Chiang, Wu and Huang (2001) state that the current BMI normative data is out dated and does not account for the secular trend changes in weight and height. Additionally it is based on both normal, overweight and obese children and not just physically active normal weight children. Consequently Chen and colleagues conducted a study on 878 207 (444 652 males and 433 555 females) Taiwan children aged 7-to-19 years utilising selected fitness measures and BMI. Only children who were classified as ‘fair’ or ‘good’ in the 4 fitness tests conducted (long jump, bent leg curl-ups, 800/1600 m run/walk and the distance achieved in the modified sit-and-reach) were included in the BMI calculations. For future BMI centile creations the authors suggested that only normal weight and fit children be included in the calculations. Additionally the authors added that skinfold thickness and anthropometric measures should be taken in conjunction with BMI to ensure for more accurate depictions of overweight and obesity status in children.

Regardless of the BMI shortcomings discussed, in comparison to employing body composition assessment techniques such skinfold measurements, dual energy X-ray absorption, underwater weighing and or bioelectrical impedance; BMI measurements are easier to administer, less invasive and more cost and time efficient (Chen et al. 2000:225). Furthermore and according to Dietz and Ballizza (1999:123S) BMI is an acceptable measure to assess fatness in children and corresponds with the obesity type 1 and 2 grades for adults. Even though BMI measures the amount of excess weight and not body fatness directly, studies have nevertheless found a positive
correlation between BMI readings and adipose fat in children, this however varies according to BMI ranking with rankings above the >95th percentile providing more accurate predictions of body fatness than that of lower percentile values (Freedman & Sherry, 2009). BMI should hence only be used as a screening tool and subsequently as a warning towards increased propensity for overweight and obesity and the diseases associated with it for those candidates who exceed the relevant BMI cut-off scores. Furthermore BMI calculations should be used in conjunction with skinfold assessment to increase the reliability of findings (Freedman, Wang, Ogden, Thornton, Mei, Pierson, Dietz & Horlick, 2007).

Confounding variables other than BMI and body mass affect FMS proficiency scores. That is, according to Newell’s constraint theory other personal structural constraints such as growth, maturation and developmental changes with aging and gender can affect motor proficiency and hence necessitate further discussion.

2.4.2 Growth and Maturations Affect

Growth refers to the measurable changes in cell number through hyperplasia (division of cells) or hypertrophy (enlargement of cells) (Malina et al., 2004:4-7). Changes in height, weight, muscle mass and limb length with aging and the effect it may have on FMS proficiency levels are of particular importance when investigating the FMS status of children. In terms of Newell’s constraint theory (Newell, 1991) this personal structural constraint would have an effect on an individual’s movement capacity and hence it is a confounding variable that should be accounted for when assessing movement. For example an increase in limb length and or muscle size could have a positive effect on a child’s FMS product performance due to increased velocity of a moving limb and or the power generated by the muscles respectively (Haywood & Getchell, 2009:297-300). This point was illustrated in Malina et al. (2004:225) in which it was established that postnatal related growth changes in body size and height can affect strength positively due to increased muscle mass. That is taller and heavier children tended to be able to exert more force against an object and consequently displace it further when compared to their smaller peers. However in contrast Malina et al. (2004:225) additionally mentions that motor skills which require an individual to propel their own body weight through the air or lift their body
weight whilst participating in non-locomotor motor skills can be negatively affected by their own body weight as they do not have the necessary strength to propel themselves.

When referring to anthropometric changes with aging it is furthermore important to consider the diversity in the rate of change in children’s bodily proportions. For example the effect of a growth spurt, which is a sudden increase in the height of an individual during the adolescent years and which is unique to each individual, can possibly result in COG changes which can negatively alter movement proficiency and the injury profile of individuals in late childhood and adolescents (Quatman-Yates, Quatman & Meszaros, 2012). According to the Quatman-Yates et al. (2012) systematic review on the sensorimotor functional changes which occur during adolescents, although research on the effects that growth related changes have on the movement proficiency of adolescents is sparse and or of poor quality, some children do experience sensorimotor changes. One of the primary FMS abilities which incorporate the sensorimotor system and which is considered a rate limiter to movement acquisition is balance (Haywood & Getchell, 2009:114-116). Balance is the ability to maintain one’s COG within the base of support and maintain a state of equilibrium and steadiness. Hence any change in the COG due to height, weight or limb variations can alter an individual’s COG and result in a possible lack of coordination and balance.

Early and late maturation may additionally have an effect on a child’s performance. If a child starts puberty sooner than his/her peers then the longer legs and stronger muscles of the early maturer will give them an advantage (Sherar, Cumming, Eisenmann, Baxtar-Jones and Malina, 2010:339). However, contrary to maturing early, those who mature later are hypothesised to have an extended period of growth, maturation and development and take advantage of the window of opportunity for motor skill development which present in middle childhood (Balyi & Way, 2005:8). Consequently these late maturers may surpass their fellow peers in motor ability in the future once they have reached full maturity.

The effect that bodily changes can have on FMS product scores tend to be researched more than that of FMS process scores. Eunice (2008:1-124) investigated
the relationship between motor skill performance (process scores) and anthropometric measures of body segments in 60 males and females aged 3-to-5 years. Twelve (12) FMS were assessed with the TGMD II. Limb length, height and weight were found to have a positive significant relationship to object-control and locomotor skills. More specifically according to the author thigh and hand length were the best predictors of locomotor scores whereas foot and thigh length were the best predictors of object-control skills. Additionally children who were larger, taller and heavier performed better in their process scores. The reasons provided by the researchers for the relevant associations found between the anthropometric changes and the FMS proficiency scores are debatable. More specifically, stating that only increases in limb length or size resulted in process scores improvements as children aged does not take into account the possible motor learning effects which may have transpired during the aging process. As literature has indicated confounding variables such as exposure to practice (Newell, 1991; Thelen, 2000) and neural development and maturation affect movement proficiency attainment, perhaps in accordance with the increases in anthropometric measures with age; exposure to practice, neural system maturation and improvements in strength and balance could have resulted in the correlations presented between anthropometry and FMS proficiency as opposed to exclusively anthropometric measurement increases. As indicated by Haywood and Getchell (2009:114-116), rate limiters to movement such as balance and strength facilitate participants in improving their motor skill ability with aging due to an increase in neural development and muscle size respectively. This point was illustrated in the study by Heriza et al. (1991:106) which indicated that when an infant’s body mass was altered in order to decrease the amount of strength the infant needed to overcome their body weight and produce the specific motor skill under investigation.

In terms of maturation, and when particularly investigating the effect it has on female learners PA levels Sherar’s et al. (2010) systematic review indicated that although research on the topic is sparse and or of poor quality, the onset of menarche in female learners’ can result in body image problems and numerous behavioural changes due to hormonal fluctuations. Whether these changes have a positive or negative effect on PA levels necessitate further investigation. In Sherar’s et al. (2010:341) investigation it seemed as though female learners’ PA levels were
associated more with the grade the individual was in as opposed to their maturational level indicating that cultural norms played a more important part than maturational status. It is hence difficult to deduce whether the onset of menarche and hormonal changes would affect the amount of PA endeavours female learners participate in and possibly the amount of time spent participating in FMS type activities. However, what can be deduced from menarche is that it correlates with PHV. That is, menarche usually commences 12 months after PHV onset (Balyi et al., 2010:17). Furthermore menarche and hormonal changes can affect weight gain as girls develop secondary sex characteristics (Freedman et al., 2003:2). Additionally according to Berk (2012:198) during the onset of puberty there is an increase in calorie intake among girls due to hormonal changes. Additionally this natural inclination to increase food consumption is coupled with the fact that the adolescent years are when the most unhealthy food options are chosen, magnifying the inclination for females to become overweight or obese.

As already discussed, overweight and obesity levels can affect the ability of children to perform their FMS proficiently (Marchall and Bouffard, 1997; Riddiford-Harland et al., 2006:42-49; D’Hondt et al., 2009; Lubans et al., 2010; Truter et al., 2010:227-233). However, what should additionally be accounted for is the effect that being underweight may have on children’s ability to perform motor skills proficiently. The negative influence weight related changes can have on movement proficiency was illustrated in the Beínefficé, Foueíre and Malina (1999:443-455) study on the effects of under-nutrition on motor proficiency in a sample of girls and boys aged 4-to–6 years. Results showed body size and muscle mass were positively correlated to the motor skills investigated, however, when age and body size were removed for their statistical effects, differences between nutritional groups disappeared. Lack of body size and muscle mass due to under-nutrition were thought to be the main contributors to lack of motor performance.

In summary and based on these literature findings it is hence important to measure anthropometric changes such as height and weight with aging but additionally to consider the associated improvements in strength and balance with neural maturation and exposure to opportunities to practice skills which may allow children to produce better FMS proficiency scores. Gender related changes with aging
additionally seem to be a personal structural confounding variable which can affect FMS proficiency due to anthropometric changes which occur at puberty. However it should be noted that in addition to gender related anthropometric changes, it is furthermore important to consider gender sporting stereotypes and cultural norms which present in a population and which can affect the PA endeavours and sporting codes individuals participate in.

2.4.3 Gender and Cultural Influences

When reviewing literature on FMS proficiency in children, object control skills are most often found to be more proficient in males when compared to female learners (Thomas & French, 1985; Teixeira & Gasparetto, 2002; Barnett et al., 2008:2137–2144; Spessato et al., 2013). This is particularly concerning as researchers have indicated that possessing proficient object-control skills in childhood is indicative of cardiovascular fitness in adolescence (Barnett et al., 2008). The primary reasons for the differences noted in male and female FMS proficiency scores provided by researchers is the exposure to opportunities to practice specific FMS and cultural sporting norms.

Booth and Okely (2004:369) investigated the FMS proficiency of the vertical jump, balance, dodge, two handed strike, skip, side gallop, hop, catch, run, leap, throw and kick in Sydney girls and boys aged 6-to-8 years from randomly selected schools and classes. The mastery and near mastery for FMS in both girls and boys did not exceed 35%. Boys tended to perform significantly better in object control skills and running. However for locomotor skills other than running boys and girls performed equally well. Hume et al. (2008:163) found similar gender disparities with girls performing poorly in object-control skills when compared to boys. Teixeira and Gasparetto (2002:151-160) observed similar results in the object control skill investigated. In their study girls aged ten years had a throwing maturity level of a boy aged 4 years. In a study by Ziviani, Poulsen and Hansen (2009:262) boys’ balls skills were found to be better than girls but girls balance skills were found to be better than that of boys. In a study by Spessato et al. (2012) on 1248 males and females aged 3-to-10 years they found that object-control skills were significantly better in males but no locomotor skill differences were noted between genders. Additionally
Zachopoulou, Bakle & Deli (2006:18), Oldemar (2008:42) and Barnett et al. (2008:2137-2144) found that girls’ object control skills were poor in comparison to boys and additionally at a low level of proficiency in general. It can hence be concluded that based on these literature findings, females generally tend to perform poorly in object control skills when compared to males. This is particularly true for the FMS of throwing overarm. According to Roberton and Konczak (2001:92) most studies on the throwing ability in girls and boys indicate that boys are more proficient and advanced at every age when compared to girls. In their findings gender could not be used as a prediction of ball velocity as it only accounted for 2% of the variance in velocity. Nevertheless it should be noted that girls became progressively developmentally delayed up until the age of 13 years and then the gap between throwing ability widened between boys and girls. The velocities between girls and boys were not different but the movement sequence employed was. That is, when compared to boys, girls threw as fast but their technique employed was of sub-standard quality.

Gender differences have furthermore been found in studies in which interventions have been put in place to improve movement proficiency in children. That is, studies indicate that girls do not respond as well as boys do to interventions focusing on improving FMS proficiency levels. In a study by O’Conner (2000:253) the effects of an intervention on motor skill performance of an overarm throw and side arm strike were assessed. Males were found to outperform girls on all pre- and post-test throw- and strike-related measures. The only skill showing no gender differences in performance was in the lacrosse throw. The author concluded that this must have been a very novel experience for both genders and hence no gender disparities were noted. Larsen (2003:1-138) found similar lack of improvement in movement ability after instruction when assessing the step, trunk, humerus and forearm action of the overarm throw component model in 124 children from first and second grade. Even after instruction, large significant differences were noted between girls’ and boys’ throwing ability, with boys outperforming girls. This finding extends to the Move It Grove It (MIGI) study which assessed the effect of a one year intervention on children’s motor skill and PA levels (van Beurden et al., 2002; MIGI, 2003). Boys were found to perform better than girls in the kick, throw and catch whereas girls performed better in the sprint, jump, hop, gallop and balance. After the one year
intervention, large significant improvements where noted for both genders, however, differences in skill ability between genders were still present.

A possible reason behind the gender differences noted even though interventions were put in place, may be due to studies not individualising training programs to male and female needs. That is, by providing generic programs to both genders, improvements can be expected but the differences between genders will remain the same as no specific BC variables pertaining to the specific FMS that lacks movement proficiency was being targeted. Most of the studies investigated thus far indicated that gender differences exist and most authors stated that social and cultural influences may have negated what type of motor skill endeavours children participate in (Thomas & French, 1985; Roberton & Konczak: 2001:102; Teixeira & Gasparetto, 2002; Larsen, 2003:1-138; Booth & Okely, 2004:269; Deli et al., 2006:18; Barnett, et al., 2008, 2137–2144; Hume, et al. 2008:163; Ziviani et al, 2009:262; Puciato, 2010:67). One could deduct from the evidence given that if there are known differences, individualised programs based on the needs of each gender should be created.

Gender differences noted between males and females have commonly been attributed to the effect that puberty has on growth, maturation and development in males and females (Malina et al., 2004:219). However, body characteristics such as body type, body composition and strength and limb length are similar between boys and girls before the onset of puberty and hence maturation cannot explain the gender disparities present before the onset of puberty. This point was illustrated in a study by Teixeira and Gasparetto (2002:151-160) whilst investigating the development of lateral asymmetry in the overarm throw between boys and girls. An interesting discovery was that when boys performed with the non-dominant hand, their performance was as good as the girls’ dominant hand. The authors surmised that practice and or cultural ideologies in terms of the types of games children play contributed to the attainment of a mature movement skill.

Horita’s (2008:84) study on 8-to-11 year old boys and girls, on the other hand, found no significant differences present in FMS ability between genders and according the author the lack of difference between genders was due to the absence of the onset
of puberty. This reasoning may in fact be a valid argument; however, most literature findings thus far indicate that even with interventions, gender differences present nonetheless (O’ Conner, 2000). Two other additional possible reasons as to why no gender differences emerged are that either the type of PA intervention participants were exposed to was not specific to the needs of each gender or the fact that males had higher levels of overweight and obesity when compared to females. No specific information as to what type of interventions participants were exposed to was provided and hence this point cannot be discussed. However, study findings indicated that 33.3% and 18.8% of boys and 16.6% and 5.5% of girls were overweight and obese respectively. This finding is controversial as based on literature findings girls tend to, on average, have higher overweight and obesity rates when compared to boys. Barring Horita’s (2008) use of a small non-randomised sample, the fact that males’ overweight and obesity scores were more than double that of girls could explain the lack of movement proficiency differences between the gender groups. As mentioned, research has shown that children who are overweight or obese tend to perform poorly in movement tasks (Marchall & Bouffard, 1997; Riddiford-Harland et al., 2006:42-49; D’Hondt et al., 2009; Lubans et al., 2010; Truter et al., 2010:227-233) and hence this could be a viable explanation.

In summary, with literature clearly indicating that gender difference in movement proficiency exist and females tend to perform poorly in comparison to their male peers, the presence of South Africa’s patriarchal society (Shehu, 2010:113) and a poor history of implementing physical education into the South African school curriculum (van Deventer, 2004, 2009, 2012), females learners were viewed as a special population group more in need of research focus and hence the unit of analysis selected for the present study.

According to Newell’s constraint theory, an additional constraint to consider other than the personal structural variables (anthropometry and gender) already discussed is the environment which an individual is exposed to. Hence identifying the current South African environmental influences which may be affecting FMS proficiency attainment of individuals necessitates further investigation.


2.4.4 Socio-economic Status

According to Seeking and Nattrass (2005) the poverty rate in South Africa has increased since apartheid ended and the level of inequality between race and socio-economic groups has enlarged. On closer examination of the Eastern Cape, research indicates that it is one of the South African provinces with the highest unemployment and lowest education rates (Makiwane & Dan, 2011). More Makiwane and Dan (2011:16) stated that ‘extraordinary measures by government and its partners are required in order to break the shackles of structural poverty and their consequences among the population of the province’. It can consequently be deduced that many children in the Eastern Cape are disadvantaged.

Based on the premise that the Eastern Cape is a province within South African in need of facilitation to improve the status of lives of many people living within, the Department of Education initiated a Mass Participation program. The Mass Participation Program was initiated in accordance with the Sport and Recreation, Arts and Culture Department and the Department of Education who had identified the need for PA and education in school curriculums and communities as a whole (Mass Participation, 2010). The initiative was generated particularly due to physical education’s omission from the school curriculum (van Deventer, 2004, 2009, 2012). This school initiative was primarily delivered to schools within a quintile 3 or less ranking. A quintile is a poverty ranking system employed by the government to assist in fund distribution among schools (Hall & Giese, 2009:38). The poorest schools are in quintile 1 and the least poor schools are in quintile 5. Quintile rankings are based on the income, unemployment rate and education levels. Quintiles 1 to 3 are deemed as low income schools. According to Hall and Geese (2006:38-40) the quintile system has disadvantages in that schools of unequal ranking in the same area get the same quintile ranking, transfer of money into school funds is delayed, the budget allocations are inflexible and there is a lack of management. Lastly the increased funding to schools does not directly result in improved quality education or service delivery. Consequently by only selecting schools from a quintile 3 ranking, lower SES groups would be sourced.
Although there are South African studies investigating the effect of apartheid and poverty on disadvantaged children, the focus has not been on the effect that living in a low SES community or coming from a previously disadvantaged district has on motor development and movement proficiency. That is, only international studies have evaluated the influence of SES on FMS proficiency and or motor ability in youth. Additionally, as mentioned in chapter 1 of this study, the correlation between SES and FMS proficiency are controversial and necessitate further investigation.

In a study by Okely and Booth (2004:358-372) no consistent association was found between SES and FMS status in their study on NSW children aged 6-to-8 years. The throw, catch, kick, vertical jump, dodge, strike, hop, skip, side gallop, leap and run were assessed. Only the catch, vertical jump and dodge had statistical significance across SES groups for girls. It was noted that even though only a few skills were significantly affected by SES, overall girls and boys in the highest SES showed higher levels of FMS mastery. Greater access to sporting facilities and PA were thought to be the contributing factors. According to these authors the lack of significant differences obtained in this regard indicated that other variables such as quality instruction and practice additionally contribute to FMS acquisition. Similar results were found in the NSW SPAN survey (SPAN, 2004) conducted in Sydney. The study investigated PA levels, nutritional intake and FMS proficiency in a sample of 5500 participants aged 5-to-16 years. Results indicated that participants from lower SES groups were poorer at performing FMS and were less fit. On the contrary SES did not influence PA levels.

Comparable findings were obtained from a study by Puciato (2010:66-70). In this study somatic variables and motor fitness linked to a child’s objective quality of life was assessed in 524 children aged 8-to-16 years. Plate tapping, 10 × 5m shuttle run, standing long jump, sit-ups, 1 kg medicine ball-throw- and sit-and-reach- tests were conducted together with BMI and 3 skinfold measurements. Findings indicated that girls upper body limb speed (plate tapping test) and height and weight were affected by SES. Additionally girls who ran faster were from higher SES. However, these relationships were not significant. Explanations as to the non-significant relationship were similar to those of Okely and Booth (2004) in that motor skill ability is affected by additional variables such as cultural influences.
The negative influences of SES on motor ability was additionally reported in the Półtorak (2009:35-45) study on the influence of SES on Polish pubescent adolescent boys’ and girls’ motor ability and PA levels. Adolescents were divided into rural and urban groups. SES and PA were determined via a questionnaire and physical fitness was assessed with a shuttle run, medicine-ball-throw, plate tapping, shuttle run, handgrip, sit-and-reach, burpee, flamingo balance and standing long jump tests. Although SES variables affected urban and rural girls and boys differently; the overall result concluded that children of better SES with fathers whom had a higher income, mothers with a better education and occupation and households with less children performed better in physical fitness tests (Półtorak, 2009:35-44). Yet, even though SES had a significant influence on physical fitness levels, this influence was low (Półtorak, 2009:43). Differences noted between SES groups were attributed to the fact that less than 50% of children from rural areas had access to physical education classes and none of these rural children had access to any other forms of recreational activity (Poltorak, 2009:43). Additionally it was surmised that rural children’s free time was taken up by house chores. One South African study assessing PA levels in disadvantaged schools had similar findings in that black South African girls were expected to do household chores which detoured them from participating in extra-mural activities after school (Walter, 2011:785).

In summary, SES is significantly associated with FMS acquisition, but this relationship is controversial. Hence variables other than SES affect FMS proficiency. As mentioned, Newell’s constraint theory states that personal structural and environmental variables affect FMS proficiency. An additional variable to consider is the task constraints affecting FMS proficiency. In terms of the dynamic systems theory this additionally equates to the type of FMS intervention being put in place to facilitate individuals in achieving an attractor state.
2.4.5 Physical Education

As mentioned in the theoretical review of this chapter and as illustrated in the empirical research findings thus far, movement acquisition is influenced by numerous personal, environmental and task constraints (Newell, 1991). Additionally it has been indicated that appropriate instruction and a supportive environment to facilitate the attainment of proficient motor skills is necessitated (Thelen, 2000; Cronin & Mandich, 2005:29; Malina, 2004; Gallahue, 2010).

Zachopoulou et al. (2006:12) investigated a ten week movement intervention’s effect utilising the TGMD on kindergarten children’s FMS proficiency levels. The authors found a significant improvement in FMS proficiency levels in the movement control and rhythmic group which focused on FMS proficiency as opposed to the control free-play group. As children were found to perform poorly in FMS proficiency levels in pre- and post- intervention, authors concluded that movement interventions should commence at a pre-school level and be implemented for more than ten weeks to realise measurable improvements.

In addition to ensuring that movement interventions are implemented for more than ten weeks, Garcia and Garcia (2005) specified that the frequency of practice sessions is an important component required to obtain proficient FMS. That is, the required amount of time spent on practicing an overarm throw to allow for the development of a mature sequence in children was found to be between 643 to 843 trials. That is, even with these practice trials only 40% of the children tested demonstrated a mature overarm movement pattern. Similar findings were illustrated in the O’Conner (2006:265) investigation into the effects of a 10 week intervention on FMS proficiency. A significant but small improvement in the overarm throwing proficiency level was noted; indicating the need for more time spent practicing the skill.

The effect of investing more time into improving movement was illustrated in the Move It Groove It program in Australia (van Beurden et al., 2002) and by Pang and Fong (2009) Hong Kong study. In the NSW study the effect of a 1 year FMS and PA intervention was assessed with the use of a cross sectional quasi-experimental
design involving baseline and follow-up surveys. The FMS assessed were static balance, sprint run, vertical jump, kick, hop, catch, overhand throw and side gallop. The sample size consisted of 515 third year and 530 fourth year students (8-to-9 year olds). Mostly significant improvements were recorded and girls and boys were found to improve equally well, even in skills which were initially found to be performed most insufficient. The long term effects of a FMS intervention within a school was additionally demonstrated in a study by Pang and Fong (2009). Most children were found to perform FMS proficiently. Authors attributed the well-executed FMS to the fact that physical education sessions focused on improving FMS proficiency was deemed an essential learning activity and hence was placed permanently within the school curriculum.

As mentioned in chapter 1 of this study, South African children have lacked interventions which focus on PA and improving movement ability due to the omission of physical education from the school curriculum (Amusa & Toriola, 2006; Van Deventer, 2009:127-128). In addition to the omission of PA from all school curriculums, apartheid caused many inequalities between ethnic groups with black South African schools particularly being affected (Mchunu & Le Roux, 2010). Physical education was reintroduced into the school curriculums via a subject called Life Orientation (LO). However, the lack of qualified teachers conducting the syllabus and the lack of movement assessment and feedback provided did not allow for the efficient implementation of the program or even permit for a successful movement intervention (Van Deventer, 2009:140). The next updated version of LO syllabus was English Life Skills (English Life Skills, 2011). The new syllabus has provided specific guidelines in terms of time allocation and the types of activities that should take place in physical education classes. Additionally an assessment protocol was added. However, limited training was provided to support teachers in delivering an effective movement intervention class. Additionally the assessment criteria, the movement activities and the teaching pedagogy employed in offering the Life Skills module and or the delivery of the service by teachers to children has not been evaluated. The evidence for the effectiveness of, and consequently a need for, movement interventions on movement proficiency have been illustrated through the literature studies and consequently the need for determining South African children’s FMS proficiency levels is justified once more.
An additional variable to consider when assessing FMS proficiency is the perceptual-motor development of an individual. This would fall under Newell’s personal structural constraint.

### 2.4.6 Perceptual-motor Development

The perceptual-motor system integrates visual, kinaesthetic, auditory and other sensory information within the CNS in order to produce a movement (Williams, 1983). The perceptual-motor system allows an individual, for example, to be adequate in hand-eye co-ordination, reaction time, body awareness, directionality, auditory perception and depth perception to name but a few (Haywood & Getchell, 2009:191-229). A very important variable that is necessary to ensure for adequate perceptual-motor development is practice and exposure to movement experiences. Additionally the degree of maturation within each system and or any underlying abnormalities in eye sight, hearing and kinaesthetic precision and or in the neural system can inhibit perceptual-motor development and consequently motor ability. According to literature the perceptual-motor system is fully functional by middle childhood and hence for the purposes of this study, and due to the fact that the inclusion criterion for participants studied within this study stipulated that only normally developing healthy individuals were to be included, the perceptual-motor system functionality was deemed adequate for motor learning.

As the focus of the present study is on FMS status of children and not the underlying neural, visual, auditory and kinaesthetic elements that assist in producing a movement; the perceptual-motor system’s elements were not assessed directly as this was deemed beyond the scope of this study.
2.5 SUMMARY, RELEVANT IMPLICATIONS AND CONCLUSION

Due to the large volume of work covered in the aforementioned review of literature, the following section reflects a summary of the literature revised in this chapter and where applicable the associated implications for this study.

In terms of FMS definition, importance of possessing proficient FMS and the theories explaining the acquisition thereof, the following is relevant:

- FMS are foundational movements; namely locomotor, non-locomotor and object-control skills which should be performed at a proficient level by all normally developing children (Burton & Miller, 1998:215). These FMS form part of an individual’s physical literacy, which is the ability to perform a repertoire of movements required for sustained involvement in sport and recreational endeavours (Delaney et al, 2008:2). According to Gallahue (2010:19-20) the attainment of mature FMS should occur between the ages of 2-to-7 years.

- In the FMS phase within the motor development spectrum children progress in movement proficiency (which refers to the effectiveness, accuracy and precision with which a movement skill is performed) from an initial to elementary and eventually mature movement stage (McClenaghan & Gallahue, 1978; Gallahue & Cleland-Donnelly, 2003:62). However, literature findings indicate that children older than 7 years do not possess proficient FMS (Booth et al., 1999; Ulrich, 2000; van Beurden et al., 2002; Okely & Booth, 2004; SPAN, 2004; Hume et al., 2008; SPAN, 2010; Cowley et al., 2010; Hardy et al. 2012; Spessato et al., 2012) and according to Ford et al. (2013) there is not enough empirical research to confirm that the 2-to-7 year old span is the window of opportunity for FMS development.

- Due to environmental, individual and task constraints and the movement experiences individuals are exposed to there are between-pattern differences (to be mature in one FMS and at an initial development pattern in another), within pattern differences (at an initial pattern in one body element and mature in another) and between child differences in FMS proficiency ability (Gallaue, 2010:19-20), hence justifying the need to examine the FMS status in children.
- FMS acquisition is additionally affected by rate limiters such as adequate stability (balance), strength ability and coordination (Wickstrom, 1986:44; Haywood & Getchell, 2009:114-116). These are important variables to consider when evaluating aging children’s movement proficiency scores as this could explain the lack of improvements in FMS.

- When referring to the theoretical framework of this study, according to Newell's constraint theory (Newell, 1991) motor development is affected by environmental, personal structural and functional and task constraints. Additionally O’Conner (2000), Thelen (2000:390), Malina (2004:57-58) and Bakhtiar (2013:106) believe that movement attainment is affected by the type and amount of practice individuals are exposed to. More specifically and in terms of the dynamic systems theory, practice is needed for an attractor state to emerge (Thelen, 2000). Consequently these aforementioned variables should be accounted for when evaluating FMS proficiency status or creating a FMS intervention.

- The dynamic systems theory states that interventions put in place should ensure for an attractor state to emerge (Thelen, 2000). Hence FMS interventions are needed to ensure for motor skill attainment. This must take place at a pre-school and primary school level and must be long term in duration (van Beurden et al., 2002; Deli et al., 2006:12; Garcia & Garcia, 2002; Garcia & Garcia, 2005:17; O’Conner; 2006:265). These interventions should additionally be implemented into the school structure as a stand-alone subject for a long period of time and specifically focus on the acquisition of FMS mastery (van Beurden et al., 2002; Pang & Fong, 2009; Cowley et al., 2010). Consequently the school sporting management structure and the FMS interventions put in place should be addressed when evaluating the FMS of a group of children.

- The importance of experiencing movement and the effect that the environment has on movement ability are further validated in Schmidt’s (Schmidt, 2003) GMP and the contemporary dynamic systems theory (Cronin & Mandich, 2005:7). Each theory has its merits and demerits; however, each advocates the importance of practice and an environment that is conducive to movement attainment. Hence evaluating the physical education system in
place, sporting codes available to children and the PA children participate in is important when assessing FMS proficiency status.

- Proficient FMS are correlated to increased PA levels (Mckenzie et al., 2004; Wrotniak et al., 2006:e1759; Barnett et al., 2008; Stodden’s et al., 2008), decreased overweight and obesity rates (Riddiford-Harland et al., 2006; Lubans et al., 2010:1019-1035; D'Hondt et al., 2009; Truter & Pienaar, 2012), are precursor to specialized skills (O’Conner, 2000:1-407; O’Keeffe et al., 2007) and are linked to increased perception of movement ability (Barnett et al., 2008; Stodden et al., 2008:295-297). Hence ensuring for FMS proficiency is justified.

- Object-control skills were found to correlate to increased cardiovascular fitness due to the fact that these FMS are usually performed in high intensity natured sports (Barnett et al., 2008). Another finding which illustrated the importance of motor competency in FMS was that the standing long jump and the run for speed were highly correlated with increased levels of PA, leading authors to infer that these skills may be fundamental to building strength and endurance and hence should be incorporated into interventions and or test batteries to ensure for proficiency in their performance (Wrotniak et al., 2006:e1759).

In terms of the South African context, theory governing FMS acquisition and any additional factors considered important when evaluating the FMS status of children, the following are relevant:

- In the South African context FMS acquisition should occur in the foundation phase years (5-to-8 years old) of the school curriculum (Foundation Phase Curriculum, 2012). Consequently assessing children older than 8 years will provide information as to whether this window of opportunity for FMS acquisition was employed. The assessment of the FMS status of children is particularly justified since physical education has been eradicated and subsequently been reintroduced into the education curriculum without the support of qualified facilitators (van Deventer, 2004, 2009, 2012).

- A personal structural constraint to movement attainment is body mass (Newell, 1991). Being underweight or wasting, overweight or obese affects FMS proficiency and or motor ability (Marchall & Bouffard, 1997; Beïneífice et
Studies have shown that South African children’s overweight and obesity rates are on the rise (de Onis & Blissner, 2000:1033-1034; Armstrong et al., 2006; Kelishadi, 2007:62; Rossouw et al., 2012:3-7) further validating the need for assessing overweight and obesity status.

Due to poverty, South Africa is faced with a double-burden of rising overweight and obesity rates and wasting and underweight levels (de Onis & Blissner, 2000:1033-1034; Jinabhai et al., 2003:358-365), validating the need to assess children’s nutritional status in terms of underweight, normal weight, overweight and obesity.

BMI cut-offs can be used to categorise children as normal weight, underweight, overweight or obese. The most commonly used BMI cut-off is the IOTF cut-offs (Cole et al., 2000). The primary limitation to the employment of the IOTF cut-offs is that they are based on averaging centile curves from different Caucasian Westernised population groups. Regardless of the shortcomings of the ITOF cut-offs, South African studies have employed them for comparative purposes (Armstrong et al., 2006; Truter et al., 2010; Rossouw et al., 2012).

An additional environmental constraint as proposed by Newell’s constraint theory is SES (Newell, 1991). Studies have indicated that children from lower SES communities are disadvantaged in terms of motor development and FMS or motor ability acquisition. Therefore children from disadvantaged communities have been found to perform poorer in comparison to their peers from higher SES area (Okely & Booth, 2004:358-372; SPAN, 2004; Póltorak, 2009:35-45; Póltorak, 2009:35-45), however these findings are controversial with variables other than SES additionally affecting motor skill proficiency.

South Africa is a country burdened by high unemployment and low education rates (Seeking & Natrass, 2005). The Eastern Cape is one of the worst affected provinces in South Africa (Makiwane & Dan, 2011). Hence many children in the Eastern Cape can be considered disadvantaged. Examining
the FMS status of previously disadvantaged groups within the Eastern Cape should provide insight into whether motor skill interventions are needed.

- Disadvantaged individuals may be due to the lack of access to basic infrastructure, sporting opportunities, medical attention, education, nutritional foods and general quality of living. Additionally some of these disadvantaged children are exposed to hostile or poor family dynamics (Solarsh & Goga, 2003).

- A quintile is a poverty ranking system employed by the South African government to assist in fund distribution among schools (Hall & Giese, 2009:38). The poorest schools are in quintile 1 and the least poor schools are in quintile 5. Hence focusing on quintile 1 to 3 schools, participants from lower SES schools are being targeted.

- A personal structural constraint according to Newell’s constraint theory is gender (Newell, 1991). Gender stereotyping and cultural influences can affect which games children participate in and the amount of PA they can partake in and hence the differences noted between male and female scores (Thomas & French, 1985; Roberton & Konczak: 2001:102; Teixeira & Gasparetto, 2002; Larsen, 2003:1-138; Booth & Okely, 2004:269; Barnett, et al., 2008, 2137–2144). It is consequently important to investigate the cultural background and school structure so as to contribute to conclusions drawn about the FMS status of a population group.

- In girls object-control skills tend to be the least proficient FMS when compared to boys (Roberton & Konczak, 2001:92; Hume et al., 2008:163; Oldemar, 2008:42; Ziviani et al., 2009:261; Spessato et al., 2012). This is concerning as research has indicated that possessing proficient object-control skills in childhood is indicative of cardiovascular fitness in adolescence (Barnett et al., 2008) and is correlated to children possessing a positive perception of their motor ability (Barnett et al., 2008). Within the South African context, particularly black girls were found to perform less proficiently in motor skills when compared to their male peers and other ethnic groups (Armstrong et al., 2011). Consequently it can be deducted that there is a more urgent need for girls to be the focus of motor skill interventions.

- Even after motor skill interventions have been implemented there are still gender disparities between males and females (O’Conner, 2000:253; Larsen,
Interventions should consequently not be generic programs and instead individualised to meet the motor abilities of boys and girls. Furthermore interventions should take into account that males and females and different cultural groups are motivated differently (Garcia & Garcia, 2005:16; Puciato, 2010:67). Consequently the types of interventions put in place and or the type of PA children participate in should be considered when evaluating FMS status.

Gender disparities tend to be attributed to the effects of puberty on bodily changes. Although this statement has merit biological characteristics such as body type, body composition and strength and limb length are similar between boys and girls before the onset of puberty (Malina et al., 2004) and hence maturation’s influence cannot be used to explain the movement acquisition differences in males and females before the onset of puberty. However, after puberty menarche and hormonal changes can affect weight gain as girls develop secondary sex characteristics (Seifert & Hoffnung, 1999:512). This intern can have an effect on the self-mage, emotional status and motivational levels in girls (Sherar et al., 2010: 339). There is, however, a lack of research on the effects of puberty on female PA endeavours. Hence assessing for the presence of menarche is important when investigating FMS status as it may have an effect.

An additional personal structural constraint proposed by Newell’s constraint theory (Newell, 1991) is the effect that growth and maturation on motor skill ability. Limb length, height, weight and muscle mass changes, to name but a few, affect motor skill ability negatively or positively (Eunice, 2008; Haywood & Getchell, 2009:295-300). More specifically changes in body dimensions can affect balance due to the affect it has on COG. Powers, speed, rotational force and velocity, to name but a few, are additionally affected by changes in anthropometric measures with aging (Malina et al., 2004:225; Haywood & Getchell, 2009:297-300). Furthermore many inter-individual differences are present as early and late maturation affects all these aforementioned anthropometry and neural changes (Balyi & Way, 2005:8). Hence accounting for anthropometric changes is essential when evaluating FMS acquisition between children.
- Although not within the scope of this study, the perceptual-motor system plays an important role in movement skill acquisition and should be considered when evaluating motor ability FMS proficiency levels (Williams, 1983; Haywood & Getchell, 2009:191-229).

- Lastly, although motivational levels of participants are positively affected by proficient FMS (Stodden et al., 2008:295-297), poor motivational levels can additionally affect FMS proficiency scores as participants who are not motivated to partake in FMS PA endeavours will not improve in their ability to perform these FMS. The motivational levels and behavioural traits of children, although important, are out of the scope of this study.

In the conclusion of this chapter, it can be deduced that possessing proficient FMS positively contributes to holistic development, increased PA and improved participation in sporting and recreational endeavours in children and adolescents. Whether or not South African children’s FMS are proficient and or the movement interventions that have been put in place have positively affected motor learning is debatable and necessitates further investigation.

As mentioned within chapter 1 and as discussed within this chapter 2, FMS acquisition is a multi-dimensional process. Figure 2 depicts that variables such as presence or lack of quality instruction, long term interventions focusing on FMS acquisition, the motivation and attitude a child has toward PA and exercise, the opportunity to play and or participate in PA or exercise endeavours, SES, being overweight or obese, task constraints, gender stereotyping, neurological and perceptual-motor development and genetics’ influence on growth, maturation and neural maturation which play a part in the acquisition of proficient FMS. These aforementioned factors would fall within Newell’s constraint and the dynamic systems theory. In terms of Newell’s constraint theory the above variables would fall within either the task, environmental and personal (functional and or structural) constraints (Newell, 1991). In terms of the movement interventions put in place, this would encompass the dynamic systems theory (Thelen, 2000).
Figure 2: Variables affecting FMS acquisition

Within the South African context there are numerous studies indicating that these aforementioned variables may be negatively affecting FMS acquisition. However, there is a lack of investigation into the FMS status of children, particularly in previously disadvantaged black female learners. Hence investigating the FMS proficiency status of female learners aged 9-to-12 years from previously disadvantaged areas within the Nelson Mandela Bay is justified.

As previously mentioned, for organisational purposes and ease of reading, the literature review was divided into chapter 2 and 3. This chapter focused on defining FMS and FMS proficiency, discussed where FMS acquisition occurs within the motor development spectrum, and deliberated the evidence in literature on the importance of possessing proficient FMS and the theories that govern motor development and consequently FMS proficiency attainment. Lastly the evidence through literature on
the factors which affect FMS acquisition was discussed. These literature findings were completed with a summary and with relevant implications sections for the present study and an overall conclusion.

Consequently to follow is chapter 3 which focuses specifically on the assessment of FMS and the FMS under investigation, namely the run for speed, standing long jump, throw for distance, static balance and throw for accuracy.
CHAPTER 3: FUNDAMENTAL MOVEMENT SKILLS UNDER INVESTIGATION

3.1 INTRODUCTION

Literature is reviewed to provide both theoretical and empirical research background relevant to the problem under investigation. As mentioned in chapter 2, the literature review of this study was divided into 2 sections for organisational purposes and ease of reading. Chapter 2 defined FMS and FMS proficiency, discussed where FMS acquisition occurs within the motor development spectrum, deliberated the evidence in literature on the importance of possessing proficient FMS and the theories that govern motor development and consequently FMS proficiency attainment. Lastly the evidence through literature on the factors which affect FMS acquisition was discussed.

This chapter 3 firstly focuses on the assessment techniques available to evaluate FMS acquisition in terms of the literature governing how FMS transpire and the strengths and weakness of each FMS assessment technique. Hereafter each FMS under investigation for the purposes of this review; namely running for speed, the standing long jump, throwing for distance, catch, static balancing and throwing for accuracy are discussed. At the outset each FMS is elucidated in terms of the importance of the skill in ADL and recreational and sporting endeavours. Hereafter the literature findings on the ability of children to perform these respective FMS at a near mastery and mastery level are conveyed. Subsequently the FMS developmental progressions from an initial to a mature FMS proficiency level are deliberated. Lastly the characteristics of a mature movement stage are conversed.
3.2 ASSESSING FUNDAMENTAL MOVEMENT SKILLS

When investigating the FMS proficiency status of children it is important to understand which assessment tools are available, their strengths and weakness and the type of data that each can generate. A child’s FMS proficiency abilities can be assessed both qualitatively (process score) or quantitatively (product score). Early investigations into child development focused primarily on quantitative assessments, outcome variables and generating normative data (Thelen, 2000). Researchers subsequently transitioned to a qualitative assessment approach, which involved the assessment of the execution of the movement. One of the primary limitations noted in Luban’s (2010) review of the health benefits associated with proficient FMS in children and adolescents was that many investigations on FMS proficiency did not include both qualitative and quantitative assessment measures within FMS assessment batteries. Consequently evaluating which FMS assessment protocols are employed by researchers warrants further discussion.

3.2.1 Fundamental Movement Skill Assessments

As quantitative assessments entail less intensive discussions of literature due to the fact that the evaluation of product scores consists of measurements such as the distance achieved in centimetres or meters and the speed attained in seconds, the focus of the following section will primarily be on the qualitative assessments of FMS. Due to fact that in comparison to quantitative assessments, qualitative assessments are derived from detailed theoretical models and literature descriptions of the FMS movement progressions, a more in depth discussion of the qualitative assessment techniques is possible and justified.

When assessing movement and in order to obtain data for analysis purposes, a means of scoring an individual’s ability to execute the movement patterns (qualitative or process score) is necessitated. According to Burton and Miller (1997:67) there are distinctive difference between proficient and non-proficient movements employed by an individual when executing a given movement task and hence a ranking system which orders movement abilities from ‘immature’ to ‘mature’ movement patterns is possible. As mentioned previously, FMS progress from an initial movement stage to
a mature movement stage as an individual is exposed to more practice and improves in strength, balance and coordination (McClenaghan & Gallahue, 1978:78; Haywood & Getchell, 2009:114-116, 220-221). As these qualitative descriptions of movement cannot entail assigning numbers directly, instead categorical (nonmetric) variables with descriptions of the criteria are awarded to the respective nonmetric value in order to obtain measurable data (Burton & Miller, 1997:67). More specifically when assessing FMS no quantitative parameters are present and a score of ‘zero’ cannot be awarded to an individual and consequently employing ordinal scales to rank movements are possible. Initial movement stages are awarded a score of 1, elementary a score of 2 and mature movement stages a score of 3 when employing the BC approach. As assessing the quality of movement in real-time may result in an individual missing critical performance elements of a movement skill Cools, Martelaer, Samaey and Andries (2008:157) states that the use of video analysis is necessary.

Motor development dictates that movement progresses and transpires in a predictable manner (Corbin, 1980:48-77; Espenschade & Eckert, 1980:139-160; Thomas, 1984:48-88; Roberton & Konczak, 2001; Malina et al., 2003:195-210; Malina, 2004; Haywood & Getchell, 2009:111-177; Gallahue, 2010:17-19) and hence the ranking of movement from an initial to mature stage can be implemented. Based on the in depth analysis of movement by motor development researchers two particular qualitative assessment tools, the total body configuration and the BC approach, were developed.

In 1983 Wild created the total body configuration approach which assessed skills in stages (Burton & Miller, 1998:222; Miller, Vine & Larkin, 2007:63). It was based on the premise that all bodily movements incorporated to accomplish a skill mature as a single unit and that all BC parts look the same within a given stage. However, this approach has been questioned due to research indicating that BC variables do not mature as a single unit. In addition to Gallahue’s (2010:19-20) sentiments discussed in chapter 2 about the between-pattern, within-pattern and between child differences in FMS proficiency levels; research by Roberton and Konczak (2001:101-103) on the motor development sequence of the overarm throw when employing the BC approach indicated that different BC variables played a more crucial role at different
ages of a child’s development. Additionally certain BC variables were at a mature level of movement proficiency while others were not at the same chronological age. The authors concluded that the total body configuration approach does not reflect the differences in BC variables and hence the BC approach is a better tool for assessment purposes. The BC approach thus allows for the identification of inter-individual differences, individualised feedback and hence a more composite measure of a child’s ability. Each BC variables is divided into 3 or 4 levels with each level being ordered successively from initial to mature stage of movement proficiency (McClenaghan & Gallahue, 1978:78; Miller et al., 2007:63). Consequently, for FMS evaluative purposes, the most comprehensive evaluation tool is the BC approach, however according to authors and with the exception of the overhand throwing technique, these instruments lack longitudinal research and hence their validity is questionable (Burton & Miller, 1998:220). Due to the intensive scrutiny of a movement when employing the BC approach, researchers tend to employ criterion referenced FMS assessment techniques.

As opposed to employing the BC approach, criterion referenced standards can be used to evaluate motor skill ability (Burton & Miller, 1998:95; Ulrich, 2000; Cools et al., 2009). More specifically when employing criterion referenced standards as cut-offs, children are compared to critical features of the skill which are considered to be a necessity for successful performance. If the critical element is not present a score of zero is awarded. In contrast to the BC approach, the primary limitation of employing criterion scales is that no differentiation can be made between children’s movement ability as a movement is simply rated as present or not present. There are numerous criterion assessment tools which can be viewed in Cools et al. (2009:165), however the TGMD I and II tends to be the most commonly employed in international investigations on FMS proficiency status (Ulrich, 2000; Pang & Fong, 2009; Spessatto et al., 2012; Valentini et al., 2012). Furthermore similar criterion reference cut-off assessment protocols have been used in New Zealand (Cowley et al., 2010) and Australia (Booth et al., 1999; van Beurden et al., 2002; Okely & Booth, 2004; Hardy et al., 2012) hence making the TGMD I and II mastery and near mastery cut-offs a viable assessment tool.
Cools et al. (2009:154) stated that ‘research in the area of movement skill development mainly focuses on motor impairment and motor deficits. Hence, research on FMS development and performance in developing children is scarce and rather fragmentary’. An additional limitation noted by Cools et al. (2009) in terms of movement assessment protocols was that the comparative data available in the movement assessment tools are based on European, Westernised and Caucasian samples. Although the review by Cools et al. (2009) indicated that the Motoriktest für vier- bis sechsjährige Kinder (MOT 4-6), Movement Assessment Battery for Children (M-ABC) and Peabody Developmental Motor Scales- Second Edition (PDMS) can be employed to assess FMS ability; based on the literature review conducted for the purposes of this study, as mentioned, the TGMD I or II were found to be the most commonly used FMS assessment protocol when analysing FMS proficiency levels in primary school children (Barnett et al., 2008; Pang & Fong, 2009; Spessato et al., 2012; Velentini, 2012).

3.2.2 Test of Gross Motor Development Assessment I and II

Although the TGMD has been used to differentiate children’s’ motor skill ability in terms of identifying motor development disorders it can be used as a FMS assessment battery and consequently it is a better choice over the identified assessment batteries as depicted in Cools et al. (2009). According to Burton and Miller (1999), Ulrich (2000) and Cools et al. (2009) the TGMD is quick and easy to administer, it has good reliability on subtest and composite scores and the manual is inexpensive. The primary disadvantage of the TGMD is that it is a criterion referenced assessment tool. Furthermore the definitions used to describe the BC variables being assessed are limited in description and hence may be difficult to interpret.

Ulrich (2000) validated the construct validity of the TGMD II in a study of 1208 USA children aged 3-to-10 years from 10 different states. That is, construct-description, criterion-prediction and construct-identification were analysed. These were found to be acceptable. Additionally the TGMD II has been validated and deemed reliable in a study by Velentini (2012) in which 2645 Brazilian children aged 2-to-10 years were assessed for the FMS proficiency levels. The construct, content and criterion validity
and test-retest and inter-rater reliability, goodness of fit and internal consistency were tested and found to be satisfactory. Lastly skills were videotaped and the TGMD II was found to have high concurrent validity with the Children’s Activity and Movement in Preschool Study Motor Skill Protocol and the Fundamental Motor Skill Polygon test (Velentini, 2012:279).

The TGMD classification of motor skill proficiency is ‘near mastery’. That is instead of employing mastery, which is defined as possessing all BC variables; a near mastery category was created (Ulrich, 2000). The near mastery category is defined as possessing all BC variables except for one. Authors decided to create this category as the mastery classification deemed most children as poor at FMS (Ulrich, 2000). According to the authors the score can be converted into percentile ranks and standard scores and compared to age matched peers.

What was additionally noted in the literature review of this study was that the Australian studies assessing FMS status employed similar criterion assessment approaches to that to the TGMD and additionally used the same mastery and near mastery cut-offs when assessing children. More specifically, the Manual for Classroom Teachers (Walkley et al., 1999) and the updated version of this manual, the Get Skilled Get Active manual (Davy et al., 2000) were employed to assess movement proficiency in participants.

As can be deduced from the literature reviewed thus far, the most appropriate FMS proficiency assessment tools to employ are the BC approach and the TGMD II.
3.2.3 Summary and Relevant Implications

The following is a summary and the implications of the literature review on the FMS assessment tools available:

- Children’s motor skill proficiency can be assessed qualitatively (process score) or quantitatively (product score) (Thelen, 2000). When assessing qualitatively video-analysis can be employed to evaluate the movement sequence in real-time (and even slowed) to allow for more scrutiny of a movement sequence (Cools et al., 2008:157).

- When analysing movement a total body configuration or BC approach can be employed. Findings indicate that the BC assessment approach is the superior assessment tool to employ as it provides a more valid reflection of an individual's movement ability and can differentiate FMS proficiency into an initial, elementary and mature movement stage (Roberton & Konczak, 2001:101-103).

- Numerous assessment tools have been created to evaluate movement ability in children. Each tool has its strengths and weaknesses (Cools et al., 2009:165). Assessment techniques which are commonly used are those which employ criterion referenced standards to evaluate motor skill ability (Ulrich, 2000).

- The most commonly employed criterion referenced FMS assessment tool is the TGMD I or II.

- Other than dividing movement into an initial, elementary and mature stage of proficiency; employing a near mastery and mastery definition is possible (Ulrich, 2000). Near mastery refers to performing proficiently in all BC parts being assessed, except for one, whereas mastery refers to being proficient at performing all BC parts being assessed (Ulrich, 2000).

The following section elucidates each FMS in terms of the importance of the skill during ADL and recreational and sporting endeavours, the ability of children to perform these respective FMS at a near mastery and mastery level and the FMS developmental progressions from an initial to a mature FMS proficiency level within each FMS. Lastly the characteristics of a mature movement stage for each respective FMS are discussed.
3.3 FUNDAMENTAL MOVEMENT SKILLS UNDER INVESTIGATION

As previously discussed in chapter 1 and 2, FMS proficiency positively correlates to physical, social and cognitive development. FMS additionally forms part of many sporting endeavours and even certain ADL. The FMS that have been included in the assessment battery for the purpose of this study are running for speed, the standing long jump, throwing for distance, catch, static balancing and throwing for accuracy; each of which will be discussed in detail in the following section.

3.3.1 Run for Speed

Aerobic activities are defined as movement events that require oxygen utilization in the mitochondria of the body’s cells to produce energy called adenosine triphosphate (ATP) (Powers & Howley, 2007:57-58). An activity is considered purely aerobic when gross muscle movements are employed for PA endeavours lasting longer than 10 minutes (Powers & Howley, 2007:57-58). Aerobic fitness is also known as cardiovascular fitness, which refers to the body’s heart and blood vessels ability to adequately provide oxygen to working muscles whilst performing activities (Malina et al., 2004:238-239). Studies have found that children and adolescents with poor cardiovascular fitness have increased risk of hypokinetic diseases (Ruiz, 2008; Steene-johannessen, Anderssen, Kolle & Andersen, 2009). Additionally in Tomkinson, Leger, Olds and Cazorla (2003) systematic review of the secular trend changes in children and adolescents age 6-to-19 years aerobic performance between 1980 and the year 2000, it was found that shuttle run test scores in children declined, indicating a decrease in cardiovascular fitness. The primary FMS employed by children in these tests was the run. A shortfall noted in these investigations was that only product as opposed to process scores was investigated. Hence research analysing the ability of individuals to execute the proficient movements to achieve a successful run is warranted.

Anaerobic activities are those which last less than 45 seconds (Powers & Howley, 2007:33-36). The anaerobic system is divided between 2 energy systems. That is, the ATP- Phosphocreatine (PC) system, which provides ATP for PA lasting less than 5 seconds, and the glycolytic system, which is employed for activities after 5-to-6
seconds and up to 45 seconds (Powers & Howley, 2007). After 45 seconds all 3 energy systems are employed but as time progresses, especially after 2 minutes or more of activity, the aerobic system is primarily utilised (Prentice, 2009:100-101). Anaerobic activities can be considered as short-duration and explosive activities. Bailey, Olsen, Pepper, Porszasz, Barstow and Cooper (1995) state that anaerobic fitness is one of the primary energy system utilizations in young children, with short duration activity making up the bulk of daily PA. That is, in their study of 6-to-10 year olds, 95% of activities lasted less than 15 seconds, indicating that anaerobic fitness and the proficient performance of anaerobic activities is important in children. An activity which is classified as anaerobic is a maximal sprint over short distances. Hence based on these literature findings, performing an activity such as the sprint proficiently may result in increased participation in ADL and sporting and recreational endeavours. Balyi et al. (2005:21) supports this point further by illustrating how many sporting endeavours necessitate running or sprinting as a skill required to master the game (figure 3). Consequently including running for speed in an assessment battery when assessing FMS proficiency levels seems warranted.

Figure 3: Consequences of poor proficiency in the run (Balyi et al., 2005)

The run for speed is a FMS necessary before achieving endeavours such as changing direction whilst sprinting and or sprinting and running whilst catching, kicking or throwing a ball. However, as illustrated in the next section, studies have indicated that children and adolescents proficiency in the sprint is generally poor.
3.3.1.1 Children’s proficiency in the run for speed

Table 4 is a summary on the run for speed findings in Australia from Booth et al. (1999); van Beurden et al. (2002), Okely and Booth (2004), SPAN (2004:98), SPAN (2010:168-201) and Hardy et al. (2012). Additionally table 4 reflects the run for speed results from Ulrich’s (2000) study in the USA and Pang and Fong’s (2009) study in Hong Kong. For an overview of each study’s sampling methods, sample size, assessment techniques and so forth, refer to chapter 2 (subsection 2.2.2.2 and pages 22-27. Furthermore refer to addendum 1).

Motor proficiency was defined in terms of mastery and near mastery (Ulrich, 2000) in all studies. What should be noted is that Australian studies employed the Manual for Classroom Teachers (Walkley et al., 1999) and the Get Skilled Get Active (Davy et al., 2000) assessment protocols whereas the USA (Ulrich, 2000) and Hong Kong (Pang & Fong, 2009) studies employed the TGMD II for FMS assessment purposes. The different FMS assessment manuals incorporated within studies has resulted in arduous comparisons as each has a different number of BC variables assessed. Additionally, as can be noted, each study has clustered different age groups together for analysis purposes and hence at times averaged percentage values include early and middle childhood and adolescent results. This is problematic due to the difference in children’s movement capacity as they age due to neurological maturation, strength and balance differences. Hence by collating results over a large age span it may be less reflective of specific age group.
Table 4: Studies conducted on the run for speed proficiency levels

<table>
<thead>
<tr>
<th>Study</th>
<th>Age group</th>
<th>n</th>
<th>Proficiency</th>
<th>Assessment Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Booth et al. (1999) SPAN</td>
<td>9-to-16 years</td>
<td>A total number of 5518 Australian students aged 9-to-16 years (year 4, 6, 8 and 10)</td>
<td>Mastery of sprint was 25.7% and 29.9% for year 4 and 6 (9-to-12 years old) respectively (SPAN, 2010:193).</td>
<td>Manual for classroom teachers</td>
</tr>
<tr>
<td>van Beurden et al. (2002), MIGI (2000:40)</td>
<td>8-to-10 years</td>
<td>A total number of 1045 Australian students participated. That is, 515 participants aged 8-to-9 years (year 3 students) and 530 participants aged 9-to-10 years (year 4 students)</td>
<td>In year 3 (8-to-9 year old) 33.8% of girls achieved near mastery and mastery scores for the sprint (van Beurden et al., 2002:245).</td>
<td>Manual for classroom teachers</td>
</tr>
<tr>
<td>Okely &amp; Booth, 2004 SPAN</td>
<td>8-to-12 years</td>
<td>Overall 18 schools participated in the study and 1288 Australian girls and boys aged 6-to-9 years old (year 1 to 3) took part.</td>
<td>In year 3 (8-to-9 years old) 19.2% had mastery and near mastery scores (Okely &amp; Booth, 2004:362). Mastery of sprint was 9.8% and 15.3% for year 4 and 6 (9-to-12 years old) respectively (SPAN, 2010:193).</td>
<td>Get Skilled Get Active</td>
</tr>
<tr>
<td>SPAN Hardy et al., (2012)</td>
<td>7-to-16 years</td>
<td>Sample size was 6197 Australian students aged 7-to-15 years old in year 2, 4, 6, 8 and 10.</td>
<td>Near mastery and mastery scores were obtained in 22% of all girls in all years. In 9-to-12 year olds (year 3-to-4) 40.6% to 44.4% achieved a near mastery and mastery score.</td>
<td>Get Skilled Get Active</td>
</tr>
</tbody>
</table>
As can be noted in the table 4, overall findings indicated that children and adolescents do not perform running for speed at a proficient level within the Australian studies. Similarly low proficiency levels were recorded in Brazil (Spessato et al., 2012); however FMS were not reported as individual scores but instead as composite locomotor and object-control skills. More specifically, overall 69% and 82% of boys and girls performed below average TGMD II norms indicating an overall low level of FMS proficiency (Spessato et al., 2012:4).

It should be noted that, although overall results were poor, Ulrich’s investigation on a USA sample of children aged 8-to-10 years (Ulrich, 2000) and Pang and Fong’s (2009) Hong Kong study on children aged 6-to-9 years reported high levels of running proficiency. The common denominator between these studies is the use of the TGMD II protocol for assessment purposes, whereas the other studies employed either the Manual for Classroom Teachers or the Get Active Get Skilled manual. The TGMD II had fewer criterion cut-off elements to assess versus the Australian manuals. Consequently comparisons between studies are difficult due to the employment of different assessment tools and additionally these inconsistencies highlight that the assessment tools employed should be scrutinised for their ability to adequately assess FMS proficiency.

An additional variable that could have caused the differences in the outcomes noted between studies was that physical education classes focusing on FMS proficiency were a priority in the Hong Kong school structure (Pang & Fong, 2009). Studies
conducted in Australia and Brazil indicated that limited physical education classes took place that specifically focused on FMS proficiency. Secondly interventions put in place in Australia were only a year in duration and did not produce significant improvements in children’s ability to perform FMS (van Beurden et al., 2002). Authors concluded that interventions lasting longer than a year are needed for significant improvements in performance.

As mentioned in chapter 2 section 2.2.2.1 (pages 20-22), studies conducted in South Africa have not focused on primary school children’s FMS proficiency levels and hence no comparisons are compromised.

3.3.1.2 Developmental progression of running

For the purposes of this review a run for speed (sprint) was the FMS under investigation. Before the developmental progressions of a sprint can be discussed the difference between a run and a sprint necessitate clarification.

Sprinting is a form of running in which an individual accelerates to a maximum speed (Dugan & Bhat, 2005:603). According to Novacheck (1998:78) ‘sprinting activities are done over shorter distances and at faster speeds, with the goal of covering a relatively short distance in the fastest period of time possible without regard for maintaining aerobic metabolism.’ Dugan and Bhat (2005:608) state that other than accelerating to maximal speeds over short distances, in the sprint the foot placement is on the ball of the foot whereas in a run the foot strike action is initiated with heel strike. When analysing the run for speed, most studies focus on the side view (sagittal plane of the run for speed) but it is additionally important to assess rotatory movements which occur around the vertical axis of the body. Hence frontal and dorsal views of the runner are required (Wickstrom, 1983:49).

When analysing the sprint and according to Wickstrom (1983:51), a novice sprinting style can be identified by the following characteristics.
Beginner legs:
- Knee of the recovery leg swings outward and then forward in anticipation for the support phase.
- Toeing out occurs to allow for foot clearance.
- The recovery knee crosses the midline of the body before moving around and forward.
- Stride length is short.

Beginner arms:
- Arm action is straight.
- The arc of the arm swing is short.
- The elbow of the opposite arm to leg makes an exaggerated forward hooking motion toward the midline of the body.
- The arms are in an abducted position.

When children first start attempting to run they do so flat footed with little flexion in the knees (straight legged jerky movements), a minimal flight phase and no heel-to-toe landing (Payne & Isaacs, 1999:259). Initially the arms are abducted and or straight to assist with balance. Additionally some children may run with ipsilateral arms and leg movements (Horita, 2008:14). As balance and strength improves and a child is exposed to practice so a more mature running style is adopted.

When analysing the sprint and according to Wickstrom (1893:47-51), a mature sprinting style can be identified by the following characteristics.

Mature arm action:
- Hands hook less toward the midline of the trunk at the end of the forward swing and the arm loops outward less on the backswing.
- The arm swings through a longer arc in an anteroposterior plane.
- The arms are bent more toward a right angle.

Mature legs (Wickstrom, 1983:47-51):
- Less lateral movements at the hips.
- Rare foot is fully extended at take-off and the swinging leg is parallel to the ground. More precisely the ankle, knee and hip at take-off are more extended.
- The strike of the foot is nearly under the body and the foot seems to strike flat or more on the forefoot.
- The in the terminal swing, the foot reaches up behind the buttocks, assisting in increased acceleration of the lower extremity.
- Less time is spent in the non-support phase.
- Increased stride length and frequency.
When assessing the run the total body configuration or the BC approach can be used. As noted in Roberton and Konczak (2001) the BC approach is best as it can identify inter-individual differences within each BC variable. The BC approach can be viewed in McClenaghan and Gallahue (1978:85-87), Corbin (1980:47), Wickstrom (1986:43-61); Payne and Isaacs (1999:261), Dugan and Bhat (2005:608), Horita (2008:49) and Haywood and Getchell (2009:111-177). As mentioned in chapter 2, the BC approach is divided into developmental stages from initial to mature movement stages and is ranked from stage 1 to 3. Each progressive level is a developmental motor sequence which becomes progressively more efficient as the child progresses through each stage. In the sprint the individual eventually reaches a mature movement pattern by projecting force in the intended sagittal direction of movement as opposed to wasting energy in the transverse plane. Additionally the angles at the elbow joint remains more stable and within a 90 degree range. Hip and knee angles reach maximum flexion and extension respectively with each successive developmental stage in the sprint.

Fountain, Ulrich, Haubenstricker and Seefeld (1981) studied the relationship between developmental stage and running velocity. The total body configuration approach by Seefeldt, Reuschlein and Vogel was used to assess children’s running form. A 3 year mixed longitudinal sample was employed in which 153 boys and 106 girls were assessed. Results indicated that developmental level accounted for 19% and 29% of the variance in total run times in boys and girls respectively. Consequently based on these findings it can be deduced that running form plays an important role in sprinting ability.

To comprehend why a mature run is deemed as a proficient and efficient movement it is best to closely examine the running phases in terms of inertia, joint kinematics and the placement of the COG.
3.3.1.3 Characteristics of a mature run for speed

According to Corbin (1980:62) the following is a checklist for running performance:

Trunk position:
- Upright except for slight lean as speed increases.

Movement of arms:
- Elbows bent at 90 degrees.
- Arm action in opposition to leg action.
- Arms swing in direction of movement.
- Arms do not cross midline.
- Arms swing as pendulum with pathway of hand extending from chin to buttock.
- Hands and shoulder swing relaxed.

Movement of legs:
- Relaxed stride.
- Weight on sole of foot.
- Feet and knees point straight ahead.
- COG rides over support foot.
- Support knee bends slightly (12 degrees).
- High knee lift.
- Heel of rear foot near buttock.

To understand why Corbin (1980) and Wickstrom's (1983) example of mature running patterns constitute the most efficient sprinting form, closer examination of the running phases in terms of inertia and the COG is necessitated.

Sprinting can be divided into a loading, mid-stance, drive-off and swing (early and late) phases (Grimshaw, Fowler, Lees & Burdon, 2006:254-260). From Payne and Isaacs (1999:259) point of view sprint is divided into a support, flight and recovery phase.

Loading phase/support phase: In sprinting, the loading phase or absorption period (initiated by forefoot contact) is shorter with the non-support knee flexing less than 45 degrees as when compared to running (Dugan & Bhat, 2005:608). According to Wickstrom (1983:52-55) the knee and ankle of the support leg bend slightly after the foot has made contact with the ground in a mature stage of running. This assists in a smooth transition to the next stride, decreases the drop in the COG and placing the ankle in a dorsiflexed position to allow for more time to exert force against the
ground. In an inexperienced child, the foot contacts the ground with a full sole and limited flight is attained due to lack of strength (Payne & Isaacs, 1999:260). This inadvertently creates a breaking motion.

*Drive-off phase:* In the drive-off or propulsion phase that follows the initial contact phase; the action of the support leg at the hip, knee and ankle propels the body forward and upward into the non-support phase (Wickstrom, 1983:52-53). According to Novacheck (1997) the knee extension reaches up to 20 degrees during the propulsive phase. Ankle, knee and hip extension increase with maturity. The recovery leg must make contact with the buttocks and the knee and thigh is then swung forward to nearly parallel to the ground (90 degrees) (Payne & Isaacs, 1999:260). Inexperienced runners cannot flex the knee to this extent and consequently, in order to gain ground clearance their toes turn either inward or outward.

*Early and Late swing phase:* After forefoot strike the heel is propelled closer to the buttocks. This decreases the moment of inertia and allows the leg to be accelerated forward into the late swing phase where the knee assumes a parallel position (Novacheck, 1997:83). At this point the hip is also flexed 90 degrees. This maximum hip flexion leads to a longer stride length (Novacheck, 1997:83). This improves the recovery legs ground reaction and enhances the forward thrust of the body (Wickstrom, 1986:56). According to Dugan and Bhat (2005:611) the greater range of motion allows for minimized vertical displacement of the COG during sprinting.

There should be less dorsiflexion in sprinting as hip and knee flexion ought to be greater and hence foot clearance greater. During maximal sprinting mainly plantarflexion is exhibited as forefoot contact is made at initial contact and the generation phase of the stance phase (Novacheck, 1997:83).

*Mid-stance:* Extension at the hip and knee of the recovery leg causes the foot to move backward rapidly and contact the ground approximately flat and under the body’s COG. If contact is ahead or behind then breaking action is increased and propulsive effort is decreased respectively (Wickstrom, 1983: 55). The trunk should maintain a slight forward lean throughout the stride pattern but should be mostly
upright. According to James and Brubaker (1973 In Wickstrom, 1983:54) ‘excessive forward lean reduces mobility of the lumber spine-pelvic unit, reduces hip flexion relative to the running surface, prevents maximum forward placement of the recovery foot, places excessive stress on the foot at foot strike and requires additional effort from the postural muscles to maintain balance’.

In addition to employing the BC approach to assess the run for speed FMS proficiency score, studies assessing FMS status additionally employ the Manual for Classroom Teachers (Walkley et al., 1999), TGMD II (Ulrich, 2000) and the Get Active Get Skilled manual (Davy et al., 2000) to assess the run for speed.

3.3.1.4 Summary and implications of the run for speed

The following is a summary of the main implications for the run for speed for the purposes of this study:

- Poor cardiovascular fitness has been linked to hypokinetic diseases in both children and adolescents (Ruiz, 2007; Steene-johannessen et al., 2008) and hence aerobic activities such as the run should be performed at a proficient level to ensure for continued participation.

- As indicated in Tomkinson et al. (2003) there has been a global decline in the aerobic performance field test in youth but a maintenance in anaerobic performance over the last decade. It is hence important to assess the running and run for speed proficiency (process scores) of children as this could provide further in site into the secular changes in product scores.

- Although aerobic performance and its positive link to cardiovascular fitness and negative correlation to hypokinetic diseases in youth has been established, according to Bailey (1995) 95% of activities employed in early and middle childhood are anaerobic in nature. Consequently in accordance with the running spectrum, sprinting (running at maximal speeds) is a form of anaerobic activity that children employ mostly whilst participating in PA endeavours and it should hence be assessed for its proficiency levels.

- Wrotniak et al. (2006) found that running for speed correlates highly with PA levels and hence the proficiency thereof should be assessed.
- Balyi et al. (2005) indicated that running and sprinting are FMS that should be proficient in all children as it is linked to numerous sporting activities.

- Strength, balance and co-ordination are required to perform a proficient run or sprint (Wickstrom, 1893:44; Haywood & Getchell, 2009:122; Payne & Isaacs, 1999:259) and hence may be rate limiters to running performance.

- International studies on children’s running for speed indicate that overall running performance is at a poor level of proficiency (MIGI, 1999:31; SPAN, 2004:120; Valentini et al., 2007; Hume et al., 2008:162; SPAN, 2010:8). Hence investigating South African children’s running proficiency is necessitated to identify whether there is a need for intervention.

- Sprinting should be assessed from a frontal and sagittal view so as to account for rotatory movements (Wickstrom, 1893:49).

- Findings in Australia from Booth et al. (1999); van Beurden et al. (2002), Okely & Booth (2004), SPAN (2004:98), SPAN (2010:168-201) and Hardy et al. (2012) and the Brazilian study by Spessato et al. (2012) indicate that children and adolescents do not have proficient sprinting process scores. If many children are performing poorly in the run for speed internationally then this warrants assessing FMS within the South African context.

- To explain sprinting form and a mature level of proficiency, sprinting can be divided into a loading, mid-stance, drive-off and swing (early and late) phases (Grimshaw et al., 2006:254-260). From Payne and Isaacs’ (1999:259) point of view sprint is divided into a support, flight and recovery phase. Each phase is governed by biomechanics which allow for maximal speed attainment, minimum rotatory movements in the transverse plane and minimising the effects of inertia.

- There are many assessment tools employed to analyse the run for speed. The manual for classroom teachers (Walkley et al., 1999), TGMD II (Ulrich, 2000) and the Get Skilled Get Active (Davy et al., 2000) have been found to be the most commonly employed criterion referenced FMS assessment tools. For comparative purposes the TGMD II and the BC approach assessment protocols for the run for speed are best to employ due to the fact that they provide percent allocations of which participants performed at a near mastery and mastery level and which participants performed at an initial, elementary and mature level of FMS proficiency respectively.
3.3.2 Standing long jump

Numerous forms of jumping are present; namely vertical and horizontal jumping, jumping from a height, running long jump and hopping or bounding. Jumping can furthermore be in all directions. For the purposes of this study jumping has been defined as the propelling and transferring of the body into the air by thrusting from both feet and then landing on both feet which is known as the standing long jump (Wickstrom, 1983:65; Payne & Isaacs, 1999:266). Many variations of the jump are employed in these sports however the underlying goal of the jump remains the same and that is to project the body through space either to intercept or receive an object, get past an opponent, clear a length of distance and so forth. According to Wickstrom (1983:65) and Balyi et al. (2005) jumping is a FMS required for many sporting and recreational activities; including, but not being limited to, the athletic arena (high jump, long jump, triple jump), on the basketball courts, cricket fields, netball, rugby, tennis and volleyball.

The standing long jump has mostly been studied in terms of the negative effect BMI has on the ability to propel the body through space (Marchell & Boufford, 1997; Riddiford-Harland et al., 2006; D’Hondt et al., 2009; Halme, Parkkisenniemi, Kujala & Nupponen, 2009). The movement proficiency of the standing long jump and its relation to participation in PA has not been studied in as much depth, however Wrotniak et al. (2006:e1762) assessed the product scores for the standing long jump and its relationship to PA levels. A positive correlation was found between the standing long jump and PA levels, indicating that this FMS should be trained to a proficient level and form part of a FMS assessment battery.

The standing long jump has additionally been linked to lower body strength ability and hence a poor jump performance is indicative of inadequate lower body strength; strength being one of the rate limiters to many bipedal motion endeavours (Haywood & Getchell, 2009:129). Castro-Pinero, Ortega, Artero, Girela-Rejon, Mora, Sjöström & Ruiz (2010) examined the standing long jump, vertical jump, squat jump and countermovement jump’s correlation to upper and lower body strength. Girls and boys aged 6-to-17 years were tested and correlations were made between the upper and lower body muscular strength tests. The standing long jump was strongly
associated with both upper and lower body muscular strength tests. The authors concluded that the standing long broad jump test may be considered as a general index of muscular fitness in youth aged 6-to-17 years old. Additionally the test is inexpensive and time efficient. Miliken, Faigenbaum, Loud and Westcott (2008) correlated lower and upper body field tests to 1 repetition maximum (RM) strength tests in 7-to-12 year old children. A 1 RM chest and leg press test, handgrip test, vertical jump, long jump and sit-and reach and height and weight tests were conducted. Overall findings indicated that BMI, handgrip strength, standing long jump and vertical jump correlated to one RM strength in children. Consequently, based on the literature reviewed thus far in terms of the standing long jump, it can be deduced that a poor jumping ability may be indicative of possessing excessive body weight in terms of adipose tissue, limited lower body strength and possibly decreased PA levels.

The standing long jump requires the coordination of the upper body with the lower body (Wakai & Linthorne, 2005:84). Additionally, adequate lower body strength and power is a prerequisite for maximum distance displacement in the standing long jump. A coordinated effort of the counter movements are essential for an optimal jump, with forward inclination of the total body together with double arm and leg swing (Wakai & Linthorne, 2005:82). A jump can be considered successful when balance is maintained and the individual does not fall backwards (Wickstrom, 1983:65). Due to the coordinative motor ability demanded for the standing long jump children tend to master the skill after the vertical jump and may only reach a mature stage by the age of 9-to-10 years (Horita, 2008:16). Usually once a child has mastered the ability to run (which in essence is jumping off one leg and landing on the other) there is enough strength and power necessary to attempt a jump. Based on these literature findings identifying how many children possess proficient standing long jumping motor abilities consequently necessitates further investigation.
3.3.2.1 Children’s proficiency in the standing long jump

Table 5 reflects a summary on the standing long jump findings in Australia from Booth et al. (1999); van Beurden et al. (2002), Okely & Booth (2004), SPAN (2004:98), SPAN (2010:168-201) and Hardy et al. (2012). Additionally table 5 reflects the standing long jump results from Ulrich’s (2000) study in the USA and Pang and Fong’s (2009) study in Hong Kong. For an overview of each study’s sampling methods, sample size, assessment techniques and so forth, refer to chapter 2 (subsection 2.2.2.2 and page 22-27. Furthermore refer to addendum 1). As these are the same studies discussed in the previous run for speed section the same limitations noted for comparative purposes between studies apply. That is, comparisons between studies are difficult as large age span’s data is collated; different assessment manuals were employed and the children in each study were being exposed to different physical education programs.

Table 5: Studies conducted on the vertical jump proficiency level

<table>
<thead>
<tr>
<th>Study</th>
<th>Age group</th>
<th>n</th>
<th>Proficiency</th>
<th>Assessment Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Booth et al. (1999)</td>
<td>9-to-16 years</td>
<td>A total number of 5518 Australian students aged 9-to-16 years (year 4, 6, 8 and 10)</td>
<td>Mastery of vertical jump was 21.3% and 25.4% for year 4 and 6 (9-to-12 years old) respectively (SPAN, 2010:194).</td>
<td>Manual for classroom teachers</td>
</tr>
<tr>
<td>SPAN (2010:168-201)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>van Beurden et al. (2002), MIGI (2000:40)</td>
<td>8-to-10 years</td>
<td>A total number of 1045 Australian students participated. That is, 515 participants aged 8-to-9 years (year 3 students) and 530 participants aged 9-to-10 years (year 4 students).</td>
<td>Overall 41.2% of year 3 (8-to-9 year old) girls achieved near mastery and mastery scores for the sprint (van Beurden et al., 2002:246).</td>
<td>Manual for classroom teachers</td>
</tr>
<tr>
<td>Okely &amp; Booth, 2004</td>
<td>8-to-12 years</td>
<td>Overall 18 schools participated in the study and 1288 Australian girls and</td>
<td>Overall 30.4% and 33.5% of year 4 and 6 (9-to-12 years old)</td>
<td>Get Skilled Get Active</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
<td>Results</td>
<td>Study</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>---------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>SPAN (2004:98)</td>
<td>boys aged 6-to-9 years old (year 1 to 3) took part.</td>
<td>achieved mastery for the sprint (SPAN, 2010:193).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN (2010:169) Hardy et al., (2012)</td>
<td>7-to-16 years</td>
<td>Sample size was 6197 Australian students aged 7-to-15 years old in year 2, 4, 6, 8 and 10.</td>
<td>Overall 18.9% to 22% of girls aged 9-to 12 year olds (year 4-to-6) were proficient in the vertical jump. Get Skilled Get Active</td>
<td></td>
</tr>
<tr>
<td>Pang &amp; Fong (2009:132)</td>
<td>6-to-9 years</td>
<td>Overall 76 females and 91 males (M=7.6 years) Hong Kong participants from 6 local primary schools.</td>
<td>On average 99% of children aged 6-to9 years achieved near mastery. TGMD II</td>
<td></td>
</tr>
<tr>
<td>Ulrich (2000)</td>
<td>3-to-10 years</td>
<td>A total number of 1208 USA children aged 3-to-10 year olds from 10 different states</td>
<td>Not assessed TGMD II</td>
<td></td>
</tr>
</tbody>
</table>

As can be noted in the above studies, the only study which investigated the standing long jump as opposed to the vertical jump was by Pang and Fong (2009). According to literature, the vertical jump is achieved before the standing long jump as it requires less lower body strength and co-ordination (Haywood & Getchell, 2009:126). Based on the results in table 5, if children and adolescents could not master the vertical jump and hence deductively it can be concluded that most children and adolescents investigated in the above studies would not have mastered the standing long jump either.

Overall it can be deduced that children and adolescents in Australia do not perform the standing long jump (process scores) at a proficient level. Examining the developmental progression of the standing long jump will assist in explaining the types of movements necessary to ensure for a mature pattern of movement and consequently the teaching cues needed to facilitate children in reaching a proficient level of performance.
3.3.2.2 Developmental progression of the standing long jump

As depicted in Haywood and Getchell (2009:125-127) an initial jumping pattern is characterised some of the following variables:

- One-foot take-off.
- Limited preparatory leg flexion.
- Limited arm action to initiate the jump.
- The knee and hip angle do not fully extend before take-off.
- The vertical component of force may be greater than horizontal and the resulting jump is then upward rather than forward. ds
- After take-off the arms may "wing" or abduct to maintain balance.
- During the flight phase the knees remain relatively straight and do not flex towards to a position near horizontal to allow for adequate ground clearance.
- During the landing the arms abduct, the knees do not flex to absorb the force of impact, the landing may be a double footed and or off-balance.

As an individual improves in strength, co-ordination and balance and as an individual is exposed to quality practice and movement instruction; the initial motor sequence of standing long jump transpires to a mature form of movement which is characterised by the following (Cronin, 1980:65):

- Hip, knees and ankles flexed 90 degrees during the preparation phase.
- Arms swing back and upward during the preparation phase.
- Trunk lean forward of 30 degrees or more during the preparation phase.
- Heels are pulled off floor as arms move upward.
- Full knee, hip and ankle extension in take-off.
- Take-off angle is 45 degrees.
- Both feet leave the ground simultaneously.
- Arms flex forward and reach full extension overhead, in line with body.
- In flight full tuck of knee is attained. Thighs to the horizontal.
- In flight trunk remains forward at 30 degrees.
- In flight arms are extended overhead and then are brought forward.
- Legs forward with trunk close to thighs.
- As the feet touch the ground, there is a bending of the knees with the body weight continuing forward and downward.
Assessing children’s movement proficiency and placing them into an initial, elementary and mature movement pattern will facilitate in identifying which variables of the standing long jump are being performed poorly, consequently resulting in an individualised intervention program.

3.3.2.3 Characteristics of a mature standing long jump

Jumping for distance is divided into three phases; the take-off, flight and landing phase (Horita, 2008:15). Payne and Isaacs (1999:266) state that there is an additional preparatory phase.

A mature standing long jump is characterized by the following (Wickstrom, 1983:82):

- Joints are cocked by crouching and swinging the arms backward and upwards. The preparatory crouch is deep so as to increase the time over which force can be applied. The crouch is deeper when the arms move forward before the take-off of the legs.
- Arms swing forward and upward and body extension begins in quick succession at the hips, knees and ankles. The body reaches full extension once off the ground. The arms remain in an extended position and reach forward and upward to assist moving the COG forward over the feet.
- Hips flex, bringing knees forward, and arms and trunk move forward and downward. The take-off angle is approximately 45 degrees but in more advanced jumpers it can be deeper.
- Complete flexion of the feet and extension of the knees, hips and arms occurs after take-off. That is, approximately 180 degrees extension of the body is achieved after which the thighs, knees and arms begin to flex as the individual is propelled into the air. During this period the heels move toward the buttocks.
- The lower legs extend just prior to landing and the trunk is close to the thighs. This keeps the COG high and the body moving forward. The angle the foot has with the ground is approximately 45 degrees or lower in skilled jumpers.
- Knees bend at impact and body weight continues forward and downward in the line of flight.
Closer inspection of the mechanisms underlying a proficient standing long jump motor development sequence can explain why certain movements are considered a mature movement sequence.

According to Payne and Isaacs (1999:266) when there is a limited preparatory crouch and corresponding arm swing in novice jumpers, subsequently a limited extension of the body occurs and a short horizontal distance is achieved. By limited preparatory crouch the stretch re-coil of muscles cannot be taken advantage of and additionally the time over which force can be exerted is limited. Full-extension of the knees and hips cannot take place as there is limited force exerted through the body to assist in causing full extension.

Poor co-ordination of the upper and lower body during the jump can result limiting the distance achieved. In a study by Ashby and Delp (2006:1732) arm motion enhanced standing long jump performance due to the increase in vertical and horizontal positions and velocities of the COG at take-off. Without the use of arms jumping distance decreased. Zheng, Chiu, Hsieh and Liao (2007:S627) randomly selected 84 girls and boys and assessed them for their standing long jump ability and found that arm action additionally correlated highly with jumping distances achieved. Hence arm action should be vigorous and forcefully flexed from an extended position during the preparatory crouch phase to an overhead position and remain there during the flight phase. Once the body starts to move towards the ground the arms should be forceful thrown forward, assisting in placing the COG forward and over the feet. By placing the COG forward and over the feet there is less chance of falling backwards onto the buttocks (Corbin, 1980:63).

Optimal angles together with appropriate limb kinematics and kinetics are a necessity whilst executing the standing long jump. The angle of take-off in standing long jump affects the maximum distance achieved. A sub-optimal angle decreases the speed of take-off and alters the projection of the body (Wakai & Linthorne, 2005:82). According to Wakai and Linthorne (2005:82), ‘a projection angle of 45 degrees is only appropriate if the magnitude of the projection speed generated by the jumper is the same for all projection angles’. In other words the projection speed decreases with increasing projection angles, making jumps at 45 or above degrees
sub-optimal. For a jump to be successful the angle of take-off must be within 5 degrees of the optimal angle of take-off, which is 45 degrees (Wakai & Linthorne, 2005:94). However, it should be noted that an optimal angle of take-off must be accompanied by adequate speed. Take-off speed is more important than take-off angle, with augmented loss in distance with poorer take-off speeds. Further investigation into the optimal angle of take-off is necessitated as Wakai and Linthorne’s (2005) investigation was conducted on a small sample of male participants and is hence not representative of male and female participants. Figure 4 demonstrates a mature long jump sequence.

![Figure 4: Standing long jump (Zheng et al., 2007:S627)](image)

Figure 4: Standing long jump (Zheng et al., 2007:S627)

However, without an optimal take-off angle children are inclined to jump upwards as opposed to forward and the arms only assist in balance as opposed to increasing the distance achieved (Horitia, 2008:16)

Based on the above, good learning cues consist of instructing the child to crouch and bend the knees, swing the arms back and up as quickly as possible, to explode forward from the crouched position, to push off from the toes and to land with the heels first and knees bent to absorb the force.

The assessment protocols for the standing long jump can be viewed in McClenaghan and Gallahue (1978:88-90), Corbin (1980:65), Wickstrom (1983:78-86), Payne and Isaacs (1999:268), Haywood and Getchell (2009:126) and Horita (2008:57-58). In addition to the aforementioned BC approach ranking assessment protocols, there are many criterion cut-off assessments; namely the manual for
classroom teachers (Walkley et al., 1999), TGMD II (Ulrich, 2000) and the Get Active Get Skilled (Davy et al., 2000). As previously mentioned, for comparative purposes the TGMD II and the BC approach assessment protocols for the standing long jump are best to employ due to the fact that they provide percent allocations of which participants performed at a near mastery and mastery level and additionally which participants performed at an initial, elementary and mature level of FMS proficiency respectively.

3.3.2.4. Summary of implications of the standing long jump

The following is a summary of the main implications for the standing long jump in terms of the research aim for this study:

- Jumping has been defined as the propelling and transferring of the body into the air by thrusting from both feet and then landing on both feet (Wickstrom, 1983:65; Payne & Isaacs, 1999:266).

- It can be deduced that a poor jumping ability may be indicative of possessing excessive body weight in terms of adipose tissue (Marchell & Boufford, 1997; Riddiford-Harland et al., 2006; D’Hondt et al., 2009; Halme et al., 2009), limited lower body strength (Milliken et al., 2008; Castro-Pinero et al., 2010) and possibly decreased PA levels (Wrotniak et al., 2006). Hence the ability to perform the standing long jump proficiently is important.

- Jumping is a FMS required for many sporting and recreational activities; including, but not being limited to, the athletic arena (high jump, long jump, triple jump), on the volleyball, netball, tennis and basketball courts and rugby and cricket fields (Wickstrom, 1983:65; Balyi et al., 2005).

- Due to the coordinative motor ability, balance and strength demands for the standing long jump, this FMS is usually mastered after the vertical jump and may only reach a mature stage by the age of 9-to-10 years (Wickstrom, 1983:65; Wakai & Linthorne, 2005:82; Horita, 2008:16).

- Comparisons between studies are difficult as data over data over large age spans are collated; different assessment manuals are employed to review FMS proficiency and children are exposed to different physical education programs.
- Overall studies indicate that children cannot perform a vertical jump and hence it can be deduced that the standing long jump will additionally be poorly performed. Further investigation into the proficiency of the standing long jump is necessary as many studies do not assess the proficiency thereof.


- There are many criterion cut-off assessment tools employed to analyse the standing long jump. The manual for classroom teachers (Walkley et al., 1999), TGMD II (Ulrich, 2000) and Get Active Get Skilled (Davy et al., 2000).

- Jumping for distance is divided into 3 phases; the preparatory, take-off, flight and landing phase (Payne & Isaacs, 1999:266; Horita, 2008:15). Each aspect of the standing long jump needs to take advantage of the stretch re-coil of the muscles, full extension of limbs to take advantage of the increase time over which force can be applied, full utilization of the arms during the preparatory crouch, flight phase and landing (Corbin, 1980; Ashby & Delp, 2006:1732; Zheng et al., 2007:S627) and placing the COG in an optimal position for maximal horizontal displacement of the body (Wakai & Linthorne, 2005:82; Horitia, 2008:16).
3.3.3 Throw for Distance

The over-arm throw is a fundamental skill used in many sporting and recreational endeavours including basketball, baseball, football, netball and javelin (Wickstrom, 1983:120-123). Throwing is a complex manipulative skill that necessitates practice, with several years of instruction to ensure for a mature pattern of development (Garcia & Garcia, 2005). The coordination of the lower and upper limbs must allow for the final maximum acceleration of the arm and hand, which should resemble a whiplike motion (Wickstrom, 1983:114). According to Wickstrom (1983) a mature pattern of throwing can be achieved by age of 6 years. This achievement is however dependent on practice and gender with studies indicating that boys outperform girls at every age (Teixeira & Gasparetto, 2002). Types of throws are ‘bilateral overhand, bilateral underarm from the front, bilateral underarm from the side, bilateral over-arm, unilateral underarm and unilateral over-arm’ (Wickstrom, 1983:104). Of particular interest in the present study is the unilateral over-arm throw.

When evaluating the developmental level or technique employed for the over-arm throw, task constraints should be considered. The size, shape and mass of the object, accuracy required, distance from the target and the time allowed to throw should be regarded when evaluating performance (Burton & Rodgerson, 2003:228). Furthermore accuracy and velocity tend to dictate throwing success.

Females tend to perform throwing activities poorly in comparison to males and the differences noted tend to be based on the social and cultural influences which present and hence negate what type of motor skill endeavours children practice and participate in (Thomas & French, 1985; Roberton & Konczak, 2001:102; Booth & Okely, 2004:269; Barnett, et al., 2008:2137–2144). Investigating empirical research findings on the FMS proficiency status of female children may provide in site into the degree of intervention necessitated.
3.3.3.1 Children’s proficiency in the throw for distance

Table 6 illustrates the throw for distance proficiency levels of girls. As can be noted in the table below, most children in the Australian studies by Booth et al. (1999); van Beurden et al. (2002), Okely & Booth (2004), SPAN (2004:98), SPAN (2010:168-201) and Hardy et al. (2012) could not throw overarm proficiently. Additionally nearly half of the USA participants could not throw proficiently (Ulrich, 2000). In Pang and Fong (2009) study most girls performed at a proficient level. For an overview of each study’s sampling methods, sample size, assessment techniques and so forth, refer to chapter 2 (subsection 2.2.2.2 and page 22-27. Furthermore refer to addendum 1).

Table 6: Studies conducted on the overarm throw proficiency level

<table>
<thead>
<tr>
<th>Study</th>
<th>Age group</th>
<th>n</th>
<th>Proficiency</th>
<th>Assessment Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Booth et al. (1999)</td>
<td>9-to-16 years</td>
<td>A total number of 5518 Australian students aged 9-to-16 years (year 4, 6, 8 and 10)</td>
<td>Mastery of overarm throw was: 4.2% to 10.5% for year 4 and 6 (9-to-12 years old) respectively (SPAN, 2010:196)</td>
<td>Manual for classroom teachers</td>
</tr>
<tr>
<td>SPAN (2010:168-201)</td>
<td></td>
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</tr>
<tr>
<td>van Beurden et al. (2002), MIGI (2000:40)</td>
<td>8-to-10 years</td>
<td>A total number of 1045 Australian students participated. That is, 515 participants aged 8-to-9 years (year 3 students) and 530 participants aged 9-to-10 years (year 4 students)</td>
<td>22.4% for the overarm throw (van Beurden et al., 2002:245)</td>
<td>Manual for classroom teachers</td>
</tr>
<tr>
<td>Okely &amp; Booth, 2004</td>
<td>8-to-12 years</td>
<td>Overall 18 schools participated in the study and 1288 Australian girls and boys aged 6-to-9 years old (year 1 to 3) took part.</td>
<td>Mastery of overarm throw was 3.8% to 9.7% for year 4 and 6 (9-to-12 year old) respectively (SPAN, 2010:196).</td>
<td>Get Skilled Get Active</td>
</tr>
<tr>
<td>SPAN (2004:98)</td>
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</tbody>
</table>
In year 3 a total of 3.7% achieved mastery and near mastery score for the throw for distance (Okely & Booth, 2004:362).

<table>
<thead>
<tr>
<th>Study</th>
<th>Age Range</th>
<th>Sample Description</th>
<th>Overall Findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAN (2010:169)</td>
<td>7-to-16</td>
<td>Sample size was 6197 Australian students aged 7-to-15 years old in year 2, 4, 6, 8 and 10.</td>
<td>Overall 89% were non-proficient overarm throwers in year 4 (Hardy et al., 2012:e392). In year 4 and 6 (9-to-12 years old) 44% to 57.7% were found to be at a near mastery and mastery level. For year 4 and 6 respectively only 3% to 7.3% were found to master the skill (SPAN, 2010:196).</td>
<td>Get Skilled Get Active</td>
</tr>
<tr>
<td>Hardy et al., (2012)</td>
<td>7-to-16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pang &amp; Fong (2009:132)</td>
<td>6-to-9 years</td>
<td>Overall 76 females and 91 males (M=7.6 years) Hong Kong participants from 6 local primary schools.</td>
<td>&gt;80% mastery attained in children aged 6-to-9 years</td>
<td>TGMD II</td>
</tr>
<tr>
<td>Ulrich (2000)</td>
<td>3-to-10</td>
<td>A total number of 1208 USA children aged 3-to-10 year olds from 10 different states</td>
<td>52% to 55% for children aged 9-to-10 years</td>
<td>TGMD II</td>
</tr>
</tbody>
</table>

As previously mentioned, comparisons between studies are difficult as large age span’s data was collated; different assessment manuals were employed and the children in each study were being exposed to different physical education programs. However, overall it would seem that girls cannot throw proficiently, especially in Australia. Assessing the BC variables required to perform a proficient overarm throw can perhaps add in site as to which critical learning cues to focus on when providing FMS interventions.
3.3.3.2 Developmental progression of the throw for distance

The least efficient overarm throwing action is depicted by Wickstrom (1983:113-114). The preparatory arm action has no backswing, an oblique humeral action is employed as opposed to a humeral action characterised by lagging behind the body, the elbow is collapsed and there is no forearm lag. Furthermore there is limited trunk action, no differentiated rotation of the body segments from the hip to shoulder girdle to upper arm and no or an ipsilateral stepping action. As children are exposed to practice and progress in their movement ability, so a more mature movement pattern is attained.

According to Wickstrom (1983:115) a mature over-arm throw is characterized by the following in sequential order:

Preparatory movement

1. The body pivots to the right with the weight on the right foot and the throwing arm swings backward and upward.

Throwing movements

2. The left foot strides forward in the intended direction of the throw.

3. The hips, then spine, and shoulders rotate counterclockwise as the throwing arm is retracted to the final point of its reversal.

4. The upper arm is rotated medially and the forearm is extended with a whipping action.

5. The ball is released at a point just forward of the head with the arm nearly extended at the elbow

Follow through

6. The movement is continued until the momentum generated in the throwing action is dissipated.
Roberton (1977 *In* Wickstrom, 1983) and Wild (1983 *In* Wickstrom, 1983) have added a wealth of information to the qualitative observation of the throwing action with the BC approach and total body configuration respectively. As previously mentioned, Wild’s total body configuration assessment approach (Wickstrom, 1983:106-109) is characterized by all BC variables development progressions being assessed as one unit. Roberton and Konczak (2001:92) challenged Wild’s total body configuration approach by stating that BC variables develop independently and that this accounts for the inter-individual differences noted in children.

Roberton and Konczak (2001:91-103) studied the relationship between outcome variables (horizontal ball velocity) and Roberton’s and Halversons (1983 *In* Roberton & Konczak, 2001:91) BC developmental level of the forceful over-arm throw. The humerus, forearm, trunk, step and stride length were assessed. The authors additionally evaluated the developmental change in each BC variable with aging, whether a relationship existed between BC variable, whether the developmental proficiency could statistically explain group variance and if gender was a good predictor of the forceful over-arm throw ball velocity and distance achieved. The study was based on a continuation of Roberton, Halverson and Erbaugh (1981 *In* Roberton & Konczak, 2001:91) investigation in which 73 girls and boys aged 6-to-13 years old were assessed. Of this original study only 32 children managed to complete the 7 year longitudinal study. Results indicated that 4 of the 5 BC variables correlated with ball velocity achieved on a yearly basis. Arm action (humerus or forearm) was found to be most significant in the first 3 years (aged 6-to-8 years old) whereas trunk action only came into play in children aged 13 years old. According to the authors, this was thought to be due to the spinal or block rotation utilised by the younger children, resulting in the arm action playing a more significant role. The step breadth became more important than just taking a step as the children aged, with children stepping at least the width of half their body height (refer to figure 5’s pie chart which depicts which BC variable played a more important role in children aged 8 and 13 years).
The overall findings in Roberton and Konczak's (2001) investigation indicated that the FMS development stage is a strong predictor of ball velocity. It was found to account for 69% to 85% of variance in throwing velocities. It was furthermore concluded that the BC approach is the better tool to employ when compared to the total body configuration approach as the BC approach accounts for individual differences and is a sensitive assessment tool by appraising individual BC variables and movement profiles more comprehensively. Lastly, the authors recommended that physical education instructors need to instruct children individually based on their developmental level as with so many inter-individual difference, applying a generic training program may not produce positive results (Roberton & Koanczak, 2001:101).

A similar study was conducted by Stodden, Langendorfer, Fleisig and Andrews (2006:417–427). This study consisted of two parts. Part one examined the relationship between kinematic variables and the development of the trunk and stepping action of the throw and part two investigated upper extremity kinematics and the development of arm movement components. As was noted in Roberton and Konczak (2001) the stepping action played an important role in over-arm throwing ability. That is, the stepping length and action could predict the stepping developmental level 85.4% of the time. In addition, it was positively related to ball velocity achieved and could explain 69.3% of the velocity accomplished (Stodden et al., 2006: 423). The stepping action progressions can be seen in figure 6.
Figure 6: Step development as children aged ‘Visual descriptions of differences in step action levels (1–4). Level 1 – no step (A); Level 2 – homolateral step (B); Level 3 – contralateral short step (C); Level 4 - contralateral long step (D)’. (Stodden et al., 2006:420).

The trunk biomechanics improved with each developmental level and was moreover related to increased velocity at each developmental level. This finding is similar to Roberton and Konczak (2001). The trunk progressions can be seen in figure 7.
It is hence important to include the critical component identified in Roberton and Konczak (2001) and Stodden et al. (2006) such as the stepping length and trunk dynamics during the overarm throw. Further investigation into the characteristics of a mature overarm throw can provide further evidence of critical variable to include when assessing the FMS proficiency of this skill.

3.3.3.3 Characteristics of a mature throw for distance

As mentioned in the previous section, a mature overarm throwing action is characterised by a preparatory arm action which is circular and downward in motion during the back swing, is characterised by a humeral and forearm lags, an elbow held at a right angle, differentiated rotation with lateral flexion of the trunk and a contralateral and long stepping action (Wickstrom, 1983:113-114). From a biomechanical point of view, there are specific reasons why these aforementioned motions would result in the most efficient throwing action.

According to Burton and Roberton (2003:270), and as noted in Wickstrom (1983:115), in order for the optimal transfer of momentum from the lower body to the upper body and subsequently to the object being thrown to occur, the hips and subsequently the trunk, humerus and lastly forearm must rotate in succession. This ‘winding up’ motion allows the body to have more time to generate power and to take advantage of the eccentric and elastic properties created during the rotation of the body to produce a forceful ball release.

As can be noted in Wickstrom’s mature overarm throwing sequence, a mature stepping action is a contralateral step. An ipsilateral as opposed to a contralateral step prevents adequate trunk rotation and consequently reduces the angular velocity produced. According to Stodden et al. (2006, 424) ‘a contralateral step places the
The trunk in an advantageous position by allowing it to at first face away from the target and then ‘whined up’ and rotate towards the target, hence generating greater velocities’. The step component and positioning of one’s body in opposition to the target produces the greatest axillary affect in the throw. This together with the trunk rotation allows for more advanced humeral and forearm action. It is hence not surprising that Roberton and Konczak’s (2001) and Stodden’s et al. (2006) studies found that the stepping action predicted a positive outcome for the overarm throw performance.

Stodden et al. (2006:424-425) and Wickstrom (1983:118) stated that the trunk rotation should occur when the ipsilateral leg steps and before the contralateral foot is placed. With this movement the trunk rotates before the upper body and creates a lag effect, generating eccentric force and consequently increased velocity. It is important to additionally be able to distinguish between a push and whip action of the arm. The former is an immature form of throwing due to the arm being abducted horizontally until the elbow is nearly in front of the shoulder before extending the elbow. The latter is characterized by the ball being released near the plane and in front of the head and not farther forward when viewing the throw in the sagittal plane (Wickstrom, 1983:119). Lastly, according to Burton and Rodgerson (2003:265) the elbow should be maintained at 90 degrees through the early preparatory phase as this assists with decreasing the moment of inertia of the limb and rotational torque exerted.

The assessment protocols for the overarm throw can be viewed in Corbin (1980:65), Wickstrom (1983:79), Payne and Isaacs (1999:268) and Haywood and Getchell (2009:146-147). In addition the overarm throw is assessed in the Manual for Classroom Teachers (Walkely et al., 1999), TGMD II (Ulrich, 2000) and the Get Active Get Skilled (Davy et al., 2000). As previously mentioned, the TGMD II and the BC approach assessment protocols for the throw for distance are the best to employ for comparative purposes.
3.3.3.4 Summary of implications for the throw for distance

The following is a summary of the main implications for the throw for distance that were considered relevant for the study:

- The over-arm throw is a fundamental skill used in many sporting and recreational endeavours including basketball, baseball, football, netball and javelin to name but a few (Wickstrom, 1983:120-123).

- Throwing is a complex manipulative skill that necessitates practice, with several years of instruction to ensure for a mature pattern of development (Garcia & Garcia, 2005).

- Girls throwing performance tends to be at an initial or elementary level and poor when compared to boys (Thomas & French, 1985; Robertson & Konczak: 2001:102; Booth & Okely, 2004:269; Barnett, et al., 2008, 2137–2144) and this gap tends to increase with age (Teixeira & Gasparetto, 2002), hence validating the need to focus on female children’s overarm throwing ability.

- Different BC variables play more crucial roles at different ages in the overarm throw and there are many inter-individual differences between children, hence indicating that the total body configuration approach is not as accurate as the BC approach (Roberton & Konczak, 2001:100; Stodden et al., 2006). The BC approach is hence the better assessment tool to employ when evaluating the throw for distance.

- By standing with the body in opposition to the target, taking a longer stride length in the stepping action, producing faster pelvic and then upper torso rotation (wind-up motion) followed by a whiplike motion of the upper arm, then forearm and then wrist (all of which should lag behind lower body and torso before release) can contribute to better throwing performance. This is due to taking advantage of the eccentric and elastic forces produced when the successive rotation from lower body to upper body is adequately executed (Roberton and Konczak, 2001; Stodden et al., 2006:425).

- According to Burton and Rodgerson (2003:265), the elbow should be maintained at 90 degrees through the early preparatory phase as this assists the moment of inertia of the limb and rotational torque exerted.
- There are criterion and BC approach assessment tools to employ when evaluating the throw for distance. The TGMD II and the BC approach assessment protocols are the best to employ for comparative purposes based on the literature reviewed.

3.3.4 Catch

Catching is a FMS in which an individual is required to use the hand(s) to halt and then manipulate the direction and speed of an object (Wickstrom, 1983:137). This skill is used in sports such as basketball, baseball, cricket, football, netball and rugby to name but a few. The study by Barnett et al. (2008) on childhood motor proficiency’s and their link to adolescent PA levels indicated that children with better object-control skills tended to become physically active adolescents. The 3 object control skills assessed were the kick, catch and throw, hence indicating that increased FMS proficiency in any of these skills may result in increased PA endeavours.

Catching a ball can be a challenging skill to execute and evaluate as its success is based on the task constraints imposed and the motor-perceptual ability (optical flow and anticipatory ability) of the catcher (Haywood & Getchell, 2009:177-184). Savelsbergh and Whiting (1996:461-496) discuss perceptions role in catching ability in depth in their review on motor learning and the developmental perspective of catching. The authors state that overall, temporal and spatial prediction ability are important aspects to master when catching and these can only be acquired if children experience diverse catching situations. Savelsbergh, Rosengren, van der Kamp and Verheul (2003:191-207) additionally discuss how the numerous task, environmental and personal constraints and perceptual-motor cues affect movement proficiency. These authors findings are in agreement with Savelsbergh and Whiting’s (1996) sentiments which state that vision and perception are critical to successfully catching a ball but add that specificity of training should be ensured for as this affects catching ability. These are hence variables to consider when assessing or implementing a training program for children.
Children’s first attempts at catching a ball are occur at the age of 2 years with a proficient catch being attained by the age of 6-and-a-half years (Malina, 2004:55). This acquisition of a mature catching ability is, however as mentioned, based on practice and specificity of training. A closer examination of the catching proficiency levels can assist in determining whether children these aforementioned variables are being optimised in PA and sporting endeavours.

### 3.3.4.1 Children’s proficiency in the catch

Table 7 is a summary on the catching ability of children in Australia from Booth et al. (1999); van Beurden et al. (2002), Okely & Booth (2004), SPAN (2004:98), SPAN (2010:168-201) and Hardy et al. (2012). Additionally table 7 reflects the catching results from Ulrich’s (2000) study in the USA and Pang and Fong’s (2009) study in Hong Kong. For an overview of each study’s sampling methods, sample size, assessment techniques and so forth, refer to chapter 2 (subsection 2.2.2.2 and page 22-27. Furthermore refer to addendum 1).

**Table 7: Studies investigating catching process proficiency levels**

<table>
<thead>
<tr>
<th>Study</th>
<th>Age group</th>
<th>n</th>
<th>Proficiency</th>
<th>Assessment Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Booth et al. (1999)</td>
<td>9-to-16 years</td>
<td>A total number of 5518 Australian students aged 9-to-16 years (year 4, 6, 8 and 10)</td>
<td>Overall 8.8% and 13.1% of children in year 4 and 6 (9-to-12 years old) respectively achieved mastery of the catch (SPAN, 2010:197).</td>
<td>Manual for classroom teachers</td>
</tr>
<tr>
<td>SPAN (2010:168-201)</td>
<td>9-to-16 years</td>
<td>A total number of 5518 Australian students aged 9-to-16 years (year 4, 6, 8 and 10)</td>
<td>Overall 8.8% and 13.1% of children in year 4 and 6 (9-to-12 years old) respectively achieved mastery of the catch (SPAN, 2010:197).</td>
<td>Manual for classroom teachers</td>
</tr>
<tr>
<td>van Beurden et al. (2002), MIGI (2000:40)</td>
<td>8-to-10 years</td>
<td>A total number of 1045 Australian students participated. That is, 515 participants aged 8-to-9 years (year 3 students) and 530 participants aged 9-to-10 years (year 4 students)</td>
<td>Overall 34.2% of 8-to-10 year olds achieved mastery and near mastery scores for the catch (van Beurden et al., 2002:245).</td>
<td>Manual for classroom teachers</td>
</tr>
<tr>
<td>Study</td>
<td>Year Range</td>
<td>Sample Size</td>
<td>Achievements</td>
<td>Comments</td>
</tr>
<tr>
<td>-------</td>
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<tr>
<td>Okely &amp; Booth, 2004</td>
<td>8-12 years</td>
<td>Overall 18 schools participated in the study and 1288 Australian girls and boys aged 6 to 9 years old (year 1 to 3) took part.</td>
<td>Overall 45.8% of children in year 3 (8- to-9 year olds) achieved near mastery and mastery for the catch (Okely &amp; Booth, 2004:362) Overall 21.1% and 35.8% of children in year 4 and 6 (9-to-12 year olds) respectively (SPAN, 2010:197) achieved mastery.</td>
<td>Get Skilled Get Active</td>
</tr>
<tr>
<td>SPAN (2004:98)</td>
<td>7-16 years</td>
<td>Sample size was 6197 Australian students aged 7 to 15 years old in year 2, 4, 6, 8 and 10.</td>
<td>Between 21% and 80% were proficient catchers in year 2-to-10 (7-to-16 year olds). For year 4 and 6 (9-to-12 year olds) 43.3% to 58% of children were at mastery and near mastery levels. Overall 23.2% and 37.8% of year 4 and 6 (9-to-12 year olds) were found to be at a mastery level respectively (SPAN, 2010:197)</td>
<td>Get Skilled Get Active</td>
</tr>
<tr>
<td>Hardy et al., (2012)</td>
<td>6-9 years</td>
<td>Overall 76 females and 91 males (M=7.6 years) Hong Kong participants from 6 local primary schools.</td>
<td>&gt;84% of children aged 8-to-11 years old.</td>
<td>TGMD II</td>
</tr>
<tr>
<td>Pang &amp; Fong (2009:132)</td>
<td>6-10 years</td>
<td>A total number of 1208 USA children aged 3-to-10 year olds from 10 different states</td>
<td>76% to 83% of children aged 9-to-10 years old.</td>
<td>TGMD II</td>
</tr>
</tbody>
</table>
Most children in Australia could not catch efficiently. However, children in the USA (Ulrich, 2000) and Hong Kong (Pang & Fong, 2009) could catch. As previously mentioned comparisons between studies are difficult as data over large age span’s was collated; different assessment manuals were employed and the children in each study were being exposed to different physical education programs. However, overall it would seem that girls cannot catch proficiently, especially in Australia. Assessing the BC variables required to perform a proficient catch can perhaps add in site as to which critical learning cues to focus on when providing FMS interventions.

3.3.4.2 Developmental progression of the catch

An immature pattern of catching is characterized by (Wickstrom, 1983:144-145):

- Negative reaction and fear of the ball such as turning the head to the side to prevent the eyes and head coming into contact with the ball, closing the eyes and or moving the trunk posteriorly.
- Extended arms in front of the trunk with fingers spread in anticipation of the ball.
- The ball being ‘hugged’ against the body.

A mature pattern for the catch is characterized by (Wickstrom, 1983:143-150):

- No fearful reaction. Eyes fixed on the ball.
- Use hands to grasp the ball and the elbows flex and ‘give way’ to soften the impact of the ball. The motion of the elbows are downward.
- Fingers face forward and palms are up.

With practice, children’s perceptual-motor skills improve and their fear of catching the ball decreases, hence resulting in a mature catching action.
3.3.4.3 Characteristics of a mature catch

In comparison to the run for speed and standing long jump, when evaluating the catch, empirical research tends to focus more on the perceptual system and the task, environmental and personal constraints affecting the catcher’s ability. More specifically, empirical research tends to depict that the development of a mature catching skill is affected by the ball size, speed, trajectory and distance from the object the participant.

Task constraints that affect catching are the ball size, speed, the horizontal distance between the catcher and thrower and the trajectory of the ball or object (Belka, 1985:42). According to Wickstrom (1983:138-143) the direction of the ball in relation to the catcher, the degree of pre-catch change of body position required before the ball is caught and the arm-hand action of the catcher additionally affects the individual’s ability to catch. More specifically, the difficulty in catching a ball is based on whether the ball is being projected overhead, lateral and or below the knees. Lastly, the testing procedure employed to assess catching ability can affect performance (Van Waelvelde, De Weerdt, De Cock & Smits Engelsman, 2003).

In a study by Belka (1985:42-51) 30 randomly selected males and females aged 6, 8 and 10 years old were assessed for their catching ability when different task constraints were manipulated. Children were required to catch 3 different ball sizes when an underhand chest pass was administered. Each child had to catch a ball from different heights of interception (chest, waist and knee heights) and each child was required to catch a ball from different horizontal distances. Findings indicated that the ball size had no influence on the catching ability of children. Consequently the authors concluded that the medium sized balls between 12.7cm to 21.6cm in diameter did not have an effect on catching ability (Belka, 1985:48). In a separate study conducted by Morris (1976) the effect of ball colour on catching ability was assessed. In this study on participants in grades 2, 4 and 6 older participants were found to throw better than younger participants and ball colour was found to have a significant effect on catching process scores. More specifically, blue and yellow ball were produced better catching scores than white balls consequently indicating the role that the visual-perceptual system plays in children when catching a ball. The
effect that ball size and colour have on catching ability could additionally be attributed to specificity of training. If children only catch certain sized and colour balls then these are the balls will result in the most successful catches. Additionally the standards employed to identify a catch as successful should be considered. Assessing a catch in terms of not dropping the ball versus the catching developmental sequence employed when catching a ball will cause discrepancies in findings as the former is based on a product score whereas the latter is based on a process score. Hence further investigation into the variables affecting catching ability is warranted.

The reliability of the under-arm throw catch test was assessed by Van Waelvelde et al. (2004:49-60) in 133 children aged 7-to-9 years in which the MABC’s validity as a test battery was assessed. The under-arm throw catch test consists of throwing a ball underarm to a designated point on a wall and subsequently catching it before the ball contacts the ground. In order to test the validity and reliability of the catching test, it was assessed against the gold standard test in which 80 ball catching trials in varied situations were administered. A significant but lower correlation was found between the gold standard test and the throw-catch test for the 9 year old children. The primary constraint identified was that the throw-catch test additionally assessed a child’s ability to throw underarm at a target accurately. Consequently having someone throw the ball to a child could make it a more valid test. However, merely throwing a ball to a child additionally has its inherent lack of reliability. Hence in summary when analysing a catch it is important to consider the task constraints imposed and the variability and specificity of training the individuals being assessed are exposed to as this may affect their catching ability.

The assessment protocols for the catch can be viewed in Corbin (1980:65), Wickstrom (1983:145-148) and Haywood and Getchell (2009:179). In addition the overarm throw is assessed in the Manual for Classroom Teachers (Walkely et al., 1999), TGMD II (Ulrich, 2000) and the Get Active Get Skilled (Davy et al., 2000). The TGMD II and the BC approach assessment protocols for the catch are the best to employ for comparative purposes.
3.3.4.4 Summary of implications for the catch

The following is a summary of the main implications for the catch in terms of the research aim for this study:

- Task constraints and perceptual motor ability must be taken into consideration when evaluating catching ability (Belka, 1985).
- Catching is diverse in game settings and hence finding a standardized test to validly assess catching ability is limited (Van Waelvelde et al., 2004).
- When employing the underarm pass to a set point on a wall with a subsequent catch, caution must be taken as this not only assesses catching ability but additionally the ability to throw underarm and to be accurate (Van Waelvelde et al., 2004).
- Further investigations into standardized tests for catching are needed. Additionally longitudinal studies on the developmental sequence of the catch are necessitated.

3.3.5 Balance

The ability to maintain the COG within one’s limits of stability or base of support is known as balance (Haywood & Getchell, 2009:38-39). In other words balance is the aptitude to keep the body in a state of equilibrium whilst performing static or dynamic activities, regardless of the body’s position. Static balance refers to maintaining equilibrium whilst being stationary whereas dynamic balance refers to maintaining balance whilst moving (Overlock, 2004:5). Postural muscles together with the neural system activation and perceptual-motor development in the different planes of movements whilst executing static and dynamic activities contribute to the development of balance (Williams, 1983:270). More specifically, and according to Hatzitaki, Zisi, Kollias and Kioumourtzoglou (2002), sensorimotor information, musculoskeletal responses and a combination of the visual, vestibular and somatosensory inputs allow for postural control and consequently balance. As such, balance can be thought of as a difficult FMS to master due to the integration of numerous systems within the body which have to be controlled by the CNS. However, whether balance is easy or hard to perform tends to be based on how balance is being assessed.
The relationship between balance and FMS proficiency tends to be moderate to small with inconsistent statistically significant findings (Overlock, 2004:27). Overlock (2004) attributes these findings to how balance is assessed. That is, the difficulty required to perform either the static or dynamic balance test. According to Hardy et al. (2010:504) a ceiling effect in static balance skills, such as standing on one leg, may be observed due to it being a skill that should be developed from a young age and that is inherent within many FMS. Hence ensuring that the assessment of balance is age appropriate and contains some degree of difficulty is important. Although static balance assessments may produce ceiling affects in performance Malina (2004:54) states that balance is an important variable governing the attainment of motor skills such as walking. Haywood and Getchell (2009:119-122) additionally adds that balancing is a rate limiter to the attainment of many FMS, with a lack thereof usually depicted in FMS by abducted arms, rotatory and abducted leg positions or widening the base of support. Hence, although balance correlations to FMS have produced inconsistent findings there is no doubt that balance plays an important role in ADL and should be included in a FMS assessment battery, especially since it forms part of the non-locomotor domain of FMS.

**3.3.5.1 Children’s proficiency in the balance**

Findings studies focusing specifically on the static or dynamic balance status of children seems to be sparse as many balance studies tend to focus on balance performance in children with Developmental Coordination Disorders (Geuze, 2005) or other forms of impairments such as visual or vestibular. Furthermore studies tend to investigate whether balance ability can predict FMS proficiency ability (Overlock, 2004) and or the effect of weight status on balance performance (Deforche, Hills, Wortingham, Davies, Murphy, Bouckaert & De Bourdeaudhuij, 2011). Furthermore different assessment protocols are employed when evaluating static balance. For example, Overlock (2004) assessed static balance on a computerised platform; Saar’s (2008) employed a 60 second static balance test whereas Kalaja (2012) employed a 30 second static balance assessment. However, based on literature findings it would seem as though the most commonly employed static balance assessment test is the one-legged balance test, also known as the flamingo balance or stork-stand test which is used to assess the number of times a child loses balance.
whilst standing on one leg (Atwater, Crowe, Deltz & Richardson, 1990; Overlock, 2004:8; Saar, 2008; Tomkinson, Olds & Borns, 2011). Static balance is additionally assessed qualitatively. That is, by employing a criterion referenced assessment protocol to obtain a process score. In Davy et al. (2000:18) balance is assessed by observing the following whilst an individual stands on one leg with eyes open:

- Support leg still, foot flat on the ground.
- Non-support leg bent, not touching the support leg.
- Head stable, eyes focused forward.
- Trunk stable and upright.
- No excessive arm movements.

There seems to be controversial findings on whether static balance tests are valid and reliable measures of balance. The Atwater’s et al. (1990) study on children aged 4-to-9 years old indicated that the test-retest reliability between test observers of the one-legged balance test was moderate to high, however, the inter-rater reliability tended to be low indicating that those analysing the children balancing subjective assessment of a balance errors differed. Employing a one-legged balance stance on a computerised platform in children aged 5-to-9 years seemed to additionally yield low to high inter-rater correlation coefficients (ICC) in children’s performance (Overlock, 2004:8). However, regardless of these aforementioned limitations static balance seemed to be a more reliable assessment protocol when compared to dynamic balance. That is the test-retest reliability of the dynamic assessment protocols was found to be lower than static balance in both studies. Other than the possibility that researchers lacked objectivity whilst measuring dynamic balance, these inconsistent test-retest results may indicate that dynamic balance tasks were harder for children to perform consistently well between trials. Hence it could be surmised that static balance skills are easier for children to perform accurately from trial-to-trial. However, even though static balance would seem to be produce possible ceiling effects in statistical analysis due to it being a FMS developed from a young age Hardy et al. (2010:504) the one-legged static balance test has merits in that it can identify individuals who have not had adequate exposure to motor learning opportunities. Furthermore the one-legged balance test is employed in fitness assessment batteries, such as the Eurofit (which is known as the flamingo test), and has been used in large scale assessments of children (Tomkinson, Olds & Borns 2011). Lastly, the static balance assessment test tends to be able to differentiate
age related improvements in performance, hence possessing differentiating capacity (Williams, 1983:266-267; Overlock, 2004:8).

Based on these findings, investigating normative data on the one-legged balance test is justified. However, as mentioned, it would seem as though there are limited high quality studies which include a representative sample of the population under investigation focusing specifically on the static balance FMS status proficiency. This sentiment was justified by Tomkinson et al. (2011:123) systematic review on the Eurofit performance of European children aged 6-to-19 years between the years 1953 and 2003 from 27 countries. According to the authors the lack of representative samples, differences in ethnic, cultural and SES groups assessed and the differences in exposure to PA to name but a few were factors possibly affecting the performance differences noted between the European countries investigated.

A study conducted by Saar (2008) in which the PA levels and motor abilities of 525 Estonian girls and boys aged 10-to-17 years was investigated included the 60 second one-legged balance test within its test battery. The Eurofit physical fitness test battery was employed to assess motor ability, convenience sampling was used to recruit participants and PA was examined with a PARQ. Children aged 10-to-11 years achieved a score of 10.5 (±3.0) errors and children aged 12-to-13 years achieved an average balance error score of 7.3 (± 1.9) errors (Saar, 2008:31). Hence as children aged so their ability to balance improved. Higher error scores were reported in a study by Wilczewski, Sklad, Krawczyk, Saczuk and Majle (1998:117) in which Polish girls aged 11 (n=51) and 12 (n=54) years from urban areas were found to achieve error scores of 12.2 (±6.8) and 11.6 (±5.0) respectively. Conversely, lower balance error scores were recorded for the Polish rural girls in that only 3.6(±2.4) and 4.5(±3.5) balance errors were recorded for the 11 and 12 year old girls respectively. The authors surmised that the differences between the urban and rural girls performance was due to the fact that the girls from rural areas had to participate in farming duties and travel far distances to get to school whereas girls in urban areas spent more time participating in sedentary leisure activities. As Saar’s (2008) did not diverge the SES and ethnicity of the participants under investigation it is difficult to draw comparisons. However, what can be deduced is that there is a definite differences in balancing ability between groups and as Tomkinson et
(2007) indicated, cultural norms and exposure to PA differences in the samples under investigation could have caused these differences.

As previously mentioned qualitative assessments of the balance have been investigated. In a study by Okely and Booth (2004:364) the Get Skilled Get Active User Manual (Davy et al., 2000:18) protocol for qualitative static balance assessments indicated that more than 60% of participants in year 3 (aged 7 years) performed the static balance at a near mastery and mastery level. In the MIGI study (2003:30) in which 515 participants aged 9 years (year 3 students) and 530 participants aged 10 years (year 4 students) FMS were assessed most participants performed the static balance proficiently. That is 75.4% of participants performed the static balance at a near mastery and mastery level.

In summary it would hence seem as though the BC variables of the static balance are performed well but the number of errors during the performance of the one-legged static balance test is performed poorly by children, depending on where they live, the type of PA they are exposed to and their cultural norms.

3.3.5.2 Developmental progression of balance

As previously mentioned, static balance assessments indicate that as children age so their ability to balance improves (Williams, 1983:266-267; Overlock, 2004:8). The tests employed to assess balance mostly result in product scores. There are no progressive developmental stages depicted in literature findings, as is normally portrayed in gross and object-control FMS, and hence children’s balance scores cannot be described in terms of being at an initial, elementary or mature stage of development (McClenaghan & Gallahue, 1978:78). Instead static balance is mostly depicted as error or process quantitative score whilst performing a static or dynamic activity. Research tends to indicate that children should be able to statically balance on one leg by the age of 3-to-5 years (Gallahue, 2010:19)

Williams (1983:275) provides a theoretical model for balance progressions. The theoretical model depicts that balance progresses in levels from 1 to 4. Level 1 consists of sitting and standing and level 4 consists of walking on a beam with eyes
closed. The one-foot balance test with eyes open is placed into level IIC. According to the author balance is dependent on ‘elevation, vision, stability, number of limbs used, body positions, and the kind of locomotion involved (William, 1983:279).

Further investigation into a representative sample of the South African population’s static balance ability employing an array of balance assessments which result in both product and process scores and which is internationally comparable is warranted as presently there seems to be a lack of consensus between studies in terms of the static balance test employed.

3.3.5.3 Summary of implications for balance

The following is a summary of the main implications for the balance in terms of the research aim for this study:

- Balance is a FMS that is required for ADL and is additionally a rate limiter to the acquisition of proficient FMS (Malina, 2004:54). Hence, ensuring for the development thereof is justified.
- Balance can either be static or dynamic (Overlock, 2004:5). Based on literature findings the assessment of static balance seems to be more reliable (Atwater’s et al., 1990; Overlock, 2004), can differentiate balance ability between children (Williams, 1983:266-267; Overlock, 2004:8) and is employed in test batteries which are used for large scale fitness surveys of children (Tomkinson et al., 2007).
- Sensorimotor information, musculoskeletal responses and a combination of the visual, vestibular and somatosensory inputs allow for postural control and consequently balance. As such, balance can be thought of as a difficult FMS to master due to the integration of numerous perceptual-motor systems (Williams, 1983:270, Hatzitaki et al., 2002; Overlock, 2004:5). Balance is hence task specific and necessitates practice and learning.
- There is no developmental progression BC variable assessment tool for the balance. Instead William’s theoretical model on balance progression is employed to illustrate balance development (William, 1983:275). The one-foot balance test with eyes open is placed into level IIC of Williams’ theoretical model for balance progressions (William, 1983:275).
Based on the aforementioned literature on balance development it can be deduced that balance proficiency and development is based on specificity of balance training. When choosing an assessment protocol to investigate static or dynamic balance, possibly a combination of balance tests may provide an overall depiction of participants’ balancing ability.

Further investigation into a representative sample of the South African population’s static balance ability employing an array of balance assessments which result in both product and process scores and which is internationally comparable is warranted.

3.3.6 Throw for Accuracy

Throwing for accuracy is not formally classified as a FMS, however, many movements are performed with the goal of hitting a target with an object, hence requiring accuracy. The throwing action is often employed to hit a target whilst participating in recreational and sporting activities and consequently assessing the throw for accuracy in children is warranted. Similarly to catching a ball and balancing, researchers investigating the accuracy skills in children tend to focus on the perceptual-motor systems involvement in the attainment of accuracy (Williams, 1983:114). Perceptual-motor skills such as depth perception, perception of movement and visual acuity are variables which can affect accuracy (Wickstrom, 1983: 102; Williams, 1983:108-114). Furthermore and similarly to catching and balancing type movements, task constraints affect the accuracy of an individual. In terms of accuracy skills this tends to result in either an increase or decrease in accuracy. Hence it can be deduced that accuracy tasks require specificity of training as different tasks will impose different demands on the perceptual-motor system (Sullivan, Kantak & Burtner, 2008).
3.3.6.1 Children’s proficiency in the throw for accuracy

Literature findings indicate that females tend to be outperformed by males when throwing for accuracy is concerned. In the Kalaja’s (2012) study the effect of an intervention on Flemish males and females aged 13 years FMS ability, motivational and PA level was examined. A quasi-experimental design employing convenience sampling methods was employed to assess FMS. Of particular interest in this study was the throwing for accuracy ability of female participants. A wooden circle hanging vertically from a wall was used as the target. The target was set at eye level and participants were expected to throw a tennis ball overarm to hit the target from a distance of 5m. The target’s diameter of the 3-point area was 20cm, 2-point area 40cm, and the 1-point area 60cm. Boys were found to perform better in the throwing for accuracy when compared to girls. This was attributed to the games that boys and girls play and hence cultural influences. Jardine and Martin (1983:311-399) tended to believe that the accuracy differences between males and females were due to genetics which were linked to survival purposes. Their investigation into 83 sets of twins indicated that males outperformed females in throwing for accuracy and spatial tests. However, in hindsight the authors agreed that the difference could not purely be attributed to a genetic component as cultural norms and gender stereotyping influences could have affected the results.

Normative data available on throwing accuracy for children is sparse as studies tend to employ different assessment protocols (Wickstrom, 1983:102). Additionally, studies tend to focus on identifying either the effects of task demands on the throwing accuracy of a motor skill (Moore, Reeve & Pissanos 1987), generating normative data from throwing balls into a basket (Garner, 1979) or identifying critical elements which makes a throwing for accuracy task possible (Hore, Watts, Tweed & Miller, 2006). However, a commonality noted between these throwing for accuracy studies is that as children age and or were exposed to practice so their ability to throw accurately improve. As can be noted many throw for accuracy studies tend to be out-dated resulting in a lack of research in the 21st century for comparative purposes. Additionally there is a lack of research on a representative sample of the South African population.
3.3.6.2 Developmental progression of the throw for accuracy

Similarly to the catch and balance literature reviewed for the purposes of this study, the throw for accuracy does not have a BC variable assessment protocol and hence children’s proficiency in the throw for accuracy cannot be classified in terms at an initial, elementary or mature stage. Instead different assessment protocols are employed to assess the accuracy of participants. What literature does depict is that with aging accuracy improves (Sullivan et al., 2008). Additionally literature illustrates that accuracy tasks require practice and specificity of training (Hore et al., 2006; Sullivan et al., 2008). Hence when choosing an assessment protocol to identify throwing accuracy in children it is important to consider the training participants are exposed to and the task constraints and perceptual-motor development influences on the accuracy ability of participants.

3.3.6.3 Summary of implications for the throw for accuracy

The following is a summary of the main implications for the throw for accuracy in terms of the research aim for this study:

- The throwing action is often employed to hit a target whilst participating in recreational and sporting activities and consequently assessing the throw for accuracy in children is warranted.

- Perceptual-motor skills such as depth perception, perception of movement and visual acuity are variables which can affect accuracy (Wickstrom, 1983: 102; Williams, 1983:108-114).

- Literature findings indicate that females tend to be outperformed by males when throwing for accuracy is concerned (Jardine & Martin, 1983:311-399; Kalaja, 2012).

- The overall proficiency of throw for accuracy performance in children is difficult to depict as empirical research findings employ different assessment protocols.
3.4 CONCLUSION

The literature review of this study was divided into 2 sections for organisational purposes and ease of reading. That is a chapter 2 and 3 where dedicated to communicating the theoretical and empirical research underpinning this study’s aims and objectives. Within this chapter 3 the focus was on the assessment techniques available to evaluate FMS acquisition in terms of the literature governing how FMS transpire and the strengths and weakness of each FMS assessment technique. Hereafter each FMS under investigation for the purposes of this review was deliberated. Due to the large volume of work covered in chapter 3, each section depicting the main findings in terms of the run for speed, the standing long jump, throwing for distance, catch, static balancing and throwing for accuracy are conversed in summary and implication sections. Consequently the main summary and implications of this chapter can be reviewed within each section deliberating the FMS under investigation. However, in conclusion it can be stated that each FMS has:

- Unique BC variables which necessitate addressing in order for a mature movement pattern to transpire.
- The testing protocols are varied and result in study comparison difficulties.
- There is a lack of FMS process and product normative data on a representative sample of the South African population, resulting in study comparison difficulties.

Lastly Female learners can perform certain FMS better than others indicating the possible role of cultural sporting norms.

Chapter 2 and 3 have hence provided the theoretical and empirical underpinning of this study. In order to put these theoretical and empirical finding implications into practice, chapter 4 depicts the methods and procedures employed to meet the primary aim of this study.
CHAPTER 4: RESEARCH METHODS AND PROCEDURES

4.1 INTRODUCTION

In order to produce credible results the research methodology and procedures must be conducted in a standardized, non-biased, reliable and valid manner. This chapter provides a detailed description of the methods and procedures employed to meet these aforementioned criteria, taking into account the limitations imposed and the scope of this study. The research design, the population under investigation, sampling methods employed, the testing environment in which data collection took place, and the quantitative and qualitative data collection assessment tools and procedures utilized are discussed in this chapter. The final sections of this chapter discuss the statistical analysis employed and the steps taken to ensure for standardization. Lastly the relevant ethical considerations are conveyed.

4.2 RESEARCH DESIGN

A descriptive-exploratory-contextual cross-sectional study design, employing quantitative assessment techniques, was utilized in this study.

Descriptive research is the study of a current status or a snapshot of elements at a given point in time (Hair, Babin, Money & Samoeul, 2003:419). Descriptive research employs objective research and thorough reports to solve problems (Thomas, Nelson & Silverman, 2005:261). Surveys are the most common descriptive research methods employed and consist of questionnaires and or interviews (Greig, Taylor & MacKay, 2007:128). Surveys seek to evaluate present practices or situations, individual characteristics or opinions of specified populations and assist in identifying relationships (McBurney & White, 2007:215). The design of the present study was thought to be most fitting as the primary aim was to identify the status of FMS in 9, 10, 11 and 12 year olds and then to compare these age groups with one another. Additionally information pertaining to SES, PA level, anatomical variables and demographic factors were collected with the aim of determining their relationship with the FMS proficiency levels, one of the main objectives of this study. The fact
that objective performance tests and structured observations and questionnaires were used to collect data for this study (details of which are presented later in this chapter) is justification for its descriptive nature.

According to Hair et al. (2003:57) an exploratory design is one that is useful when the decision maker has very little information. The status of FMS proficiency in South African children is not well documented and therefore necessitates exploration and further investigation.

The contextual study design refers to children being part of a system that consists of role models such as families, teachers and friends and different settings such as a home, play park, school and neighbourhood. According to Greig et al. (2007:38) the environment a child is exposed to consists of a microsystem, mesosystem, exosystem and macrosystem. The microsystem is the immediate environment or setting (physical space, activity or presence of people), the mesosystem is the relationship between settings (school, home, playground), the exosystem is a system without the child but which influences his or her life (social networks and employment) and the macrosystem refers to the culture and subcultures (neighbourhood, ethnicity and the presence or absence of poverty) (Greig et al., 2007:38). As mentioned in chapters 1 and 2 of this study, Newell (1986, 1991) stated that FMS proficiency attainment is a multi-dimensional process that is affected by personal, task and environmental constraints. In terms of the current South African environmental context the history of the poor implementation of physical education into schools (van Deventer, 2004, 2009, 2012), poor employment and education rates (especially within the Eastern Cape (Makiwane & Dan, 2011) and the patriarchal society, sporting gender stereotypes and consequently cultural norms (Mchunu & Le Roux, 2005; Shehu, 2010; Cornelison & Grundlingh, 2012) which have prevailed throughout history; these environmental variables should be consider as each may have affected the participants under investigation. As previously disadvantaged schools and female learners where made the focus of this study, certain environmental influences may be unique to this group of participants when compared to others. Through examining these variables and by taking into consideration Newell’s constraint theory (Newell, 1986, 1991), Greig’s et al. (2007)
environmental systems and the dynamic systems theory (Thelen, 2000) there is justification for the claims that this study is contextualised.

The quantitative measures employed in this study consisted of both process and product scores. According to Malina et al. (2004:197) and Williams (1983:210) when assessing the process of a movement pattern, specific body mechanical elements are assessed for their movement proficiency levels and ranking scales are used to quantify the qualitative aspects of the movement. When assessing the product scores of a movement the distance a child can jump, how fast child can run and how long a child can balance are investigated. Hence through investigating both the product and process scores of the FMS under investigation the effect of growth, maturation and development and the effects of motor learning could be taken into consideration.

4.3. POPULATION AND SAMPLING

4.3.1 Population

Based on literature findings indicating that children from lower SES communities tend to possess poorer FMS (Okely & Booth, 2004:358-372; SPAN, 2004; Półtorak, 2009:35-45) and based on the fact that female learners tend to be outperformed by their male counterparts in FMS (Thomas & French, 1985; Roberton & Konczak: 2001:102; Teixeira & Gasparetto, 2002; Booth & Okely, 2004:269; Barnett, et al., 2008, 2137–2144), the focus of this study was placed on female learners from previously disadvantaged communities. Furthermore, as the proposed learning time frame for FMS is between the ages of 2-to-7 years (Gallahue & Cleland-Donnelly, 2003:62) and within the South African context equates to optimising motor learning in the foundation phase (Foundation Phase Curriculum, 2012), the age group investigated was 9-to-12 year olds. More specifically, to take into account Newell’s constraint theory (Newell, 1986, 1991) and the dynamic systems theory (Thelen, 2000; Bakhtiar, 2013) which states that the environment, personal and task constraints together with an optimised learning environment are necessitated for motor learning; through investigating 9-to-12 year olds it can be deliberated as to whether these variables were optimised in the foundation phase years and provide in
site into the possible need for interventions. Lastly children from the Mass Participation program were the focus of this study (Mass Participation program, 2010). By including schools from the Mass Participation program, this study could serve as baseline data to measure the impact of the intervention in the future. Additionally, as it was believed that the program catered to children’s movement capacity development, these schools were included to identify whether such a program affected the FMS proficiency of girls under investigation.

To minimize the bias in selection and to ensure that the sample was representative of the population under investigation, the participants had to meet the following inclusion criteria:

- Be free from disability.
- Attend a school within the selected clusters from the Nelson Mandela Metropolitan District.
- Be classified as low SES.
- Be between 9- to-12 years old.
- Participated in the Mass Participation Programme.
- Female learners.

The selected schools had to meet the following criteria:

- Be classified as a quintile 3 or less category school.
- Participating in the Mass Participation Programme.
- Be from formally disadvantage community.

4.3.2 Sample Size and Sampling Technique

Randomized sampling is an unbiased sampling technique that ensures each variable has an equal chance of being selected for the research at hand (de Vos Strydom, Fouché & Delport, 2005:202). It is considered as the gold standard when selecting a sample. According to de Vos et al. (2005:202) convenience sampling is the selection of participants based on accessibility and practicality. Due to accessibility difficulties, convenience sampling was employed in respect of the schools selected for this study and hence is an identified limitation of this research study. Consequently the findings
are limited to the girls’ from the suburbs selected and are not necessarily representative of the larger South African population.

A total number of 250 participants from three schools from previously disadvantaged areas that met the specified inclusion criteria participated. Of the original 250, 23 girls did not complete all the tests and measurements as they were absent on day 1 or 2 of data collection and hence their results had to be omitted. Consequently a total of 227 participants’ data was accounted for in the statistical analysis. Table 8 identifies the number of girls from each age cohort.

Table 8: Number of participants within each age cohort

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>48</td>
<td>21%</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>26%</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>31%</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>21%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>227</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

According to Cournoyer and Klein (2000:120,141) the eventual size of the sample will be determined by the heterogeneity of the population (the more homogenous a population, the smaller the sample size needs to be), the desired degree of accuracy (larger samples are more accurate) and the type of sample. The type of sample is dependent on the study under investigation, the available resources, and the number of variables in the data to be analysed. As convenience sampling was employed and the study sample was limited by the number of participants in each age group from each school, the overall goal was to ensure that each age group contained at least 30 participants, which is in accordance with Cournoyer and Klein’s (2000:143) recommendations to allow for statistical analysis.

Hence, taking into account the aforementioned empirical and theoretical research, the focus of this study was on the FMS proficiency status of girls aged 9-to-12 years from previously disadvantaged communities within the Nelson Mandela Bay District.
4.4 MEASURING INSTRUMENTS

In order to achieve the aim and objectives of this study; FMS such as the run for speed, standing long jump, throw for distance, catch, balance and throw for accuracy were investigated. In the following section, each of the aforementioned FMS will be discussed in terms of the purpose of the test, equipment employed, space requirements, set-up specifications, procedure each participant had to follow, how each test was scored and the validity and reliability of the test. The first section will discuss the data collection of the FMS under investigation in terms of the quantitative-product scores. A discussion on the data collection procedures for the qualitative-process scores will follow. Subsequently a discussion on the data collected for the purposes of providing supporting facts to interpret the findings for the primary research question posed are discussed. More specifically the demographic information; anthropometric variables such as standing and seated height, weight and arm span will be discussed in more detail.
4.4.1 Fundamental Movement Skills: Quantitative Assessment

Before discussing the quantitative process scores it is deemed important to establish the methods and procedures of the field tests employed to measure both the quantitative product and process scores. Hence, although the quantitative process scores are discussed first in sections to come due to the manner in which the objectives have been set in order to meet the primary aim of this study, chapter 4 commences with the quantitative methods and procedures and is followed by the quantitative process evaluation of the FMS under investigation.

Even though laboratory tests and the use of advanced and endorsed testing equipment yield the most valid results, according to Tomkinson and Olds (2008:109) ‘properly conducted field tests offer a simple, feasible, practical, reasonably valid, and reliable alternative’. However the authors warn against the disadvantages of field tests which are conducted in adverse environmental conditions and the effect of practice, motivation, clothing, field surfaces, pre-test instructions and the purpose and context of testing. Although the present study made use of field tests, the potential negative effects of field testing were accounted for as far as possible in the testing environment and during the testing procedures.

The following section discusses each FMS under investigation in terms of the purpose of the test and the equipment, space, set-up and scoring requirements to adequately implement the testing procedures and the validity and reliability thereof.
4.4.1.1 Run for speed

4.4.1.1.1 Purpose

The purpose of the run for speed was to identify the 20m and 40m running speed time of each participant and to assess the qualitative aspect of each participant’s running form via video analysis (details pertaining to the latter to be discussed separately under section 4.4.2).

4.4.1.1.2 Equipment

The equipment needed for the run for speed was:
- 12 cones.
- 2x50m fiberglass measuring tapes.
- 1x20m fiberglass measuring tape.
- 4 sets of Brower System photocells and a handheld timer (refer to addendum 2 for details).
- Black spray to mark off starting point.
- Tent pegs to fastened measuring tape to ground.
- Video camera (refer to subheading 4.4.4 to obtain information on the camera used and the video analysis employed).

4.4.1.1.3 Space requirements

Each school ground was assessed for the following requirements before set-up:
- 50m by 18m space on a flat, hazard free surface to allow for adequate set-up and safety of participants.
- To allow for sufficient video analysis the background to the running area had to be free from participants, cars or moving objects in order to ensure a clear background for the camera’s view of the running subject. The respective school had to ensure for the control of their pupils during break times or when relevant during testing.
4.4.1.1.4 Set-up

Figure 8 depicts the set-up employed for the run for speed. As can be noted, cones were placed to demarcate the start, 20m, 40m and 50m points where the Brower system photocells and tripods were placed. Additionally, the start and the camera placement are illustrated.

Figure 8: Depicts the run for speed set-up.

The following dimensions were established:
- The Brower System photocells were set-up at the starting, 20m and 40m points through setting up 2x50m fiberglass measuring tapes parallel to one another and securing them with tent pegs. The 50m photocell pair was set-up as dummies.
- The perpendicular distance between the photocells was 1.5m.
- The camera was set-up 7.5m perpendicular from the 20m mark.
The following tripod and camera dimensions were used consistently (refer to subheading 4.4.4 to obtain information on the camera used and the video analysis employed):

- The tripod legs were retracted and fully extended.
- The height from the floor to bottom of lens was 1.2m.
- The camera was placed 7.5m perpendicular to the run for speed 20m mark.
- The view within camera screen was 3m on either side of 20m mark. Cones were placed on the ground to ascertain that the camera set-up was correct as this allowed the researcher to view 4-to-6 running strides within the camera view. The cones were then removed during the run for speed assessments.

### 4.4.1.1.5 Procedure

The run for speed procedure followed those set by the Australian Sport Commission (1995b). The following course of events unfolded:

- Before the sprint each participant had to stand for a snapshot of their face and identification number.
- Each participant was requested to commence the run with a standing stance, one foot in front of the other.
- Once the tester said go each participant had to run for speed as fast as they could.
- Each girl was expected to complete a 50m maximal run for speed 3 times. The first trial was a practice round and the latter 2 trial times were recorded. Only the fastest 40m time was used for analyses. The 3rd trial was video recorded for the qualitative analysis. These run for speed trials were executed consecutively, with a 3 minute rest between trials.
4.4.1.6 Scoring

The quantitative-product assessment scores were from the participants fastest run, which was obtained from the 2 recorded trials of the 3 running for speed trials (the first trial was a practice trial). The run for speed score was recorded to the nearest millisecond.

The qualitative-process assessment score for the run for speed was obtained via assessing the video footage obtained from the last recorded running for speed trial. It was analysed using dartfish (Dartfish, 2012) and the BC and TGMD II assessment protocol depicted in addendum 3 (the qualitative assessments are discussed in section 4.4.2).

4.4.1.7 Validity and reliability

The face validity of the running for speed 40m assessment has been found (Australian Sport Commission, 1995b; Armstrong & van Mechelen, 2007:118).

As no reliability values for the Brower System could be found in the literature, to assess the reliability thereof the Brower System (Brower System, 2010) was compared to the Smartspeed Timing Gate System (Fusion Sports, 2012). According to the developers of the Smartspeed system the reliability of the Smartspeed Timing Gate System has been tested and found to be adequate.

The protocol used to assess for reliability can be depicted in addendum 4. The Pearson Correlation Coefficient between the run for speed results from the Brower and Smartspeed Systems was found to be \( r=0.99 \). Hence based on these results, the timing of the Bower system was deemed to be reliable.
4.4.1.2 Standing long jump

4.4.1.2.1 Purpose

The purpose of the jump for distance test was to assess the quantitative-product and qualitative-process assessment score (details of the latter will be provided later in section 4.4.2) of each participant.

4.4.1.2.2 Equipment

The following equipment was employed during the jump for distance assessment:
- 10m fiberglass measuring tape.
- Black spray can to mark off starting point.
- 6 tent pegs to fastened measuring tape to ground.
- T-shaped measuring device to line up the jump distance perpendicularly with the measuring tape.
- A large right angled triangle to ensure that each measurement perpendicularly flush with the back of the participants ankles and the measuring tape.

4.4.1.2.3 Space requirements

The space requirement for the standing long jump was a flat surface measuring 6m by 4m squared.
4.4.1.2.4 Set-up

Figure 9 depicts the set-up employed for the standing long jump. As can be noted, a 2m measuring tape was secured to the ground with tent pegs and placed perpendicular to the starting line (which was 1m in length and put in place with black spray). At the 1.5m mark of the measuring tape the camera was set-up 5.5m perpendicularly to the measuring tape. The accuracy of the set-up was ensured for by using a right angled triangle.

As can be noted in figure 9, the T-shape measuring device was placed perpendicular to the measuring tape after an individual jump and the right angled triangle was used to ensure that the measurement was flush with the ankles of the participant and the measure obtained.

Figure 9: Standing long jump set-up

Figure 9 above illustrates the standing long jump set-up employed consistently:
- Camera set-up 5.5m perpendicular to the measuring tape’s 1.5m mark from starting point where the participant executed the two-footed standing long jump from.
- Measuring tape set up perpendicularly to starting point.

The following camera dimensions were used consistently:
- Fully extended tripod legs.
- Height from floor to bottom of lens was 1.2m.
- At the 1.5m point on the measuring tape, the camera was placed 5.5m perpendicularly to the measuring tape.

4.4.1.2.5 Procedure

The Eurofit standing long jump protocol was employed for the purpose of this study (Eurofit, 1993):
- Before each standing long jump attempt each participant had to stand for a snapshot of their face and identification number in front of the camera.
- Each participant was requested to stand with their feet shoulder width apart behind the starting line.
- Once the instructor said ‘jump as far as you can’, each participant had to perform a maximal 2 legged standing long jump.
- Each participant received 1 practice trial and 2 standing long jump attempts.
4.4.1.2.6 Scoring

Each participant was allowed 3 standing long jump attempts. The first standing long jump was to provide each participant with a practice trial. From the 2nd and 3rd attempt where documented and the furthest distance was recorded for analysis purposes. Each standing long jump score was measured to the nearest millimetre.

The furthest jump’s video footage was analysed with dartfish (Dartfish, 2012) using the BC and TGMD II approach depicted in addendum 5 in order to obtain a qualitative-process score.

4.4.1.2.7 Validity and reliability

The validity and reliability of the standing long jump has been accepted (Armstrong & van Mechelen, 2007:115).

4.4.1.3 Throw for distance

4.4.1.3.1 Purpose

The purpose of the throw for distance test protocol was to gain video footage on the quantitative-product (distance achieved in meters) and qualitative-process scores (to be discussed in section 4.4.2) of each participant.

4.4.1.3.2 Equipment

The following equipment was employed during the throw for distance protocol:
- 10 cones.
- 1 camera.
- 2x 50m measuring tape.
- 3 cricket balls (circumference measuring 22.90cm and weighing in at 156g)
- A pre-construct measuring 90 degree triangular shaped rope which extended outwards 10m in either direction.
- Right angled triangle.

4.4.1.3.3 *Space requirements*

The space requirement was a 50m by 10m demarcated area, which was flat and hazard free.

4.4.1.3.4 *Set-up*

The throw for distance set-up can be viewed in figure 10. A right angled triangular set-up which was 15m in length on either side of the right angled triangles apex was put in place. A demarcated area using a perpendicular vertical rope 1m in distance from the apex of the triangle was used to establish where participants had to stand before throwing for distance.

As can be noted, cones were placed on the ground to demarcate where each participant should stand for their snapshot. Additionally, these cones were used to identify the view within the camera screen. Lastly the cones were use highlight the area in which participants were allowed to throw.

The following illustrates the camera dimensions constantly employed for the throw for distance set-up:

- Fully extended tripod legs.
- Height from floor to bottom of lens was 1.2m.
- The camera was 5.5m from the mid-point of the triangle set-up.
- The bottom view from within camera screen was 1.9m from mid-point of triangle set-up (cone 2).
- The left margin of the view from within the camera was 2m from mid-point to outer edge (cone 3).
- The right margin of the view from within the camera was 15m’s from the apex of the right end of the right angled triangle (cone 4).
- Each participant had to be positioned below the ‘standpoint’ on the camera screen whilst throwing for distance.
Figure 10: Throw for distance set-up
4.4.1.3.5 Procedure

The throw for distance protocol employed followed the Australian Sports Commission’s protocol (1995b). The following procedure was employed:
- Before each throw for distance each participant had to stand for a snapshot in front of the camera.
- After the snapshot, each participant had 2 practice rounds and 3 attempts to throw the cricket ball as far as they could within the designated area.

4.4.1.3.6 Scoring

Each participant was allowed 2 practice trials and 3 throw for distance attempts. All 3 trials were recorded and the furthest distance (to the nearest cm) was recorded for analysis purposes.

The furthest throw for distance video footage was analysed with dartfish (Dartfish, 2012) using the BC and TGMD II approach depicted in addendum 6 in order to obtain a qualitative-process score.

4.4.1.3.7 Validity and reliability

The face validity of the throw for distance test has been accepted (Austrian Sport Commission, 1995b).
4.4.1.4. Catch

4.4.1.4.1 Purpose

The purpose of the catch test protocol was to gain video footage on the qualitative-process catching proficiency level ability (to be discussed in section 4.4.2) of each participant.

4.4.1.4.2 Equipment

The following equipment was employed during the catch protocol:

- 10 cones
- 1 camera
- 10m measuring tape
- 5x size 3 mini netball balls (circumference of 58.42cm and weighing less than 311.84g)
- Ladder
- Masking tape
- Right angled triangle

4.4.1.4.3 Space requirements

The space requirement for the catch set-up was as follows:

- A wall that was 3m tall, 3m wide and level.
- A space 6m by 6 m from the midpoint of the wall.
4.4.1.4.4 Set-up

As is depicted in figure 11, masking tape was used to demarcate the 0.2m area which was 2.4m’s above the base of the wall. This 0.2m area was demarcated horizontally using masking tape spanning 2m’s across. Participants had to hit the ball in this 0.2m area in order to catch the overhead rebound.

From the midpoint of the wall the camera was set-up 4.6m to the left. From the base of the wall a 2m area was demarcated 3m’s from the wall. Participants had to stand behind this 2m demarcated area 3m’s from the base of the wall before throwing the ball underhand to the demarcated 0.2m area on the wall.

Figure 11: Depicts the catch set-up employed
The catch set-up was employed consistently to identify the qualitative-process catching ability of each participant:

- The camera was set-up 4.6m from the mid-point of the wall.

- Each participant stood for a snapshot at cone 1, which was diagonally 2m from the camera lens.

- Each participant stood 3m’s away from the wall. Within the camera screen shot the participant would have stood under the ‘standpoint’ on the camera screen.

The following camera dimensions were employed consistently:

- Fully extended tripod legs.

- Height from floor to bottom of lens was 1.2m.

- The camera was placed 4.6m from the mid-point of wall.

- Each participant was requested to take a photo of their number by standing at the 2m cone (cone 1).

- The bottom view of the camera was 3.8m in front of the mid-point of the camera lens and was in line with the ‘standpoint’ on the camera screen (cone 2).

- View from within camera screen was 3.34m from mid-point of 2.4m line (cone 3). This was the right outer edge view of the camera.
4.4.1.4.5 Procedure

The catch procedure employed was the underarm-throw-catch test as indicated by the M-ABC for children aged 7-to-9 years (Van Waelvelde et al., 2004:57). The following was implemented:
- Before the participants commenced each had to stand for a snapshot in front of the camera.
- Succeeding the 2 practice underarm-throw-catch attempts each participant and 5 underarm-throw-catch attempts to successfully catch the ball.
- The 5 underarm-throw-catch attempts were video recorded and the number of successful catches documented.

4.4.1.4.6 Scoring

No score was awarded for the catch test. Only the number of successful catches was recorded.

A catch was deemed successful when the participant caught the ball with 2 hands. The successful catches were assessed via dartfish (Dartfish, 2012) and employing the catch BC and TGMD II assessment protocols as depicted in addendum 7 to obtain the qualitative-process score.

4.4.1.4.7 Validity and reliability

Face validity of throw-catch sequence has been accepted (Katzenellenbogen, 1976:48).

The throw-catch sequence concurrent validity was additionally compared to the video-recorded benchmark test of catching 80 balls in varied situations with the use of a tennis ball machine in children aged 7-to-9 years (Van Waelvelde et al., 2004:57). A significant but low correlation was found between the gold standard test and the throw-catch test for the 9 year old children. The primary constraint identified was that the throw-catch test additionally assessed a child’s ability to throw
underarm at a target accurately. However, as each child was provided 5 attempts the opportunity to catch was increased.

4.4.1.5 Throw for accuracy

4.4.1.5.1 Purpose

The throw for accuracy was employed to assess each participant’s ability to hit a target from a distance of 2m and 4m.

4.4.1.5.2 Equipment

No camera set-up was necessary for the throwing for accuracy station.

The following equipment was employed throughout the data collection process:
- Pre-created black 1m in diameter circle with a smaller 0.5m diameter white circle within.
- 10m measuring tape.
- Right angled triangle.
- Duck-tape.
- Masking tape.

4.4.1.5.3 Space requirements

The following were the space requirements:
- A wall that was 3m tall, 3m wide and level.
- A space of 5m from the midpoint of the wall.
4.4.1.5.4 Set-up

Figure 12 illustrates the throw-for-accuracy set-up employed consistently throughout the data collection process:
- The black 1m diameter circle with a smaller 0.5m diameter white circle within was placed 1.5m above the ground on the wall. This was placed on the wall with duck tape.
- No camera set-up was employed for the throw for accuracy.
- 2m and 4m’s from the midpoint of the wall 2m perpendicular lines were drawn with masking tape.

Figure 12 illustrates the throw-for-accuracy set-up consistently employed throughout the data collection procedure.
4.4.1.5.5 Procedure

The throw for accuracy protocol was based on Katzenellenbogen’s (1983) throw for accuracy assessment protocol. The following procedure was followed:

- Each participant had to stand behind the 2m or 4m line and wait for the instructor to call their names and give them the ball and say ‘go’ before attempting the throw towards the white circular target as depicted in figure 12.
- Each participant had 2 practice rounds and 3 attempts at the 2m and then the 4m mark to hit the white target.

4.4.1.5.6 Scoring

When the participant hit the middle white circle a score of 3 points was awarded. When the participant hit the black circle a score of 2 points was awarded. When the participant hit the wall a score of 1 point was awarded.

4.4.1.5.7 Validity and reliability

The face validity of the throw for accuracy has been established (Katzenellenbogen, 1983).
4.4.1.6 Balance

4.4.1.6.1 Purpose

The stalk-stand test was employed to assess the static balance capacity of each participant.

4.4.1.6.2 Equipment

No camera set-up was necessary for the stalk-stand balance station. Only a balance beam with the following dimensions was employed:

- A metal beam 50cm long, 4cm high and 3cm wide.
- 2 supports were placed at each ends of the beam to provide stability.

4.4.1.6.3 Space requirements

A 1m by 1m flat terrain surface area was the space requirements for the balance test.

4.4.1.6.4 Set-up

Figure 13 identifies the set-up employed throughout the testing procedure. Participants stood on a metal beam 50cm long, 4cm high and 3cm wide with no shoes for 60 seconds.

Figure 13: Stork-stand employed to assess the balance
4.4.1.6.5 Procedure

The protocol used to assess balance was the one described by the Council of Europe (Committee of Development of Sport, 1988).

The following procedure was followed consistently:
- The participant was requested to stand on the long axis of the beam with shoes removed.
- The tester placed herself in front of the participant and supported the participant onto the beam.
- While balancing on the preferred leg, the free leg was flexed at the knee and the foot of this leg was held at the popliteal fossa (standing like a flamingo).
- The test was carried out after one practice trial, which was 15 seconds in duration.
- The stopwatch was started when the participant released the tester’s supporting arm.
- The stopwatch was stopped as soon as the participant lost balance by releasing the free leg from the popliteal fossa or when touching the floor with any part of the body.
- After each fall the participant was helped into the correct starting position.
- The maximum amount of time spent on the beam was 60 seconds.

4.4.1.6.6 Scoring

An error was scored as the number of attempts and falls needed to keep in balance on the beam for 60 seconds. For example should a participant require 5 attempts to keep in balance before the 60 seconds expended, the score was recorded as 5. A fall or deviation of the foot from the popliteal fossa was deemed as an error.

4.4.1.6.7 Validity and reliability

Face validity of this test has been accepted (Council of Europe, Committee of Development of Sport, 1988).
4.4.2 Fundamental Movement Skills: Qualitative Assessment

To assess the movement ability of participants a ranking system and a criterion based FMS assessment protocol was employed. The ranking FMS assessment protocol employed was the BC approach which ranks FMS proficiency into an initial, elementary and mature level of proficiency (McClenaghan & Gallahue, 1978:68; Corbin, 1980; Wickstrom, 1983; Horita, 2008:49-60; Haywood & Getchell, 2009:119-181). Additionally, the mature ranking of the BC approach, which was defined as achieving 80% of all BC variables assessed, was utilized to provide the percentage of participants who placed into a mature level of proficiency (McClenaghan & Gallahue, 1978; O’Conner, 2000:12-13). Through employing the BC approach it allowed for the identification of inter-individual differences, individualized feedback and hence a more composite measure of a participants’ FMS ability (Roberton & Konczak, 2001:91-103). Wickstrom (1983:10-11), Burton and Miller (1998:220) and O’Conner (2000:204) stated that the BC approach, although adequate to assess FMS proficiency, should be used with caution as there is a lack of longitudinal studies to support the validity of the templates.

In accordance with the BC approach, the criterion referenced cut-off employed was the TGMD II (Ulrich, 2000). Consequently, even though the BC approach is a more sensitive assessment technique as it can detect minor changes in BC variable, for the purposes of this study the TGMD II was employed as a secondary assessment tool to assist in comparing the present study results to those of other studies which used the same mastery and near mastery cut-off assessment protocols (Booth et al., 1999; van Beurden et al., 2002; Okely & Booth, 2004; SPAN, 2004:98; Pang & Fong, 2009; SPAN, 2010:168-201; Hardy et al., 2012).

The following sections will discuss the BC and TGMD II approach in terms of how each assessment tool was employed to calculate the FMS proficiency levels of the participants under investigation and subsequently how participants were scored for each FMS using both FMS assessment protocols.
4.4.2.1 Body component approach

4.4.2.1.1 Category Scores

As mentioned, the BC approach divided FMS proficiency scores into an Initial, elementary or advance level of proficiency. Literature has illustrated that as children develop motor skills in a predictable manner, motor skill ability develops from an immature to a mature movement pattern with aging (Wickstrom, 1983:106-109; Roberton & Konczak, 2001:92; Malina, 2003:54; Gallahue, 2004:17). Consequently each participant could be placed into a stage based on their qualitative assessment score.

An Initial movement stage was defined as the inability to prepare and follow through with an efficient movement to achieve the task at hand. The basis of the initial movement stage was in accordance with McClenaghan and Gallahue, (1978:68). Consequently if a participant seemed uncoordinated, restricted in their degrees of freedom, variable in their performance, and there was a general absence of a mature movement pattern, the participant was awarded a score of 1. The movement sequences criterion employed to place the participant into an initial movement stage was based on literature findings (details of which are provided later in this chapter).

The elementary movement stage assessment criterion was furthermore in accordance with McClenaghan and Gallahue (1978:68). Participants were placed into this category when their movements were characterized by less variability of performance and a general lack of the most efficient movement pattern. More specifically, even though more mature BC variables were present, the movements employed were mostly sub-optimal. In the present study a participant was awarded a score of 2 for movements which characterised an elementary movement stage. The movement sequences criterion employed which participants where compared to was based on literature findings (details of which are provided later in this chapter).
A mature movement stage was deemed as achieving motor skill mastery in the FMS under investigation. That is mature or advance level of proficiency was defined as achieving 80% or more of the FMS BC variables being assessed (O’Conner, 2000:12-13).

Lastly, an overall BC composite mean and SD score was awarded based on all participants performance of the FMS under investigation.

4.4.2.1.2 Overall body component composite score

The overall level of proficiency for the FMS under investigation was calculated by summing each BC variable value within the BC approach for the respective FMS. A score of 80% and above was considered as mastery of the FMS under investigation (O’Conner, 2000:12-13). For example, as each FMS BC variable was divided into an initial, elementary and mature level of proficiency with each qualitative score receiving a 1, 2 or 3 respectively. If there were 6 BC variables to assess then the overall BC composite score awarded could be 18 (6 BC variables*3) and a proficiency score of 100% (18/18 *100=100%) would be awarded if the participant was to be placed in a mature level for all BC variables assessed. If, for example, a participant scored a total of 12 out of 18 (6 BC variables assessed and the participant scored 2 for each BC variable assessed) then the participant would have scored 66% (12/18*100) and consequently the participant would not have been considered as proficient as a score of 80% and more was not attained in order to be placed into a mature level of proficiency. Each BC assessment protocol is depicted in addendums 3, 5, 6 and 7.

4.4.2.2. Test of gross motor development II

The TGMD II is a criterion referenced assessment protocol and hence a participant’s qualitative assessment score was either scored as a 1 or a zero. Each FMS was assessed according to 4-to-6 component parts. If the participant did not meet the criterion set by the TGMD II then a score of zero was awarded. For example, during the run for speed a participants arms should be bent at 90 degrees to be awarded a score of 1. If the participant ran with straight arms then a score of zero was awarded.
In studies which have employed the TGMD II assessment protocol a mature movement stage was deemed as possessing all BC variables of the assessment criteria (Okely & Booth, 2004:358-372; Hume et al., 2008:158-165; Barnett et al., 2008:5-40; Cliff et al., 2009:436-449). This classification deemed most children at a poor FMS proficiency level. Consequently a new category called 'near mastery' was created. Near mastery was defined as possessing all component parts except one.

The validity and reliability of the TGMD II approach has been assessed and found to be adequate (Ulrich, 2000). It should be noted that the TGMD II is a FMS assessment battery which sums 12 FMS scores into locomotor and non-locomotor composite scores to produce a final percentile ranking in terms of the original sample of USA children aged 4-to-10 years used to determine these norms. For the purposes of this study only selected FMS criterion cut-off BC variables were utilized and consequently an overall percentile ranking and comparison to the USA criterion norms was not possible.

The conversion from the BC approach into the TGMD II criterion cut-offs will be explained in more detail in the following section.

**4.4.2.3 Converting the BC approach into the TGMD II**

During the literature review it was noted that most studies reported their results with a near mastery and mastery level and or employing the TGMD II approach. As the present study’s assessment primarily focused on employing the BC approach it was deemed necessary to convert the BC approach scores into the TGMD II for further comparative purposes (refer to addendum 8 which summaries the BC and TGMD II FMS proficiency scoring methods).

In order to convert the BC approach (which comprised of 3 scores- initial, elementary and mature) to that of the TGMD II (which comprised of 2 scores), participants who were scored at a level 1 or 2 (initial and elementary level of proficiency) in the BC approach received a score of zero in the TGMD II assessment protocol (that is, the participant would have been deemed as performing the BC variable at a non-proficient level according to the TGMD II approach). When participants scored a 3 in
the BC approach, a score of 1 in the TGMD II assessment protocol was awarded (as this participant would have been deemed as proficient in the BC variable according to the TGMD II). These aforementioned mark allocations were, however, based on the respective FMS BC and TGMD II BC variables being assessed and their qualitative definition of the movement under investigation. It is hence deemed necessary to discuss each FMS under investigation in more depth. However, before discussing the conversion it is important to identify how the results for the BC approach and TGMD II were reported.

4.4.2.4 Reporting results

The FMS proficiency overall scores were reported in percentage terms for both the BC and TGMD II approach. More specifically, the number of participants scoring within the mature category for each respective assessment protocol was identified and subsequently the percentage of participants deemed proficient reported. As most studies have reported FMS in terms of the percentage of participant rated as proficient (near mastery or mastery score in the TGMD II), a similar report format was employed for comparative purposes in this study. Figure 14 provides an example of how the standing long jump was reported.

![Bar chart showing percentage scores](chart.png)

Figure 14: Example of how percentage scores were reported for the BC and TGMD approach
This was followed by a summary of each BC approaches variable’s mean and standard deviation (SD) rating. Figure 15 provides an example of how the standing long jump’s BC approach’s BC variables were reported.

![Bar chart showing BC variables with their respective scores and standard deviations.](chart.png)

Figure 15: Example of how the BC approaches BC variables were reported

As noted in the previous section. A score of 1 indicated an initial level of proficiency, a score of 2 indicated an elementary level of proficiency and a score of 3 indicated a mature level of proficiency.

Hereafter the BC variables (as depicted in figure 15 above) were collated and an overall mean and SD BC composite score was awarded for the participants under investigation.
4.4.3 Fundamental Movement Skills: BC Approach and TGMD II Qualitative Assessment

In order to understand how the BC and TGMD II results were established, the following section explains each conversion from the BC approach scores to that of the TGMD II. Addendum 8 provides a graphical depiction of how the BC and TGMD II were scored. It is furthermore recommended that whilst analysing the conversions that attention be placed on addendums 3, 5, 6 and 7 which depicts the run for speed, standing long jump, throw for distance and catch BC proficiency assessment protocols respectively.

4.4.3.1 Run for speed

Given the information provided by other authors, Horita (2008:49) created a template for the run for speed which was further adapted and can be viewed in addendum 3. Horita’s BC approach for the run for speed (2008:49) was similar to literature findings by other researchers (Roberton & Halverson, 1984:78-79; Wickstrom, 1983:47-51; Novacheck, 1997:83; Payne & Isaacs, 1999:260; Haywood & Getchell, 2009:119-120; Dugan & Bhat, 2005:608; Grimshaw et al., 2006:254-260). Authors do indicate that longitudinal research is required to validate the run for speed BC approach but additionally state that it can be used to review movement proficiency in children.

It can be noted that the run for speed had 9 BC variables, each containing 3 stage of movement proficiency (initial, elementary and mature). Hence the total score was out of 27. If a participant achieved a score of 21.6 or above this participant would have been considered proficient at the run for speed as a score of 21.6 out of 27 would be in alignment with the 80% or above composite BC variable score depicted by McClenaghan and Gallahue (1978:68) and O’ Conner (2000:12-13) required to be deemed as a mature level of proficiency.

As mentioned the primary disadvantage of employing the BC approach is that it was difficult to compare results to other studies (as most studies report results in percentage terms). However, by additionally employing the TGMD II, study comparisons could be made. Table 9 illustrates how the BC approach variables were converted into the TGMD II for the run for speed. As previously stated, the TGMD II
scores only view a participants’ movement proficiency as present or not (a score of 1 or zero respectively). The BC approach provides a score of 1, 2 or 3.

In order to understand the conversion it is recommended that the run for speed’s BC approach’s BC variables depicted in addendum 3 be compared to the BC variables assessed in the TGMD II approach (as depicted in table 9 below). Excel was employed to facilitate the conversion of the BC approach to the TGMD II.

Table 9: Converting the run for speed BC approach scores to the TGMD II

<table>
<thead>
<tr>
<th>BC approach BC Variable</th>
<th>TGMD II BC Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight phase: a score of 3.</td>
<td>Brief period where both feet are off the ground.</td>
</tr>
<tr>
<td>Arm/Leg opposition (a score of 2 or 3). In addition to the previous score a participant would have had to score a 1, 2 or 3 in the elbow action.</td>
<td>Arms in opposition to legs, elbows bent.</td>
</tr>
<tr>
<td>Landing foot placement: a score of 2 or 3.</td>
<td>Foot placement near or on line (not flat footed).</td>
</tr>
<tr>
<td>Knee flexion recovery: a score of 3</td>
<td>Non-support leg bent approximately 90 degrees (close to buttocks).</td>
</tr>
</tbody>
</table>

The following explains the conversion from the BC approach to the TGMD II depicted in table 8:

- Scoring a 3 in the BC approach’s ‘flight phase’ resulted in a conversion to a score of 1 in the TGMD II.
- A score of 2 or 3 in the ‘arm/leg opposition’ in addition to a score of 1, 2 or 3 in the ‘elbow action’ resulted in a conversion to a score of 1 in the TGMD II.
- Scoring a 2 or 3 in the ‘landing foot placement’ in the BC approach resulted in a conversion to a score of 1 in the TGMD II.
- Scoring a 3 in the ‘recovery knee flexion’ resulted in a conversion to a score of 1 in the TGMD II.
4.4.3.2 Standing long jump

Horita (2008:49) created a template for the standing long jump which was further adapted and can be viewed in addendum 5. The adapted template was found to be similar to BC approaches depicted in McClenaghan and Gallahue (1978:88-90), Corbin (1980:65), Wickstrom (1983:78-86), Roberton and Halverson (1984: 68-69), Payne and Isaacs (1999:268) and Haywood and Getchell (2009:126). Even though longitudinal studies are required to validate certain body components, studies have proven its validity and reliability.

It can be noted that the standing long jump had 10 BC variables, each containing 3 stage of movement proficiency (initial, elementary and mature). Hence the total score was out of 30. If a participant achieved a score of 24 or above this participant would have been considered proficient at the standing long jump as a score of 24 out of 30 would be in alignment with the 80% or above composite BC variable score depicted by McClenaghan and Gallahue (1978:68) and O’ Conner (2000:12-13) required to be deemed as a mature level of proficiency.

Table 10 illustrates how the BC approach variables were converted into the TGMD II for the standing long jump. The TGMD II scores only viewed a participants’ movement proficiency as present or not (a score of 1 or zero respectively). The BC approach provides a score of 1, 2 or 3.
Table 10: Converting the standing long jump BC approach scores to the TGMD II

<table>
<thead>
<tr>
<th>BC approach BC Variable</th>
<th>TGMD II BC Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparatory crouch a score of 1 to 3 and take-off arm action a score of 3.</td>
<td>Preparatory movement includes flexion of both knees with arms extended behind body.</td>
</tr>
<tr>
<td>Flight arm action: a score of 3.</td>
<td>Arms extend forcefully forward and upward, reaching full extension above head.</td>
</tr>
<tr>
<td>Landing balance: a score of 3.</td>
<td>Take-off and land on both feet simultaneously.</td>
</tr>
<tr>
<td>Landing arm action: a score of 3</td>
<td>Arms brought downward during the landing.</td>
</tr>
</tbody>
</table>

The following explains the conversion from the BC approach to the TGMD II depicted in table 9:

- A score of 1, 2 or 3 in the ‘preparatory crouch’ and a score of 3 in the ‘take-off arm action’ together would have resulted in a score of 1 for the TGMD II BC variable depicted in table 9 alongside the BC approach BC variables.
- A score of 3 for the ‘flight arm action’ for the BC approach would have resulted in a score of 1 for the TGMD II.
- A score of 3 for the ‘landing balance’ for the BC approach would have resulted in a score of 1 for the TGMD II.
- A score of 3 for the ‘landing arm action’ for the BC approach would have resulted in a score of 1 for the TGMD II.
4.4.3.3 Throw for distance


It can be noted that the throw for distance had 6 BC variables, each containing 3 stages of movement proficiency (initial, elementary and mature). Hence the total score that could be attained was out of 18. If a participant achieved a score of 15 or above for the throw for distance this participant would have been considered proficient at the standing long jump as a score of 15 out of 18 would be in alignment with the 80% or above composite BC variable score depicted by McClenaghan and Gallahue (1978:68) and O’ Conner (2000:12-13) required to be deemed as a mature level of proficiency.

Table 11 illustrates how the BC approach variables were converted into the TGMD II for the throw for distance. The TGMD II scores only viewed a participants’ movement proficiency as present or not (a score of 1 or zero respectively). The BC approach provides a score of 1, 2 or 3.

Table 11: Converting the throw for distance BC approach scores to the TGMD II

<table>
<thead>
<tr>
<th>BC approach BC Variable</th>
<th>TGMD II BC Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparatory phase arm action: score a 3.</td>
<td>A downward arc of the throwing arm initiates the windup</td>
</tr>
<tr>
<td>Execution phase trunk action: score a 3.</td>
<td>Rotation of the hip and shoulder to a point where the non-dominant side faces an imaginary target.</td>
</tr>
<tr>
<td>Execution phase leg drive: score a 3.</td>
<td>Weight is transferred by stepping with the foot opposite the throwing hand</td>
</tr>
<tr>
<td>Execution phase arm action: score a 3.</td>
<td>Follow-through beyond ball release diagonally across the body towards side opposite throwing arm.</td>
</tr>
</tbody>
</table>
The following explains the conversion from the BC approach to the TGMD II depicted in table 11:

- A score of 3 in the ‘preparatory phase arm action’ of the throw for distance BC approach would have resulted in a score of 1 for the TGMD II.
- A score of 3 in the ‘execution phase trunk action’ would have resulted in a score of 1 for the TGMD II.
- A score of 3 in the ‘execution phase leg drive’ would have resulted in a score of 1 for the TGMD II.
- A score of 3 in the ‘execution phase arm action’ would have resulted in a score of 1 for the TGMD II.

4.4.3.4 Catch

The catching BC approach employed was adapted from Haubenstricker, Branta, and Seefeldt’s arm action BC variable (1983 In Haywood & Getchell’s, 2009:179) and Strohmeyer, William and Schaub-George’s hand and body action components (1972 In Haywood & Getchell’s, 2009:179). Literature in Mc Glenaghan & Gallahue (1978, 94-95), Wickstrom (1983:145-148), Williams (1983:233) and Roberton & Halverson (1984:134-135) was additionally consulted when creating the BC catch assessment protocols.

As depicted in addendum 7 it can be noted that the catch consisted of 4 BC variables each containing 3 stages of movement proficiency (initial, elementary and mature). Hence the total score that could be awarded for the catch when employing the BC approach was 12. If a participant achieved a score of 10 or above this participant would have been considered proficient in their catching ability as a score of 10 out of 12 would be in alignment with the 80% or above composite BC variable score depicted by O’ Conner (2000:13-14) required to deem a participant at a mature level of proficiency.

Table 12 illustrates how the BC approach variables were converted into the TGMD II for the catch. The TGMD II scores only viewed a participants’ movement proficiency as present or not (a score of 1 or zero respectively). The BC approach provides a score of 1, 2 or 3.
Table 12: Converting the catch BC approach scores to the TGMD II

<table>
<thead>
<tr>
<th>BC approach BC Variable</th>
<th>TGMD II BC Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparatory phase arm action: score a 3.</td>
<td>Preparation phase where elbows are flexed and hands are in front of body.</td>
</tr>
<tr>
<td>Preparatory phase arm action: score a 3.</td>
<td>Arms extend in preparation for ball contact.</td>
</tr>
<tr>
<td>Reception phase hand action: score a 3.</td>
<td>Ball is caught and controlled by hands only.</td>
</tr>
<tr>
<td>Reception phase arm action: score a 3.</td>
<td>Elbows bend to absorb force.</td>
</tr>
</tbody>
</table>

The following explains the conversion from the BC approach to the TGMD II depicted in table 12:

- A score of 3 in the ‘preparatory phase arm action’ of the catch BC approach would have resulted in a score of 1 for the TGMD II as this depicted the TGMD II's BC variable of ‘preparation phase where elbows are flexed and hands are in front of body’.
- A score of 3 in the ‘preparatory phase arm action’ of the catch BC approach would have resulted in a score of 1 for the TGMD II as this depicted the TGMD II's BC variable of ‘arms extend in preparation for ball contact’.
- A score of 3 in the ‘reception phase hand action’ of the catch BC approach would have resulted in a score of 1 for the TGMD II.
- A score of 3 for the ‘reception phase arm action of the catch BC approach would have resulted in a score of 1 for the TGMD II.

The run for speed, standing long jump, throw for distance and catch were all assessed qualitatively in order to get a process score. The process score was obtained through video recording and subsequently video analysing the video footage with dartfish (Dartfish, 2012) and the assessment rubrics for each FMS depicted in addendum 3, 5, 6 and 7 respectively. The video analysis will hence be discussed in more detail in the following section.
4.4.4 Video Analysis

In order to adequately appraise the qualitative components (process scores) of the aforementioned FMS under investigation, a video analysis was employed for data collection purposes. According to Cools et al. (2008:157) the use of video analysis allows for detailed assessment of skills under investigation.

The following variables were considered when employing the video analysis:
- The camera employed to allow for high definition video footage capturing.
- Camera set-up to allow for video footage which could clearly be analysed in dartfish (Dartfish, 2012).
- The procedure employed whilst recording each participant.

A Sony DCR-SR58E digital video recorder was used in the present study. The battery life was 40 to 50 minutes; however, with the use of an external battery the time duration was extended to 8 hours. The camera had liquid crystal display (LCD), allowing for extremely high-precision recording with over 99.9% of the pixels being operational for effective use. Each memory card could record 32 GB of information. Hence through using the Sony DCR-SR58E high quality video footage could be obtained for the dartfish analysis (Dartfish, 2012).

Dartfish is a computer program that allows a researcher to do game and biomechanical frame-by-frame analysis, the primary aim for utilising dartfish was to accurately ‘draw’ in angles and allow for frame-by-frame FMS footage analysis of the FMS under investigation (Dartfish, 2012). Each video camera set-up was depicted in the ‘set-up’ section discussed previously in this chapter (pages 137, 142, 145 and 149 for the run for speed, standing long jump, throw for distance and catching respectively).

The distance and dimensions for the video set-up was furthermore based on the pilot study and adjusted so as to ensure for the best observation when video analysing the FMS with dartfish (Dartfish, 2012). The following was the camera view employed:
- The run for speed was assessed in the sagittal plane with the camera set-up perpendicular to the participant. This is in accordance with run for speed assessment protocols depicted in Wickstrom (1983:45-53) and William
(1983:219-223). According to Mc Glenaghan and Gallahue (1978:103) the run for speed should also be viewed from the posterior angle as arm and leg abduction can be noted in the transverse plane. Due to resource constraints only 1 camera was employed and hence the run for speed movements could only be analysed from a perpendicular point of view.

- The video set-up for the standing long jump was perpendicular to the participant. This is in accordance with the suggestion by Mc Glenaghan and Gallahue (1978:104) and the standing long jump BC assessments depicted in Wickstrom (1983:78-84) and William (1983:215-216).

- The throw for distance was recorded perpendicular to the participant. This is in accordance with the throw for distance assessments protocols illustrated in Wickstrom (1983:129-132) and William (1983:234-235). For the purposes of this study the throw for distance was viewed from the sagittal plane.

- The camera set-up for the catch was placed in such a way that the participant could perform the catch testing protocol and a frontal view of the face and body could be observed. This is in accordance with Mc Glenaghan and Gallahue’s (1978:106), Wickstrom (1983:145-148) and William (1983:236-237) depiction of how the catch should be reviewed.

The following procedure was employed when recording each participant’s FMS:

- Each participant was videotaped individually by trained assistants.

- The participants name was called and each was required to stand in front of the camera at the designated cone which depicted where the participant should stand.

- A snapshot of the participant and their name badge was recorded.

- Hereafter each participant performed 3-to-5 trials (depending on the FMS under investigation).

- The individual recording each participant led the execution of the FMS by letting the participant and group co-ordinator know when the camera was ready for recording purposes.
In order to provide supporting evidence to deliberate the quantitative process and product FMS scores the following section illustrates the methods and procedures employed to measure the anthropometric variables, relevant demographic information and the maturational level through establishing whether menarche had commenced of each participant.

4.5 SUPPORTIVE DATA

4.5.1 Anthropometric Assessment

Development, maturation and growth effect motor ability (Balyi & Wade, 2009:3). In terms of growth; children who are larger, heavier and taller are inclined to have a lever arm and force production advantage when compared to their smaller peers (Riddiford-Harland et al., 2006:42-49). Conversely being too heavy, that is overweight or obese, tends to negatively affect a child’s ability to perform FMS (Truter et al., 2010:227-233). Studies investigating the effect of anthropometry on motor performance have been found to be more likely to focus on BMI, waist circumference and or anthropometric variables associated with excessive weight gain and their effect on motor proficiency as opposed to the effect on FMS proficiency. It was therefore deemed necessary to control for growth and development factors by employing the following anthropometric tests whilst investigating the FMS proficiency status of the participants in the present study:

- Standing height (Norton & Olds, 1996:35-36)
- Seated height (Australian Sports Commission, 1993:1995(a))
- Weight (Norton & Olds, 1996:37–38)
- BMI (Cole et al., 2000)
- Arm Length (Norton & Olds, 1992:72)
- Leg length (which was calculated by minusing seated height from standing height)
4.5.1.1 Height

4.5.1.1.1 Standing height

Height was measured with a portable SECA 213 stadiometer. The following standardized procedure was employed to measure height (Norton & Olds, 1996:35–36):

- Stature was measured with the participants wearing minimal clothing and no shoes.
- The participant's weight was placed evenly over both feet.
- The stretch method required the participant to stand with their feet together at their heels and with buttocks and scapulae touching the vertical board of the stadiometer.
- The head was placed in the Frankfort Plane. The Frankfort Plane was achieved when the orbital (lower edge of the eye socket) was in the same horizontal plane as the tragion (the notch superior to the tragus of the ear). Once the head was placed in the Frankfort Plane the head did not need to touch the vertical board of the stadiometer. The tester’s hands were placed under the participant's head, along the mastoid process, and a gentle upward pressure was applied.
- Once the participant’s head and body was placed in the correct position the headboard of the stadiometer was pushed down firmly onto the vertex (the highest point of the skull), compressing the hair as much as possible.
- The measurement was taken at the end of a deep inward breath.
- Stature was taken accurately to the nearest 0.1 cm.

4.5.1.1.2 Seated height

The following procedure was employed whilst measuring seated height (Australian Sports Commission, 1993; 1995(a)):

- The height was measured from the base of the portable SECA 213 stadiometer, on which the participant was seated with bent knees and the lower and upper back placed against the stadiometer, to the vertex of the head when the latter was in the Frankford Plane.
- The subject was instructed to hold a deep breath.
- The measurer applied a gentle upward lift through the mastoid process.
- Stature was taken accurately to the nearest 0.1 cm, which was the total of the trunk, neck and head.

4.5.1.2 Weight

Weight was measured on a calibrated Scalemaster electronic scale. The following procedure was followed when measuring weight (Norton & Olds, 1996:37–38):
- The participant had to be minimally clothed and not have shoes on.
- Before the participant stepped on the scale the reading had to be zero.
- The participant’s body weight had to be evenly distributed on both legs and the participant had to look straight ahead.
- The measurement was taken accurately to the nearest 0.01 kg.

4.5.1.3 Body Mass Index

BMI was calculated from height (m) and weight (kg) measurements by using the following formulae: \( \text{Weight}/\text{height}^2 = \text{kg.m}^2 \). The IOTF (Cole et al., 2000:4) and CDC (Freedman & Sherry, 2009) cut-offs were employed to calculated the percent of participants deemed underweight, normal weight, overweight or obese.

The IOTF cut-offs are from an international survey of nationally representative cross sectional growth studies in Brazil, Great Britain, Hong Kong, the Netherlands, Singapore and the United States (Cole et al., 2000:1). Table 13 identifies the cut-offs employed to deem the present participants as overweight and obese.
Table 13: BMI IOTF cut-offs for the age cohorts 9-to-12 years.

<table>
<thead>
<tr>
<th>Age</th>
<th>Overweight (kg/m²)</th>
<th>Obese (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>19.07</td>
<td>22.81</td>
</tr>
<tr>
<td>10</td>
<td>19.86</td>
<td>24.11</td>
</tr>
<tr>
<td>11</td>
<td>20.74</td>
<td>25.42</td>
</tr>
<tr>
<td>12</td>
<td>21.68</td>
<td>26.67</td>
</tr>
</tbody>
</table>

Source: Cole et al. (2000:4)

According to Dietz and Ballizza (1999:123S) BMI is an acceptable measure to assess fatness in children and corresponds with the obesity type 1 and 2 grades for adults. Additionally the face validity of BMI has been accepted (Norton & Olds, 1996:37-38).

4.5.1.4 Arm span

Arm span was measured according to the measuring procedure described by Norton and Olds (1992:72). A measuring tape was attached to a T-shaped arm span measuring device and the distance between the dactilion of the left and right hand when the participant was standing against a wall was measured. The T-shaped arm span measuring device was placed against the wall with the short arm placed vertically in the corner of the room. The long arm was placed parallel with the floor and at a height corresponding to shoulder height of the participant. The following procedure was followed:

- The subject’s back was towards the wall to ensure that the chest development did not obscure the results.
- The outstretched arms had to be in a horizontal position at the level of the shoulder and against the long arm of the T-shaped arm span measuring device.
- The participant's fingertip was placed on the one corner of the room in line with the O mark on the steel tape and the distance to the dactilion of the other hand was measured.
- A steel tape was mounted to the T-shaped arm span measuring device to measure the arm length.
- The measurement was taken to the nearest 0.1 cm.

4.5.1.5 Leg length

Leg length was calculated from the standing and sitting height measurements by subtracting the sitting height from the standing height. The measurement was taken to the nearest 0.1 cm.

4.5.2 Questionnaire

FMS acquisition is a multifaceted process. The amount of PA and the onset of puberty and demographic variables such as SES and gender can affect FMS status. Consequently, in order to gain insight into the contextual setting of the selected population group, a questionnaire was employed to gather the necessary information pertaining to this study.

Each participant had to fill in a questionnaire which can be viewed in addendum 9. The following information was attained for the purposes of this study:
- Surname, name, date of birth and age.
- School and grade.
- Home language.
- Extent of time spent participating in school sports and playing ball games, running around, riding bicycle and swimming after school and on weekends.
- Maturational age (menarche).

According to Wrotniak et al. (2006:e1759) the use of a self-reported physical activity recall questionnaire (PARQ) is questionable with existing validity and reliability results being moderate. A similar finding was reported by Hume, Ball and Salmon (2006:1) whereby environmental perceptions in 11 year olds were assessed with a PARQ. Telford, Salmon, Jolley and Crawford (2004) additionally reported moderate reliability and validity of self-report and proxy-report of the PARQ. Mcziza, Goedecke and Lambert (2007:117) conducted a study on the validity and reliability of the PARQ in South African Primary School girls aged 9-to-12 year. According to the Mcziza et
al. (2007), the PARQ may provide reasonable insight into the PA levels of South African Primary school children.

The success of gaining valid and reliable information from a questionnaire is based on the administration of the questions and the scrutiny the questionnaire went through in order to compile the questions. As the primary aim of this study was to identify FMS status and not PA levels the questionnaire created was employed to ensure for supplementary information to explain findings. A questionnaire was additionally employed due to resource constraints as direct PA assessments were not possible. The following procedure was employed when administering the questionnaire:

- Teachers were briefed on the questionnaire and the purpose thereof and provided the opportunity to ask questions if uncertain about any question in the questionnaire.
- Each teacher was provided with an adequate amount of questionnaires to administer with each participant volunteering to participate in the present study.
- Each teacher was provided with a 2 week period in order to complete the questionnaires with each participant.
- The teachers sat with each participant and went through the questionnaire.
- If participants did not understand a question due to language constraints, the teacher clarified the question.
4.6 DATA COLLECTION

Before data collection could take place, certain ethical procedures were followed (to be discussed in the ‘ethical consideration’ section on page 185). Once ethics approval was obtained the following course of events took place:

- A representative of the Eastern Cape Department of Sport Recreation, Arts and Culture was approached to facilitate with sourcing the schools which met the inclusion criteria depicted on page 133. A list of schools which had participated in the Mass Participation program (Mass Participation, 2010) was provided and an individual from the Eastern Cape Department of Education within the Nelson Mandela Bay District was approached to identify the relevant gatekeepers from each school and possible assistance.

- Once the schools had been chosen an official from the Eastern Cape Department of Sport Recreation, Arts and Culture assisted with gaining access to schools and setting up meetings with principals. Meetings were held based on availability of the principals and teachers of each school.

- Each meeting covered the purpose and the main components of the research including an assessment of the suitability of the testing environment.

- Possible testing and back-up testing dates were set.

When selecting the possible testing areas the following procedures were implemented:

- The principal together with the sports manager of each school gave a tour of the facilities and possible areas for the FMS assessment set-ups.

- The school’s outdoor facilities were assessed and the most hazardous-free and appropriate areas were selected. Cools et al. (2008:160) state that no distraction should be present and the environment should be bright, quiet, well-ventilated and safe and clear of hazardous material. This was hence the type of environment that was identified when enquiring as to the best areas to set-up the tests.
- When selecting an area for testing the 50m run, the horizontal jump and the throw for distance, the least hazardous and flat surfaces were identified.
- The catch and throw for accuracy were placed against a wall in an isolated area.
- Anthropometric measurements such as height, weight and arm span were placed on concrete level surfaces for accuracy and were conducted indoors.

Once the principal and teachers had decided that all was in order testing on the prescribed days commenced. Before testing could commence the following procedures were followed:
- A checklist was created to ensure that the necessary equipment was present on the days of testing.
- Data collection took place over a 2 week period. In week 1 the standing long jump, throw for accuracy, catch, balance and arm span were measured and or video recorded. Hence the checklist for week 1 was followed.
- Week 2 consisted of video recording and or measuring standing and seated height, body mass, the run for speed and throw for distance. Hence the checklist for week 2 was followed.
- In order for testing to flow, a time schedule was set up based on school starting times, break times and school ending times. Refer to addendum 10 for the time schedule. As school 3’s testing took place in a demarcated area away from the primary school grounds, testing could be conducted every hour and no provision had to be made for break times.
- Each research assistant which had been trained before the pilot study and during the pilot study was e-mailed the time schedules for week 1 and 2’s testing and the research assistant manual to review the respective test that each had been trained for.

Testing dates were originally set up for the last 2 weeks of August 2010. Due to strikes at schools the testing was postponed by 3 months and hence testing commenced during the last 2 weeks of November (addendum 11 provides a summary of the tests conducted on the specified dates and the school timetable.
followed for each respective school). Two and one week prior to testing schools were contacted and the dates of testing were confirmed. Schools were additionally contacted the day before testing. In addition to contacting each school, each assistant was contacted two and on week prior to testing and on the morning of the testing to ensure that attendance was guaranteed.

The following procedures were employed on the days of testing:

- On arrival at each school the principal, teachers, researcher and assistants met to discuss the procedures and test to be conducted on the day. An opportunity to ask questions was provided before the teachers gathered their pupils and all students assembled at a central point as indicated by the principal.

- A formal introduction to all participants was provided by the principal. The procedures and tests to be followed on the day were explained by the researcher and an opportunity to ask questions was provided to the participants.

- Each research assistant was provided with a file which included detailed information on the round robyn approach employed for station progressions, the names of each participant that would be allocated to them and a summary of the testing protocol to employ.

- Before commencing the research assistants called out the names of the participants. Each participant received a name tag, which was placed on their right upper chest.

- Once all participants had their name badges and were lined up in the correct order and grouped an assistant took each group to their first testing station.

- Each testing area was demarcated by the research assistants allocated to the specified FMS test

- As soon as the test was conducted the assistant took the group to the next station where participants were seated and waited their turn.

On completion of the testing, participants were returned to their classes. The principal was informed about the proceedings of day and the subsequent test dates for day 2 were confirmed. Additionally the following procedures were implemented after each day of testing:
The research assistance were briefed on the day’s proceedings, thanked for their efforts and reminded of the next testing dates.

- Equipment was re-checked, re-calibrated and re-charged and placed into a safe.
- The video footage was downloaded onto a laptop and back-up copies were made of all the video footage from the day’s data collection.
- Lastly the next set of schools at which testing would commence were contacted to confirm that all was still in order.

The following section depicts the steps taken to ensure that the data collection process was conducted in a standardised manner.

4.7 STANDARDIZING METHODS AND PROCEDURES

A randomized sampling technique could not be employed in this study. As such to maintain validity and reliability of findings, standardization of the testing environment, testing procedures and research assistance recruitment and training was employed.

The environment was standardized by:

- Placing the testing equipment away from the rest of the school when possible and demarcating the area.
- Employing identical equipment and set-up procedures in the most suitable areas, such as on flat and hazard-free surfaces.
- Only commencing testing on days free of rain and strong winds.

According to Cools et al. (2008:160) field workers require a basic knowledge of the test and testing equipment, of the theory behind the testing and of the participant’s background. Furthermore fieldworkers should receive standardized training and have studied the assessment manual. Hence procedures and instructions were standardized by:

- Only utilizing 3rd year and honours students from the Human Movement Science Department and training these assistants on how to conduct the tests.
- Providing each research assistant with a manual on the procedures to follow.
- Training each research assistant individually.
- Conducting a pilot study to ensure that the research assistants could conduct the tests correctly and that the correct amount of encouragement and instruction was provided to participants.
- Training research assistants to use uniform instruction when asking the participants to complete the FMS under investigation. As a true reflection of each participant’s movement ability was a necessity, research assistance were not allowed to demonstrate the FMS under investigation and only verbal instruction was allowed.
- In O’Conner (2000:171) it was found that that a run only requires 2 trials for optimal performance whereas the throw requires 5. Hence the research assistance had to ensure that each participant was provided with 2 practice trials and between 3-to-5 trials (depending on the FMS assessed) to complete the test.

To maintain organisation of the participants the following was implemented:

- Each participant was given a number and allocated a group. This assisted with the management of each group. Each participant’s name was called out to make sure that it was the correct individual being tested.
- Each research assistant in charge of a group of participants received a file which contained their group’s names, each participants name badge, the round robin approach to follow whilst testing and the testing procedures for the specific FMS under investigation.

The following procedures were followed in order to ensure the standardization of the measurements, set-up procedures and equipment:

- The relevant measuring equipment was calibrated prior to each testing session.
- The measuring was done by the same trained testers and assistants.
- The qualitative assessments and video recording of the FMS variables (running, jumping, throwing and catching) were done by the same trained testers.
To ensure that the qualitative assessment was reliable and valid the following was implemented:

- Once the BC approach and TGMD II assessment protocols were confirmed as being valid and reliable an individual qualified in Human Movement Science and trained in observing the FMS proficiency levels of children was provided with 10 random trials for each FMS under investigation to assess and score.
- The researcher additionally assessed the same 10 randomly selected trials for each FMS under investigation and provided a score. Inter-rater reliability was hence assessed (refer to chapter 5 for results).

Lastly participants clothing was standardised by requesting that on testing days each was to wear their physical education clothing. Additionally any participant that did not understand the verbal guidelines were facilitated by their teacher’s in Xhosa. In circumstances where participants were unruly and uncooperative, group coordinators kept them quiet. Participants were allowed to cheer for their classmates so as to ensure for maximum performance.

Once data was gathered Microsoft Excel® 10 and Statistica® 10 were employed to analyse results. The next section identifies the statistical applications employed to meet the primary aim and objectives set for this study.

4.8 STATISTICAL TECHNIQUES

To meet the first objective of identifying the current status of FMS proficiency in girls aged 9-to-12 years, descriptive and inferential statistics were employed. To obtain the aforementioned Microsoft Excel® 10 and Statistica® 10 were used. Descriptive statistics provided the mean and standard deviation (SD) of the variables under investigation. Inferential statistical analyses were employed to compare groups of participants to find statistical and practically significant differences.

The Analysis of variance (ANOVA) was used to compare the age groups with one another based on the mean value of each age group and assisted with identifying whether statistically significant differences were present between age groups for
each of the variables assessed. According to Gravetter and Wallnau (2009:425) ‘the primary advantage of ANOVA (compared to t test) is it allows researchers to test for significant mean differences when there are more than two treatment conditions or groups to be compared’. In the ANOVA assessments statistical significance was set at P<.05 (Cournoyer & Klein, 2000:142). Statistical significance refers to the confidence level in findings being correct. If the p<.05 then it is assumed that there is a 95% confidence level that the differences noted between variables is correct.

In order to identify which of the significant relationships identified by the ANOVA test were practically significant, posthoc tests were implemented. The post-hoc implemented was the Scheffe for pairwise comparisons for statistical significance and the Cohen’s d test to subsequently identify for practical significant differences (Gravetter and Wallnau, 2009:291-292). The criteria set for Cohen’s d for practical significance were: 0.2 (small), 0.5 (medium) and 0.8 (large).

Contingency tables and the Chi² test were employed to compare relationships between 2 categorical variables. According to Gravetter and Wallnau (2009: 618) the ‘Chi² test for independence uses the frequency data from a sample to evaluate the relationship between two variables in the population’. Subsequently the Cramer’s V test was used to determine practical significance in the case where Chi² tests reflected statistical significance. The guidelines that were used to interpret Cramer’s V values were based on Gravetter and Wallnau (2009: 618) and can be viewed in table 14 below.

Table 14: Cramer’s V Practical Significance Interpretations

<table>
<thead>
<tr>
<th>Cramer’s V</th>
<th>Small</th>
<th>Moderate</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Df = 1</td>
<td>0.10 &lt; V &lt; 0.30</td>
<td>0.30 &lt; V &lt; 0.50</td>
<td>V &gt; 0.50</td>
</tr>
<tr>
<td>Df = 2</td>
<td>0.07 &lt; V &lt; 0.21</td>
<td>0.21 &lt; V &lt; 0.35</td>
<td>V &gt; 0.35</td>
</tr>
<tr>
<td>Df &gt;=3</td>
<td>0.06 &lt; V &lt; 0.17</td>
<td>0.17 &lt; V &lt; 0.29</td>
<td>V &gt; 0.29</td>
</tr>
</tbody>
</table>

Lastly to identify correlations between two numerical variables the Pearson Correlation Coefficient was employed. Variables with a correlation of 0.1 were deemed as possessing a small correlation, 0.3 as a medium and 0.5 as a large.
4.9 ETHICAL CONSIDERATIONS

Ethics can be defined as norms of conduct that distinguish between acceptable and unacceptable behaviours (Alderson & Morrow, 2011:4-5). Children have been identified as vulnerable and in need of protection (Meaux & Bell, 2001:241-242). According to Greig et al. (2009:170), only in recent years have children’s rights and assent been considered important. Before the Second World War many children were used in the testing of vaccines and intervention procedures without regard for consequence, assent or consent (Meaux & Bell, 2001:241-242).

To ensure that ethical standards were adhered to and to ascertain the study feasibility, the following gatekeepers were approached, with subsequent approval being attained:

- Faculty of Health Sciences Research Technology and Innovation Committee (FRTI).
- NMMU Research Ethics Committee – Human (REC-H), whom granted ethics approval and provided the following reference number: H10 HEA HMS 007.
- The research proposal was discussed with the representatives of the Eastern Cape Department of Sport Recreation, Arts and Culture and the Eastern Cape Department of Education within the Nelson Mandela Bay District. In so doing possible schools were identified and approached for further consent from the principal. Following permission and support from the relevant principals, consent and assent letters were sent to parents and the identified girls aged 9-to-12 years respectively.

Refer to addendum 11 to view the approval letter from the Education Department to conduct the research which includes the ethics approval number. Also refer to addendum 12, 13, 14, 15, 16, 17, 18 and 19 for the following forms respectively:

- Letter to representative of the Eastern Cape Department of Sport Recreation, Arts and Cultures
- Letter to representative of the Eastern Cape Department of Education
- Abstract provided to representatives representative of the Eastern Cape Department of Sport Recreation, Arts and Cultures and the Eastern Cape Department of Education
- Request letter provided to each principal
- Principal consent form
- Request letter provided to each parent
- Consent form provided to each parent
- Assent forms provided to each participant

To ensure that the ethical guidelines identified by de Vos et al. (2005:56-69) and Greig et al. (2007:165-181) were abided by, the following were implemented:
- All necessary precautions were taken to avoid harm to participants.
- The relevant gatekeepers were approached and ethical clearance was obtained.
- Informed consent and assent from parents and participant were respectively attained beforehand.
- Each participant was informed about voluntary withdrawal.
- No gatekeepers, fieldworkers, parents or participants were deceived in any way and full transparency was ensured by the means of informative letters and contact details.
- No violation of privacy occurred as confidentiality of participants’ identify and that of the schools involved were maintained.
- All ethical considerations, risks and benefits involved, the purpose, processes and expectations of the study were communicated to all participants, their guardians, gatekeepers and fieldworkers.
- Competent action by the researcher was applied at all times.
- Minimal disruption to education was ensured by means of effective communication arrangements with the relevant schools and by appropriate planning and execution of the evaluation procedures used.

Plagiarism is an ethical issue faced by many tertiary institutes. Plagiarism is using or imitating an author’s work and accrediting it as one’s own work without obtaining authorization or acknowledging the original author (Eisner & Vicinus, 2008:165). In a bid to prevent plagiarism authors copyright their work (Eisner & Vicinus, 2008:79-80).
Every effort has been made to acknowledge authors’ work and to avoid copyright infringement. Please refer to addendum 20, which is a signed anti-plagiarism document.

4.10 SUMMARY

Chapter 4 highlighted the methods and procedures employed to answer the primary research question which was ‘what is the FMS proficiency status of girls aged 9-to-12 years from selected previously disadvantaged communities within the Nelson Mandela Bay’. The purpose, equipment employed, space requirements, set-up, procedures, scoring and validity and reliability of each FMS was discussed. Subsequently the qualitative assessment protocol was deliberated. Hereafter the supportive data’s data collection processes, the standardisation protocols implemented, the statistical techniques employed and the ethical considerations taken into account before, during and after conducting the research was conveyed within chapter 4. To follow is chapter 5, which illustrates the results from the application of the aforementioned methods and procedures.
CHAPTER 5: RESULTS

5.1 INTRODUCTION

As discussed in chapter 1, 2 and 3; FMS positively correlates with PA levels and are precursors to specialized movement skills (O’Conner, 2000; O’Keeffe et al., 2007; Lubans et al., 2010), positively contribute to a child’s social, physical and mental development (Lubans et al., 2010:1023-1030) and are negatively correlated to overweight and obesity levels in children and adolescents (Marchell & Bouffard, 1997; D’Hondt et al., 2013). Consequently, with empirical research supporting FMS positive effects and literature findings indicating the lack of FMS proficiency status studies within the South African context, the primary aim of this study was to identify the FMS proficiency status of 9-to-12 year old girls from previously disadvantage communities in Nelson Mandela Bay.

The specific focus of this chapter is to indicate the results obtained from the field tests conducted in order to achieve the aim and objectives of this study. Microsoft Excel® and Statistica® were used to facilitate descriptive and inferential statistical analysis. In the case of significant ANOVA results, the Scheffe post hoc test was used for pairwise comparisons. Statistical significance was set at P<.05 and the guidelines that were used for practical significance (Cohen’s d) were: 0.2 (small), 0.5 (medium) and 0.8 (large). The Pearson Correlation Coefficient was employed to identify whether statistical and practical correlations existed between 2 variables. Statistical significance was set at P<.05 and the guidelines that were used for practical significance were based on the r value which was as follows: 0.1 (small), 0.3 (medium) and 0.5 (large). Chi-square was used to test for a relationship between two categorical variables. Significance was set at p<.05. Where significance was found the Cramer’s V was used to indicate the level of practical significance of the result. The guidelines that were used to interpret Cramer’s V values were based on Gravetter and Wallnau (2009: 618) and can be viewed in table 14 (chapter 4, page 184).
5.2 FUNDAMENTAL MOVEMENT SKILLS: QUALITATIVE RESULTS

In order to answer the primary research question of this study, the first section of this chapter depicts the results from the implementation of the following objective: to determine and compare the FMS proficiencies of 9-to-12 year old girls in respect of the run for speed, throw for distance, standing long jump and catch qualitatively. Hereafter the FMS product scores and the demographic data, PA and maturational status of the present study’s participants under investigation are deliberated.

Before discussing the qualitative results for the FMS under investigation, it is important to differentiate between mastery and near mastery levels. In terms of the TGMD II, mastery is defined as achieving proficiency in movement in all the BC variables assessed (Ulrich, 2000). As depicted in chapter 3, as most studies employed the near mastery definition for FMS proficiency (possessing all body component parts except for one), the TGMD II results for this study are also depicted as near mastery FMS proficiency scores for comparative purposes (Booth et al., 1999; Ulrich’s, 2000; van Beurden et al., 2002; Okely & Booth, 2004; SPAN, 2004:98; Pang & Fong, 2009; SPAN, 2010:168-201; Hardy et al., 2012).

In terms of the BC approach employed to assess the FMS of the participants under investigation, according to O’ Conner (2000:12-13) a mature FMS is established when an individual can perform 80% or more of the BC variables correctly. Hence, in order to identify the percentage of individuals with mature movement stage in terms of the BC approach employed, this definition of FMS proficiency was utilized to depict FMS mastery.
5.2.1 Run for Speed

Figure 16 below illustrates the percentage of participants who achieved mastery scores for the BC approach. Additionally the mastery and or near mastery scores for the TGMD II run for speed are depicted (n=227).

According to the BC approach, 94.71% of participants were classified as non-proficient and 5.29% were classified as proficient sprinters. That is, out of the 9 run for speed BC variables scored utilizing the assessment rubric depicted in addendum 3 and dartfish (as illustrated in chapter 4’s methods and procedures video analysis, page 169), the mean run for speed proficiency score attained in the participants investigated was 20.26 (±1.61) out of a maximum score of 27. More specifically, as each of the 9 run for speed BC scores were marked according to a ranked scale between 1-to-3 (an initial, elementary and mature movement stage respectively) a maximum score of 27 points could have been awarded. In terms of the BC approach’s proficiency cut-off of 80% (McClenaghan & Gallahue, 1978:79; O’Conner, 2000:12-13) a score of 21.6 and above would have placed the individual into a mastery category.

In contrast to the BC approach scores, the TGMD II classified all participants as proficient runners. That is, 100% of participants scored at least 3 or 4 out of 4 for the BC variables assessed (as depicted in chapter 4’s methods and procedures).
Figure 16: Run for speed FMS proficiency level according to TGMD II and BC approach

Figure 17 illustrates the composite BC approach scores (composed of 9 BC variables with a possibility of a maximum score of 27 being awarded) for the run for speed assessed for each age group. As can be noted, participants running for speed skill ability remained relatively stable throughout aging. When applying ANOVA to assess for significant differences between age groups, no statistically significant differences were present (df=223; f=.769; p=.512). Due to the lack of significance, no post hoc tests were applied. Consequently it can be concluded that participants did not improve in their qualitative ability to run for speed as they aged.
Figure 17: Composite mean and SD process score for the run for speed per age group

Figure 18 identifies the score out of a maximum score of 3 for each of the 9 BC variables assessed for the run for speed. The mean results for all BC variables combined indicate that participants, on average, performed at a level 2 proficiency level. That is, at an elementary mastery level with a mean overall score of 2.25 (± 0.43). Participants scored the highest for the flight phase (3±0) and the knee arm-leg opposition (3±0) and lowest for maintaining a constant elbow action between 75 and 115 degrees (1.80± 0.48) and the arm swing (1.81±0.41).
Figure 18: Composite score for the run for speed BC variables

Figure 19 illustrates the percentage of participants (n:227) per BC variable that were placed into an initial, elementary and mature proficiency level for the run for speed. As can be noted, on average, most participants BC variables were placed into an elementary level of proficiency.
It is important to note that elbow action, foot clearance and arm-leg opposition were scored as either a 1 or 3. That is, elbow action was either within the designated area or not, foot clearance was either present or not and arm-leg opposition was either present or not. These three variables are illustrated in figure 20 below. As can be noted, most participants could execute arm and leg opposition and foot clearance whilst running for speed, however, most children could not maintain a stable arm movement during the run for speed.
The following section depicts the standing long jump’s qualitative results.

### 5.2.2 Standing long jump

Figure 21 displays the proficiency and non-proficiency levels for the standing long jump based on the BC and TGMD II approach. According to the BC approach 3.1% of participants were classified as proficient and 96.9% were classified as non-proficient. Hence, out of the 10 standing long jump BC variables scored utilizing the assessment rubric depicted in addendum 5 and dartfish (as illustrated in chapter 4’s methods and procedures), the mean standing long jump for distance proficiency score attained was 21.17 (±1.61) out of a maximum score of 30. More specifically, as each of the 10 standing long jump for distance BC scores were marked according to a ranked scale between 1-to-3 (an initial, elementary and mature movement stage respectively) a maximum score of 30 points could have been awarded. In terms of the BC approach’s proficiency cut-off of 80% (McClenaghan & Gallahue, 1978:79; O’Conner, 2000:12-13) a score of 24 and above would have placed the individual into a mastery category.
In accordance with the low proficiency scores reported by the BC approach, the TGMD II classified 6.22% of participants as proficient and 93.78% of participants as non-proficient when employing the near mastery and mastery cut-offs. This implies that 93.78% of participants did not score at least 3 or 4 out of 4 for the BC variables assessed (as depicted in chapter 4’s methods and procedures).

Figure 21: Percentage of proficient and non-proficient participants in standing long jump

Figure 22 illustrates the composite BC score (comprising of 10 BC variables and hence a maximum score of 30 could be awarded) for each age group. As can be noted, participants standing long jump skill ability remained relatively stable throughout aging. When applying the ANOVA to identify whether statistically significant differences between age groups presented, none were found to be significant (df=2.19; f=.084; p=.471).
Figure 22: Composite mean and process score for the standing long jump per age group

Figure 23 identifies the composite score for the standing long jump’s BC variables assessed. Mean results for all BC variables indicate that participants, on average, performed at a level 2 proficiency level. That is, at an elementary FMS proficiency level with a medium score of 2.04 (±0.55) for each BC variable assessed. Participants scored the highest for the landing leg action (2.78±0.6), which was defined as flexing at the hips before extending at the knees when landing. To follow in proficiency was the preparatory crouch (2.28±0.52) and take-off arm action (2.32±0.52), hip extension at take-off (2.11±0.76) and landing arm action (2.22±0.46). Flight arm (1.59±0.46) and leg action (1.83±0.60), knee extension at take-off (1.84±0.60) and landing balance (1.58±0.50) scored below 2 on average. Hence participants’ ability to extend the arms above the head during flight, lift the knees to parallel during flight for clearance, fully extend the knees during take-off and land with the COG forward on landing was poorly executed.
Figure 23: Mean and SD scores for the jump for distance BC variables

Figure 24 illustrates the percentage of participants per BC variable that were placed into an initial, elementary and mature proficiency level for the standing board jump. As can be noted, on average, most participants placed into an elementary level of proficiency.
Figure 24: Percentage of participants within each BC category for the standing long jump

The following section depicts the qualitative scores for the throw for distance.

5.2.3 Throw for Distance

Figure 25 displays the proficiency and non-proficiency levels for the throw for distance based on the BC and TGMD II approach. According to the BC approach, 6.22% of participants were classified as proficient and 93.78% were classified as non-proficient throwers. Hence, out of the 6 throw for distance BC variables scored utilizing the assessment rubric depicted in addendum 6 and dartfish (as illustrated in chapter 4’s methods and procedures), the mean throw for distance proficiency score was 12.24 (±1.57) out of a maximum score of 18. More specifically, as each of the 6 throw for distance BC scores were marked according to a ranked scale between 1-to-3 (an initial, elementary and mature movement stage respectively) a maximum score of 18 points could have been awarded. In terms of the BC approach’s
proficiency cut-off of 80% (McClenaghan & Gallahue, 1978:79; O’Conner, 2000:12-13) a score of 14.4 and above would have placed the individual into a mastery category.

The TGMD II approach indicated similarly low proficiency scores in that 83.56% of participants were found to be non-proficient and 16.44% were proficient throwers.

Figure 25: Percentage of proficient and non-proficient over arm throwers

Figure 26 illustrates the composite BC approach scores (composed of 6 BC variables with a possibility of a maximum score of 18 being awarded) for the throw for distance assessed for each age group. As can be noted, participants throw for distance ability remained relatively stable throughout aging. When applying the ANOVA to assess for significant differences between age groups, no statistically significant differences were present (df=2.47; f=.475; p=.700). Due to the lack of significance, no post hoc tests were applied. Consequently it can be concluded that participants did not improve in their qualitative ability to throw for distance as they aged.
Figure 26: Composite mean and process score for the throw for distance for each age group

Figure 27 identifies the score out of a maximum score of 3 for each of the 6 BC variables assessed for the throw for distance. The mean results for all BC variables combined indicate that participants, on average, performed at level 2 proficiency level (2.02±0.38). Hence, on average, participants were at an elementary level of FMS proficiency for the throw for distance. Stepping with the contralateral leg was the best performed BC variable (2.57), followed by the preparatory arm swing (2.11±0.47) and ball follow-through (2.07±0.26). The least proficiently performed variables were trunk rotation (1.96±0.79), angle of release (1.60±0.91) and body co-ordination (1.93±0.29).
Figure 27: Mean and SD scores for the throw for distance BC variables

Figure 28 illustrates the percentage of participants (n:227) placed into an initial, elementary and mature proficiency level for the BC approach. As can be noted, on average, most participants placed into an intermediate level of proficiency.
The following section depicts the qualitative scores for the catch.

### 5.2.4 Catch

Figure 29 displays the proficiency and non-proficiency levels for the catch based on the BC and TGMD II approach (n:135). Due to the loss of video footage in the field, the catch results depict 135 participants as opposed to the 227 participants assessed. According to the BC 91.19% of participants were classified as proficient and 8.81% were classified as non-proficient. Hence, out of the 4 catch BC variables scored utilizing the assessment rubric depicted in addendum 7 and dartfish (as illustrated in chapter 4’s methods and procedures), the mean catch proficiency score was 11.36 (±.42) out of a maximum score of 12. More specifically, as each of the 4 catching BC scores were marked according to a ranked scale between 1-to-3 (an initial, elementary and mature movement stage respectively) a maximum score of 12.
points could have been awarded. In terms of the BC approach’s proficiency cut-off of 80% (McClenaghan & Gallahue, 1978:79; O’Conner, 2000:12-13) a score of 8 and above would have placed the individual into a mastery category.

The TGMD classified 96.92% of participants as proficient and 3.08% of participants as non-proficient when employing the near mastery and mastery cut-offs. That is, 96.92% of participants did not score at least 3 or 4 out of 4 for the BC variables assessed (as depicted in chapter 4’s methods and procedures).

Figure 29: Percentage of proficient and non-proficient participants in catch ability

Figure 30 illustrates the composite BC score assessed for each age group. As can be noted, participants catching skill ability remained relatively stable throughout aging. After applying ANOVA a statistically significant relationship was present ($f=3.24$; $p=.024$) and after applying the Scheffe’s test a statistically significant difference was noted to be between 9 and 12 year olds ($df=131; f=3.248; p=.02$) and no of the other age groups. After applying Cohen’s D to identify whether the difference between 9 and 12 year olds was practically significant it was found to be of large practical significance ($d=0.81$).
Figure 30: Composite mean and SD process score for the catch per age group

Figure 31 identifies the BC variable score assessed and scored out of a maximum score of 3. Mean results for all BC variables indicate that participants, on average, participants performed at a mature FMS proficiency level (2.84±0.45). Hence participants were able to adjust their preparatory arm action and hand and body actions to receive the ball.

Figure 31: The catch BC variable scores and SD
Figure 32 illustrates the percentage of participants per BC variable that were placed into an initial, elementary and mature proficiency level for the catch. As can be noted, on average, most participants placed into mature level of proficiency.

Figure 32: Percentage of participants per BC variable for the catch

The following section is a summary of the qualitative results for the run for speed, standing long jump, throw for distance and catch ability.

5.2.4 Anthropometry’s Effect on the Fundamental Movement Skills Process Scores

In accordance with meeting the second objective of this study, assessing the effect of anthropometry on the FMS process scores under investigation is warranted (anthropometric changes with aging are discussed in pages 219-223). As depicted in table 15, no statistically significant or practically significant correlations were found between anthropometry measures and the FMS process scores after applying the Pearson Correlation Coefficient. Consequently it can be deduced that changes in anthropometry measures did not affect the process scores of the FMS under investigation.
Table 15: Correlations between anthropometric variables with FMS process scores

<table>
<thead>
<tr>
<th>Anthropometric variable</th>
<th>Throw proficiency</th>
<th>Jump proficiency</th>
<th>Run proficiency</th>
<th>Catch proficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>-0.004</td>
<td>-0.105</td>
<td>0.0374</td>
<td>0.0633</td>
</tr>
<tr>
<td>Seated height</td>
<td>-0.014</td>
<td>-0.0903</td>
<td>-0.0376</td>
<td>0.1109</td>
</tr>
<tr>
<td>Weight</td>
<td>0.0747</td>
<td>-0.1185</td>
<td>0.0141</td>
<td>0.066</td>
</tr>
<tr>
<td>Arm span</td>
<td>0.054</td>
<td>-0.0484</td>
<td>0.0177</td>
<td>0.0821</td>
</tr>
</tbody>
</table>

This final investigation concludes the statistical and practical analysis of the FMS process scores under investigation. To follow is a summary of the main findings for the process scores under investigation. Subsequently the FMS product scores and anthropometric, PA and menarche results are conveyed.

5.2.6 Summary of Process Scores

The primary goal of the qualitative section of this chapter was to illustrate the findings from the data collection process in order to determine and compare the FMS proficiencies of 9-to-12 year old girls in respect of the run for speed, throw for distance, standing long jump and catch process scores.

When taking into consideration the BC approach results, the run for speed (94.71%), standing long jump (96.9%) and throw for distance (83.56%) indicated that most participants had poor proficiency scores whereas the catch results (91.19%) indicated that most participants performed proficiently. Hence overall, the BC approach indicated that 75% of the FMS qualitatively investigated were performed at a poor mastery level.

Overall TGMD II results for the present study indicated that participants’ run for speed (100%) and catch (96.92%) FMS proficiency results were performed most proficiently whereas most of the participants’ standing long jump (93.78%) and throw for distance (83.56%) process scores were performed least proficiently. Hence overall, and according to the TGMD II, 50% of the FMS investigated qualitatively were performed at a poor FMS proficiency level.
No statistically or practically significant improvements in the BC approach process scores of participants were noted in the run for speed (df=223; f=.769; p=.51), throw for distance (df=2.47; f=.475; p=.70) or the standing long jump (df=2.19; f=.084; p=.471). A statistically (df=131; f=3.248; p=.02) and practically significant (d=0.82) improvement was noted in the catch between the age groups 9 and 12 years.

The following section will illustrate the quantitative results of the run for speed, throw for distance, standing long jump, balance and throw for accuracy. It is important to note that the throw for accuracy and balance skills were not analysed qualitatively and instead were assessed quantitatively.

5.3 FUNDAMENTAL MOVEMENT SKILLS: QUANTITATIVE RESULTS

This section deals with the next set of objectives created to meet the primary aim of this investigation. That is:
- To determine and compare the FMS proficiencies of 9-to-12 year old girls in respect of the run for speed, throw and jump for distance, catch, balance and throw for accuracy quantitatively.

5.3.1 Run for Speed

In the present study, participants’ fastest running time to cover the 40m’s was determined whilst also measuring the 20m time (n:227). Each participant was videotaped which was subsequently analyzed and the relevant participants’ proficiency level qualitatively determined.

Table 16 reflects the 20m mean and sprinting times per age group (n=227). The mean 20m run for speed time for all participants aged 9-to-12 years was 4.53±0.41 seconds. After applying ANOVA no statistical significant differences were noted between running speeds and the age of participants for the 20m run for speed (df=332; f=0.72; p=.541). Due to the lack of statistical significance no post hoc tests were applied to identify where these differences were practically significant.
Table 16: Descriptive statistics for the 20m run for speed (seconds)

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>Mean (seconds)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>227</td>
<td>4.53</td>
<td>0.41</td>
</tr>
<tr>
<td>9</td>
<td>48</td>
<td>4.56</td>
<td>0.42</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>4.5</td>
<td>0.37</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>4.56</td>
<td>0.46</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>4.47</td>
<td>0.39</td>
</tr>
</tbody>
</table>

Table 17 depicts the mean and SD for the 40m sprint for speed times for the participants under investigation. The overall mean score was 8.61±0.89 seconds.

Table 17: 40m run for speed mean times per age group (seconds)

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>Mean (seconds)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>227</td>
<td>8.61</td>
<td>0.89</td>
</tr>
<tr>
<td>9</td>
<td>48</td>
<td>8.69</td>
<td>0.89</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>8.53</td>
<td>0.81</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>8.68</td>
<td>0.95</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>8.51</td>
<td>0.9</td>
</tr>
</tbody>
</table>

The mean time attained by each age group tended to decrease as participants aged, however, at 11 years old participants’ times to complete the 40m sprint increased. After applying ANOVA no statistical significant differences were found between age groups in respect of time attained over the 40m distance (df=322; f=0.62; p= .603). Due to the lack of statistical significance no post hoc tests were applied to identify where these differences were practically significant.

In conclusion, the participants within the present study did not improve in their run for speed times with aging.
5.3.2 Standing long jump

As can be denoted from table 18, the mean jumping distance achieved by the participants under investigation (n=227) was 123.30± 19.22cm.

Table 18: Descriptive and inferential statistics for the standing long jump (cm)

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>Mean (cm)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>48</td>
<td>114.77</td>
<td>13.63</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>122.94</td>
<td>17.32</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>127.11</td>
<td>22.58</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>126.67</td>
<td>18.6</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td>123.3</td>
<td>19.22</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>114.77</td>
<td>13.63</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>122.94</td>
<td>17.32</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>127.11</td>
<td>22.58</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>126.67</td>
<td>18.6</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0.17</td>
<td>n.a.</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>0.007</td>
<td>0.63</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>0.023</td>
<td>0.73</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>0.658</td>
<td>n.a.</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>0.787</td>
<td>n.a.</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0.999</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Table 18 additionally identifies the ANOVA results as well as the outcome of the Scheffé post hoc tests applied. Statistically significant differences are noted between age 9 and 11 and 9 and 12 year olds. These differences were additionally found to be of a medium practical significance based on Cohen’s d tests.
5.3.3 Throw for Distance

As illustrated in table 19 the mean throwing distance achieved for the participants under investigation (n=227) was 17.95± 4.44m.

Table 19: Descriptive and inferential statistics for the throw for distance (m)

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>n</th>
<th>Mean (m)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>227</td>
<td>17.95</td>
<td>4.44</td>
</tr>
<tr>
<td>9</td>
<td>48</td>
<td>14.79</td>
<td>2.93</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>17.98</td>
<td>3.57</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>18.17</td>
<td>4.53</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>20.75</td>
<td>4.62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>Age group 2</th>
<th>Scheffé p</th>
<th>Cohen's d</th>
<th>Degree of Practical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>0.001</td>
<td>0.97</td>
<td>Large</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>&lt;.0005</td>
<td>0.85</td>
<td>Large</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>&lt;.0005</td>
<td>1.54</td>
<td>Large</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>0.995</td>
<td>n.a.</td>
<td>Medium</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>0.006</td>
<td>0.68</td>
<td>Medium</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0.009</td>
<td>0.56</td>
<td>Medium</td>
</tr>
</tbody>
</table>

After applying ANOVA, statistically significant relationships presented between throwing distance and age (p=<.0005). Table 19 illustrates the statistical and large practically significant differences between 9 and 10, 9 and 11 and 9 and 12 year olds when utilizing Scheffé’s post hoc test for statistical significance and Cohen’s d test for practical significance. Hence, as children aged so their ability to throw further improved.
5.3.4 Balance

As noted in table 20, the mean error in the 60 second stork-stand static balance test was 12.78± 4.56.

Table 20: Descriptive and inferential statistics for the balance errors

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>Age group 2</th>
<th>Scheffé p</th>
<th>Cohen’s d</th>
<th>Degree of Practical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>0.312</td>
<td>n.a</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>0.952</td>
<td>n.a</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>0.396</td>
<td>n.a</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>0.064</td>
<td>n.a</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>0.999</td>
<td>n.a</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0.109</td>
<td>n.a</td>
<td></td>
</tr>
</tbody>
</table>

As can be noted, no statistically or practically significant differences in balancing ability prevailed between age groups.

5.3.5 Throwing for Accuracy

Participants could accurately hit a target from a 2m distance (table) as the mean score obtained per age group was 8.69± 0.28 points.

After applying ANOVA and the Scheffé’s post hoc test it was revealed that there was a statistically significant difference between 9 and 12 year olds (p=.003). Cohen’s d post hoc test identified that the latter difference was also of large practical significance. Refer to table 21 below for details.
Table 21: Descriptive and inferential statistics in the 2m throw for accuracy between age groups

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>227</td>
<td>8.69</td>
<td>0.61</td>
</tr>
<tr>
<td>9</td>
<td>48</td>
<td>8.46</td>
<td>0.74</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>8.65</td>
<td>0.71</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>8.73</td>
<td>0.53</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>8.92</td>
<td>0.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>Age group 2</th>
<th>Scheffé p</th>
<th>Cohen’s d</th>
<th>Degree of Practical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>0.432</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>0.112</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>0.003</td>
<td>0.82</td>
<td>(Large)</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>0.891</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>0.152</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0.435</td>
<td>n.a.</td>
<td></td>
</tr>
</tbody>
</table>

When the distance was increased to 4m, participants’ accuracy decreased. On average a score of $6.73 \pm 1.58$ was achieved (see table 22).

After applying ANOVA and the Schefe’s post hoc test a statistically significant differences were noted between age groups. Subsequently Cohen’s d identified that a practical significant difference presented between most age groups (see table 22).

Table 22: Descriptive and inferential statistics in the 4m throw for accuracy between age groups

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>227</td>
<td>6.73</td>
<td>1.58</td>
</tr>
<tr>
<td>9</td>
<td>48</td>
<td>5.44</td>
<td>1.5</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>6.8</td>
<td>1.36</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>6.94</td>
<td>1.39</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>7.6</td>
<td>1.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>Age group 2</th>
<th>Scheffé p</th>
<th>Cohen’s d</th>
<th>Degree of Practical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>&lt;.0005</td>
<td>0.96</td>
<td>Large</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>&lt;.0005</td>
<td>1.05</td>
<td>Large</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>&lt;.0005</td>
<td>1.49</td>
<td>Large</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>0.953</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>0.036</td>
<td>0.58</td>
<td>Medium</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0.101</td>
<td>0.47</td>
<td>Medium</td>
</tr>
</tbody>
</table>
In order to meet the second objective set for this study, which was to describe and compare anthropometric measurements such as weight, height (standing and sitting), body mass index (BMI), arm span and leg length in respect of 9-to-12 year old girls as well as to determine the effect thereof on FMS proficiency, the following section depicts the effects of anthropometry on the FMS product scores under investigation. To review the anthropometric changes which occurred with aging in the present study’s participants refer to subsection 5.4.1 (pages 219-225).

5.3.6 Anthropometry’s Effect on the Fundamental Movement Skills Product Scores

The effects of anthropometric variables such as height, mass and arm span on the FMS proficiency product and process scores were assessed by means of the Pearson Correlation Coefficient in order to meet the second objective for the purposes of this study. The age groups 9-to-12 were firstly reviewed holistically and subsequently each age group was assessed separately. As noted in point 5.2.5 (page 206) no correlations between anthropometric changes and the FMS process scores under investigation were established in the female learners aged 9-to-12 years. Hence the effect anthropometry had on the FMS product scores of the female learners’ warrants further investigation.

Table 23 identifies the correlations between anthropometric measures and the run for speed 40m product scores. Small non-significant correlations were found between running speed and height, arms span and leg lengths. Additionally there was a medium statistical and practically significant correlation between the run for speed and body mass when reviewing the scores for all 9-to-12 year olds together. Hence, the heavier participants were, the slower they ran.
Table 23: Correlation between anthropometric variables and the 40m running speed

<table>
<thead>
<tr>
<th>Anthropometry measure</th>
<th>Pearson Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing Height</td>
<td>0.018 (small)</td>
</tr>
<tr>
<td>Sitting Height</td>
<td>0.045 (small)</td>
</tr>
<tr>
<td>Mass</td>
<td>0.313 (medium)</td>
</tr>
<tr>
<td>Arm Span</td>
<td>-0.013 (small)</td>
</tr>
<tr>
<td>Leg Length</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*Correlations in bold are statically significant (p<0.05)*

When reviewing each age group separately, significant correlations presented at 9 (0.398), 10 (0.265) and 11 (0.473) year olds between their mass and running speeds, indicating that the heavier a participant were the slower their running times. The height, leg length and arm span were not found to have statistically or practically significant correlations at any age. Refer to addendum 21 to review the correlations tables between anthropometric measures and the 40m running speed for each age group.

When reviewing the standing long jump for distance results and applying the Pearson Correlation Coefficient to the age group 9-to-12 years all anthropometric variables were found to be statistically significantly correlated to the jumping distances achieved, however these correlations were found to be small (see table 24 for details).

Table 24: Anthropometry’s correlation to jumping distances attained

<table>
<thead>
<tr>
<th>Anthropometry measure</th>
<th>Pearson Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing Height</td>
<td>0.171 (small)</td>
</tr>
<tr>
<td>Sitting Height</td>
<td>0.152 (small)</td>
</tr>
<tr>
<td>Mass</td>
<td>-0.170 (small)</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.175 (small)</td>
</tr>
<tr>
<td>Leg Length</td>
<td>0.16 (small)</td>
</tr>
</tbody>
</table>

*Correlations in bold are statically significant (p<0.05)*
When analyzing each age separately the only statistically significant correlation that presented was with 11 years olds and between body mass and jumping distance (-0.469: large correlation). No other anthropometric variables were found to significantly affect the standing long jumps. Hence at 11 years the heavier participants were the shorter their jumping distances. Refer to addendum 21 to review the correlations tables between anthropometric measures and the jumping for distance for each age group.

The throw for distance was also significantly affected by anthropometric variables under investigation. Table 25 depicts that the height, arms span, mass and leg length were correlated with throwing distance with small and medium practical significance. Hence the taller and heavier a participant and the longer the participants' arms span and leg length the further the distance achieved.

Table 25: Correlations of anthropometric variables with the throwing distance

<table>
<thead>
<tr>
<th>Anthropometry measure</th>
<th>Pearson Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing Height</td>
<td>0.29 (small)</td>
</tr>
<tr>
<td>Seated Height</td>
<td>0.32 (medium)</td>
</tr>
<tr>
<td>Mass</td>
<td>0.17 (small)</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.33 (medium)</td>
</tr>
<tr>
<td>Leg Length</td>
<td>0.22 (small)</td>
</tr>
</tbody>
</table>

Correlations in bold are statically significant (p<0.05)

When reviewing each age group’s throw for distances separately no statistically significant correlations were depicted. Refer to addendum 21 to review the correlations tables between anthropometric measures and the throw for distance for each age group.

When assessing the relevant anthropometric variables on balance, only 12 year olds were statistically significantly affected by all anthropometry measures, expect for leg length (see table 26 for details). No other age group was correlated to the anthropometric variables under investigations.
Table 26: Correlation of anthropometric variables with balance errors at 12 years old

<table>
<thead>
<tr>
<th>Anthropometry measure</th>
<th>Pearson Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing Height</td>
<td>0.439 (medium)</td>
</tr>
<tr>
<td>Sitting Height</td>
<td>0.329 (medium)</td>
</tr>
<tr>
<td>Mass</td>
<td>0.335 (medium)</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.399 (medium)</td>
</tr>
<tr>
<td>Leg Length</td>
<td>0.15 (small)</td>
</tr>
</tbody>
</table>

Correlations in bold are statically significant (p<0.05)

There were no product scores to assess for the catch and throw for accuracy and hence these two FMS were not correlated to the relevant anthropometric variables under investigation.

This section concludes the FMS product scores investigated for the purposes of this study. To follow is a summary of the main FMS product results. Hereafter the descriptive and comparative statistics for the anthropometric variables being assessed and the questionnaire related results on the demographic factors, SES, PA and age of menarche are conveyed.

5.3.7 Summary of Product Scores

Statistical and practical significantly differences (P<.05; d>.2) with aging were noted in the standing long jump, throw for distance and throw for accuracy product scores improved. The balance scores were found to improve statistically significantly with aging but the differences in improvements between age groups was found to not be of practical significance. No statistical or practical significant differences were noted in the 20m and 40m run for speed results.
After applying the Pearson Correlation Coefficient to identify whether there was a statistically and practically significant correlation between anthropometric changes and the FMS product scores it was noted that:

- Body mass had a medium statistically significant correlation to the run for speed indicating that heavier children ran slower. When reviewing the correlations for each age group; 9, 10 and 11 year olds run for speed scores correlated statistically and practically significantly with body mass. Arm span and standing and seated height did not correlated with the run speed product scores results significantly.

- All anthropometric variables were correlated to the jump for distances. These statistical and practically significant correlation was however small. When reviewing each age group separately, body mass was the only FMS found to have a statistically and practically significant correlation to the jump for distance at 11 years old.

- All the anthropometric variables correlated with the throw for distance results. These correlations were found to be of a small to medium significance with seated height and arm span having the highest correlations. When reviewing each age group separately none of the anthropometric variables correlated statistically or practically significantly with the participants throw for distances.

- Anthropometric variables, except for leg length, correlated to balance in only the 12 year olds. These correlations were found to be of medium significance. More specifically standing and seated height, body mass and arm span were found to have a medium significant correlation to the balance error scores.

To follow is a discussion on the descriptive and comparative statistics for the anthropometric variables under investigation.
5.4 **DESCRIPTIVE AND COMPARATIVE STATISTICS FOR THE ANTHROPOMETRIC VARIABLES ASSESSED**

The descriptive statistical data pertaining to the age and grade of each participant, anthropometric measures, PA levels and presence or absence of menarche was collected to aid in explaining the inferential statistical results obtained from the qualitative and quantitative assessment of the FMS under investigation. Consequently the following section depicts these aforementioned results. Additionally, this section particularly deals aspects of the following objectives set to answer the primary research question of this study:

- To describe and compare anthropometric measurements such as weight, height (standing and sitting), body mass index (BMI), arm span and leg length in respect of 9-to-12 year old girls. The effect on anthropometry on the process and product scores of the participants under investigation has been discussed in sections 5.2.5 and 5.3.6 (pages 206 and 214 respectively) hence in this section anthropometric change with aging is discussed.
- To describe and compare extra-mural PA participation status of 9-to-12 year old girls as well as to determine the associations thereof with FMS proficiency.
- To identify whether menarche has begun, consequently identifying the level of maturation and its association with FMS proficiency.

### 5.4.1 Anthropometric Measurements

#### 5.4.1.1 Standing height

As depicted in table 27 the mean height was 141.20± 8.79cm. In table 27 below the ANOVA and posthoc results identify the large statistical and practically significant differences between age groups. Hence, as can be expected, as participants aged so their height increased significantly.
Table 27: Descriptive and inferential statistics for the standing height (cm)

<table>
<thead>
<tr>
<th>n</th>
<th>Mean (cm)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>227</td>
<td>141.2</td>
</tr>
<tr>
<td>9</td>
<td>48</td>
<td>134.07</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>138.39</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>143.94</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>147.79</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>Age group 2</th>
<th>Scheffé p</th>
<th>Cohen’s d</th>
<th>Degree of Practical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>0.028</td>
<td>0.59</td>
<td>(Medium)</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>&lt;.0005</td>
<td>1.28</td>
<td>(Large)</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>&lt;.0005</td>
<td>1.91</td>
<td>(Large)</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>&lt;.0005</td>
<td>0.75</td>
<td>(Medium)</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>&lt;.0005</td>
<td>1.38</td>
<td>(Large)</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0.05</td>
<td>0.53</td>
<td>(Medium)</td>
</tr>
</tbody>
</table>

5.4.1.2 Seated height

The mean seated height was 70.89±4.11cm. Table 28 identifies the descriptive and inferential statistics of seated height per age group.

Table 28: Descriptive and inferential statistics for the seated height (cm)

<table>
<thead>
<tr>
<th>n</th>
<th>Mean (cm)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>227</td>
<td>70.89</td>
</tr>
<tr>
<td>9</td>
<td>48</td>
<td>67.35</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>69.62</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>72.18</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>74.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>Age group 2</th>
<th>Scheffé p</th>
<th>Cohen’s d</th>
<th>Degree of Practical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>0.007</td>
<td>0.71</td>
<td>(Medium)</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>&lt;.0005</td>
<td>1.38</td>
<td>(Large)</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>&lt;.0005</td>
<td>2.22</td>
<td>(Large)</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>&lt;.0005</td>
<td>0.72</td>
<td>(Medium)</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>&lt;.0005</td>
<td>1.42</td>
<td>(Large)</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0.024</td>
<td>0.56</td>
<td>(Medium)</td>
</tr>
</tbody>
</table>

As can be noted large statistical and practically significant differences were noted between participants. As previously mentioned and as can be expected, participants seated height increased with aging.
5.4.1.3 Mass

Table 29 illustrates descriptive and inferential statistics for mass (kg). The mean mass was 38.43 ± 10.01 kg.

As can be noted, there were statistical and practical significant differences between age groups. Hence, as participants aged so their weight increased at statistically and practically significant rate. The difference in weight gain seemed to plateau between 11 and 12 years old.

Table 29: Descriptive and inferential statistics for the mass (kg)

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>Age group 2</th>
<th>n</th>
<th>Mean (kg)</th>
<th>SD</th>
<th>Scheffé p</th>
<th>Cohen's d</th>
<th>Degree of Practical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>48</td>
<td>31.91</td>
<td>7.16</td>
<td>0.138</td>
<td></td>
<td>n.a.</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>60</td>
<td>36.07</td>
<td>8.05</td>
<td>&lt;.0005</td>
<td>1.05</td>
<td>(Large)</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>71</td>
<td>41.61</td>
<td>10.41</td>
<td>&lt;.0005</td>
<td>1.3</td>
<td>(Large)</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>48</td>
<td>43.19</td>
<td>9.95</td>
<td>0.008</td>
<td>0.59</td>
<td>(Medium)</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>48</td>
<td>43.19</td>
<td>9.95</td>
<td>0.001</td>
<td>0.8</td>
<td>(Large)</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>71</td>
<td>41.61</td>
<td>10.41</td>
<td>0.836</td>
<td></td>
<td>n.a.</td>
</tr>
</tbody>
</table>

5.4.1.4 Arm span

The mean arm span was 149.93 ± 8.61 cm. There were statistical and practically significant arm span differences noted between age groups, indicating that as participants aged so their arm span increased (see table 30). A tapering effect was evident after age 11 years.
Table 30: Descriptive and inferential statistics for the arm span (cm)

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>Age group 2</th>
<th>Schéffé p</th>
<th>Cohen’s d</th>
<th>Practically Significant Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>0.001</td>
<td>0.87</td>
<td>(Large)</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>&lt;.0005</td>
<td>1.5</td>
<td>(Large)</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>&lt;.0005</td>
<td>2</td>
<td>(Large)</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>0.001</td>
<td>0.72</td>
<td>(Medium)</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>&lt;.0005</td>
<td>1.19</td>
<td>(Large)</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0.144</td>
<td>n.a.</td>
<td></td>
</tr>
</tbody>
</table>

5.4.1.5 Leg length

The mean leg length was 70.31±5.53cm. Table 31 identifies the practical and statistical significant differences noted between age groups. The largest practically significant differences were noted between 9 and 11, 9 and 12 and 10 and 12 year olds.

Table 31: Descriptive and inferential statistics for the leg length (cm)

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>Age group 2</th>
<th>Schéffé p</th>
<th>Cohen’s d</th>
<th>Practically Significant Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>0.2</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>&lt;.0005</td>
<td>0.94</td>
<td>(Large)</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>&lt;.0005</td>
<td>1.29</td>
<td>(Large)</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>0.008</td>
<td>0.65</td>
<td>(Medium)</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>&lt;.0005</td>
<td>1.1</td>
<td>(Large)</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0.23</td>
<td>n.a.</td>
<td></td>
</tr>
</tbody>
</table>
In conclusion the participants in the present study increased statistically and practically significantly in height, mass and arm span as they aged.

5.4.1.6 Body Mass Index

5.4.1.6.1 Age related changes

BMI is the indirect measure of adiposity in children and adults and is calculated by dividing body weight by height squared (Cole et al., 2005:1). The mean BMI was 19.06±3.66 kg/m². Table 32 depicts the BMI results within each age group.

Table 32: Mean and SD for BMI

<table>
<thead>
<tr>
<th>Age</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>17.68</td>
<td>3.19</td>
<td>48</td>
</tr>
<tr>
<td>10</td>
<td>18.68</td>
<td>3.10</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
<td>19.91</td>
<td>3.97</td>
<td>71</td>
</tr>
<tr>
<td>12</td>
<td>19.67</td>
<td>3.86</td>
<td>48</td>
</tr>
<tr>
<td>Totals</td>
<td>19.06</td>
<td>3.66</td>
<td>227</td>
</tr>
</tbody>
</table>

Two BMI classifications were employed to assess the prevalence of overweight and obesity in the sample investigated. That is, the IOTF cut-offs (Cole et al., 2005) and CDC cut-offs (CDC Growth Charts, 2000:1-27; Freedman & Sherry, 2009) were employed.

The IOTF cut-off overweight and obesity results can be reviewed in table 33. According to the IOTF classifications 24.67% of children were overweight and 7.49% of children were obese.
Table 33: Level of fatness based on IOTF BMI cut-offs

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>Normal</th>
<th>N</th>
<th>Overweight</th>
<th>n</th>
<th>Obese</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>34</td>
<td>70.83%</td>
<td>11</td>
<td>22.92%</td>
<td>3</td>
<td>6.25%</td>
<td>48</td>
</tr>
<tr>
<td>10</td>
<td>43</td>
<td>71.67%</td>
<td>14</td>
<td>23.33%</td>
<td>3</td>
<td>5.00%</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
<td>44</td>
<td>61.97%</td>
<td>20</td>
<td>28.17%</td>
<td>7</td>
<td>9.86%</td>
<td>71</td>
</tr>
<tr>
<td>12</td>
<td>33</td>
<td>68.75%</td>
<td>11</td>
<td>22.92%</td>
<td>4</td>
<td>8.33%</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>154</td>
<td>67.84%</td>
<td>56</td>
<td>24.6%</td>
<td>17</td>
<td>7.49%</td>
<td>227</td>
</tr>
</tbody>
</table>

After applying ANOVA to assess for significance it was noted that significant differences were present between age and overweight and obesity rate (p: .0047). However, after applying Cohen’s d, no practical significant differences were noted between overweight and obesity and age (d: 0.61 and d: .056 respectively).

The CDC BMI calculations were based on height, weight and age. From the original sample of 227 participants, 30 participants’ birth dates could not be obtained from teachers and thus were excluded from the calculations. As indicated in the table 34 below, according to the CDC BMI classifications 24% of girls were classified as overweight, 8% of girls were obese and 4% were classified as underweight for their age.

Table 34: Participants nutritional status based on CDC cut-offs

<table>
<thead>
<tr>
<th>CDC Classification</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight (&lt; 5th %ile)</td>
<td>4%</td>
</tr>
<tr>
<td>Normal BMI (5th - 85th %ile)</td>
<td>64%</td>
</tr>
<tr>
<td>Overweight or obese (≥ 85th %ile)</td>
<td>24%</td>
</tr>
<tr>
<td>Obese (≥ 95th %ile)</td>
<td>8%</td>
</tr>
</tbody>
</table>

As the second objective of this study was to identify whether anthropometry variables affected the FMS proficiency results the following section assesses the impact BMI status had on the FMS proficiency product scores under investigation.
5.4.1.6.2 Effects of BMI on FMS product scores

In order to assess whether BMI had a statistical and practically significant effect on the FMS product scores under investigation ANOVA and Scheffe’s post hoc test for statistical significance was applied. As depicted in table 35 statistically significant differences were found only for the 40m run for speed (df=244; f=27.07; p=2.9E-11) and standing long jump (df=244; f=15.68; p=4.2E-07) when comparing product scores to normal weight, overweight and obese participants.

Table 35: Effects of BMI on the FMS product scores

<table>
<thead>
<tr>
<th>Fundamental Movement Skill</th>
<th>df Error</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>40m Run (seconds)</td>
<td>224</td>
<td>27.074406</td>
<td>2.94E-11</td>
</tr>
<tr>
<td>Throw for Distance (m)</td>
<td>224</td>
<td>0.7331453</td>
<td>0.481545</td>
</tr>
<tr>
<td>Balance Errors / 60s</td>
<td>224</td>
<td>1.4230344</td>
<td>0.243152</td>
</tr>
<tr>
<td>Standing long jump (cm)</td>
<td>224</td>
<td>15.680114</td>
<td>4.23E-07</td>
</tr>
<tr>
<td>2m Throw for Accuracy</td>
<td>224</td>
<td>1.4575734</td>
<td>0.235</td>
</tr>
<tr>
<td>2m Throw for Accuracy</td>
<td>224</td>
<td>1.054846</td>
<td>0.349969</td>
</tr>
</tbody>
</table>

In order to assess whether these differences between 40m running times between BMI categories were practically significant, cohen’s d was applied. As depicted in table 36, practically significant differences were found and these were of medium to large practical significance between the normal and obese participants for the run for speed (d=.61 to d=1.77). More specifically differences between normal weight and overweight participants was found to be of medium practical significance (d=0.61) and between normal weight and obese children it was found to be of large practical significance (d=1.77). Lastly, large practically significant (d=1.05) differences were found between overweight and obese participants 40m run for speed times.
Table 36: Marked differences are significant at p=< .05 between normal, overweight and obesity levels for the 40m run for speed

<table>
<thead>
<tr>
<th>BMI category</th>
<th>Normal</th>
<th>Overweight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>0.00090448</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>6.118E-10</td>
<td>0.000236</td>
</tr>
</tbody>
</table>

When reviewing the standing long jump results (refer to table 36) statistically significant results additionally presented between normal weight, overweight and obese individuals. In table 37 it can be seen that medium to large practically significance (d=.40 to d=1.33) differences presented between the normal and obese participants for the standing long jump. More specifically differences between normal weight and overweight participants was found to be of small practical significance (d=1.33) and between normal weight and obese children it was found to be of large practical significance (d=1.77). Lastly, large practically significant (d=1.05) differences were found between overweight and obese participants standing long jump.

Table 37: Marked differences are significant at p=< .05 between normal, overweight and obesity levels for the standing long jump

<table>
<thead>
<tr>
<th>BMI category</th>
<th>Normal</th>
<th>Overweight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>0.037735</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>1.598E-06</td>
<td>0.002927</td>
</tr>
</tbody>
</table>
5.5 DESCRIPTIVE AND COMPARATIVE STATISTICS FOR THE DEMOGRAPHIC, PHYSICAL ACTIVITY AND MATURATION LEVEL

5.5.1 Age and Grade

The participants under investigation were Xhosa speaking, black girls aged 9-to-12 years from previously disadvantaged areas within the Nelson Mandela Metropolitan District. Three schools that were participating in the Mass Participation initiative (Mass Participation, 2010) were selected for the purposes of this study. Table 38 identifies the distribution of children form school 1 to 3. School 2 had a much lower representation in the overall sample due to having less 9-to-12 year old girls to participate in the investigation.

Table 38: Number of participants within each school

<table>
<thead>
<tr>
<th>School</th>
<th>n</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>86</td>
<td>38%</td>
</tr>
<tr>
<td>2</td>
<td>39</td>
<td>17%</td>
</tr>
<tr>
<td>3</td>
<td>102</td>
<td>45%</td>
</tr>
<tr>
<td>Total</td>
<td>227</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 39 identifies the number of children in each age group. The largest portion of 9-to-12 year olds came from grade 4 and 5.

Table 39: Grade distribution of participants

<table>
<thead>
<tr>
<th>Grade</th>
<th>n</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>13</td>
<td>6%</td>
</tr>
<tr>
<td>4</td>
<td>89</td>
<td>39%</td>
</tr>
<tr>
<td>5</td>
<td>93</td>
<td>41%</td>
</tr>
<tr>
<td>6</td>
<td>24</td>
<td>11%</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>227</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 40 identifies the number of participants within each age category. A relatively even age distribution was present between age groups, with 11 year olds having a slightly larger representation in comparison to the other 3 age groups.

Table 40: Number of participants within each age category

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>n</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>48</td>
<td>21%</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>26%</td>
</tr>
<tr>
<td>11</td>
<td>71</td>
<td>31%</td>
</tr>
<tr>
<td>12</td>
<td>48</td>
<td>21%</td>
</tr>
<tr>
<td>Total</td>
<td>227</td>
<td>100%</td>
</tr>
</tbody>
</table>

Due to resource constraints, randomized sampling could not be employed and consequently the above sample is representative of the 9-to-12 year old girls from the selected schools under investigation.

5.5.2 Socio-economic Status

Questionnaires were employed to identify the SES, PA levels and menarche age of each participant. From the total of 227 girls aged 9-to-12 years tested, 167 participants handed in a completed questionnaire (73.5% response rate). Consequently, there is a disparity between questionnaire and quantitatively measured scores in terms of the number of participants results presented.

In the present study, the population under investigation was from previously disadvantaged communities. Consequently parent employment was investigated. Employment within a family was deemed present if either the legal guardian (if parents were deceased) or mother or father of the household possessed a job. From the questionnaire feedback, results indicated that 31% of the participants’ parents were not employed (table 41).
Table 41: Number of working parents

<table>
<thead>
<tr>
<th>Number working parents in household</th>
<th>n</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>51</td>
<td>31%</td>
</tr>
<tr>
<td>1</td>
<td>67</td>
<td>40%</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>24%</td>
</tr>
<tr>
<td>3+</td>
<td>9</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>167</td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

5.5.3 Menarche

Table 42 identifies the number of girls who had commenced menarche. A total of 10% of the girls had started menarche, none of which were 9 years old and most of which were 12 year olds.

Table 42: Number and percentage of participants who had and had not started menarche

<table>
<thead>
<tr>
<th>Age</th>
<th>Answered yes</th>
<th>%</th>
<th>Answered no</th>
<th>%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>0</td>
<td>0%</td>
<td>32</td>
<td>100%</td>
<td>32</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>2%</td>
<td>49</td>
<td>98%</td>
<td>50</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>8%</td>
<td>45</td>
<td>92%</td>
<td>49</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>31%</td>
<td>27</td>
<td>69%</td>
<td>36</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>17</td>
<td>10%</td>
<td>153</td>
<td>90%</td>
<td>167</td>
</tr>
</tbody>
</table>

After applying the ANOVA and post hoc tests, it was noted that a statistical and medium practically significant relationship was present between age and the onset of menarche (Chi² (d.f. = 3, n = 167) = 18.52; p < .0005; V = 0.33 Medium).
5.5.4 Physical Activity

5.5.4.1 Physical activity on week days

As mentioned, PA was assessed with a questionnaire. Direct assessments were not employed due to lack of resources. Additionally as the primary aim of this study was to identify the status of FMS proficiency and not the amount of PA each participant partook in, employing a questionnaire to gather information on PA levels was deemed adequate. Table 43 illustrates that 50% of participants participated in an hour or less of PA after school and 50% believed they participated in a hour or more of PA a day after school, hence possibly indicating that the recommended 60 minutes of daily moderate-to-vigorous activity was participated in.

Table 43: Number of hours being PA after school on week days

<table>
<thead>
<tr>
<th>Age</th>
<th>Never</th>
<th>Less 1 hour</th>
<th>1 - 2 hours</th>
<th>&gt;2 hours</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>5</td>
<td>16%</td>
<td>15</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>24%</td>
<td>15</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>8%</td>
<td>15</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>11%</td>
<td>14</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>15%</td>
<td>59</td>
<td>53</td>
<td>30</td>
</tr>
</tbody>
</table>

After applying the ANOVA and post hoc tests it was noted that a statistical and medium practically significant relationship presented between age and PA levels on week days (Chi²(d.f. = 3, n = 167) = 7.87; p = .049; V = 0.22 medium). Hence, as children got older so their PA levels increased.

As illustrated in table 44 below, 50% of PA participants spent their time playing ball games or running, 10% rode bicycle and 5% swam (table 37).
Table 44: Activities played on the week days

<table>
<thead>
<tr>
<th>Activity</th>
<th>None</th>
<th>%</th>
<th>Yes</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
<td>83</td>
<td>50%</td>
<td>84</td>
<td>50%</td>
<td>167</td>
<td>100%</td>
</tr>
<tr>
<td>Ball Games</td>
<td>83</td>
<td>50%</td>
<td>84</td>
<td>50%</td>
<td>167</td>
<td>100%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>151</td>
<td>90%</td>
<td>16</td>
<td>10%</td>
<td>167</td>
<td>100%</td>
</tr>
<tr>
<td>Swim</td>
<td>159</td>
<td>95%</td>
<td>8</td>
<td>5%</td>
<td>167</td>
<td>100%</td>
</tr>
</tbody>
</table>

5.5.4.2 Physical activity levels on weekends

Results indicated that 79% of the participants partook in some form of PA on weekends (refer to table 45).

Table 45: Participants who participated in some form of physical activity on weekends

<table>
<thead>
<tr>
<th>Age</th>
<th>None</th>
<th>%</th>
<th>Yes</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>8</td>
<td>26%</td>
<td>23</td>
<td>74%</td>
<td>31</td>
<td>100%</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>24%</td>
<td>38</td>
<td>76%</td>
<td>50</td>
<td>100%</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>25%</td>
<td>36</td>
<td>75%</td>
<td>48</td>
<td>100%</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>8%</td>
<td>35</td>
<td>92%</td>
<td>38</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>21%</td>
<td>132</td>
<td>79%</td>
<td>167</td>
<td>100%</td>
</tr>
</tbody>
</table>

From the above sample of participant who did some form of PA on weekends, 45% achieved the minimum requirement of 60 minutes PA per day (refer to table 46).

Table 46: Physical activity level of participants on weekends

<table>
<thead>
<tr>
<th>Age</th>
<th>Never</th>
<th>Less 1 hour</th>
<th>1 - 2 hours</th>
<th>More than 2 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>N</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>8</td>
<td>26%</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>20%</td>
<td>18</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>11</td>
<td>23%</td>
<td>12</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>12</td>
<td>32%</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>41</td>
<td>25%</td>
<td>42</td>
</tr>
</tbody>
</table>
After applying the ANOVA and post hoc tests it was noted that no statistical or practically significant relationship was present between weekend PA and age (Chi² (d.f. = 3, n = 167) = 1.59; p = .661). Hence on weekends there was no difference in age groups PA levels.

Table 47 identifies the activities played on weekends. The most played activities were running and ball games.

Table 47: Activities played on the weekend

<table>
<thead>
<tr>
<th>Activity</th>
<th>None</th>
<th>%</th>
<th>Yes</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
<td>88</td>
<td>53%</td>
<td>79</td>
<td>47%</td>
<td>167</td>
<td>100%</td>
</tr>
<tr>
<td>Ball games</td>
<td>93</td>
<td>56%</td>
<td>74</td>
<td>44%</td>
<td>167</td>
<td>100%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>152</td>
<td>91%</td>
<td>15</td>
<td>9%</td>
<td>167</td>
<td>100%</td>
</tr>
<tr>
<td>Swim</td>
<td>156</td>
<td>93%</td>
<td>11</td>
<td>7%</td>
<td>167</td>
<td>100%</td>
</tr>
</tbody>
</table>

5.5.4.3 Extra-mural participation

Table 48 indicates that 68% of participants took part in some form of extra-mural activity after school.

Table 48: Number of participants who did some form of extra-mural activity

<table>
<thead>
<tr>
<th>Age</th>
<th>None</th>
<th>%</th>
<th>Yes</th>
<th>%</th>
<th>None</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>8</td>
<td>26%</td>
<td>23</td>
<td>74%</td>
<td>31</td>
<td>100%</td>
</tr>
<tr>
<td>10</td>
<td>19</td>
<td>38%</td>
<td>31</td>
<td>62%</td>
<td>50</td>
<td>100%</td>
</tr>
<tr>
<td>11</td>
<td>14</td>
<td>29%</td>
<td>34</td>
<td>71%</td>
<td>48</td>
<td>100%</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>32%</td>
<td>26</td>
<td>68%</td>
<td>38</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>32%</td>
<td>114</td>
<td>68%</td>
<td>167</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 49 identifies the extra-mural activities that the participants under investigation took part in. The sports which participants engaged in the most were netball and athletics.

Table 49: Percentage of participants playing a particular sport extramurally

<table>
<thead>
<tr>
<th>Sport</th>
<th>None %</th>
<th>Yes %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athletics</td>
<td>78%</td>
<td>22%</td>
</tr>
<tr>
<td>Swimming</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Tennis</td>
<td>99%</td>
<td>1%</td>
</tr>
<tr>
<td>Netball</td>
<td>59%</td>
<td>41%</td>
</tr>
<tr>
<td>Hockey</td>
<td>96%</td>
<td>4%</td>
</tr>
<tr>
<td>Ballet</td>
<td>95%</td>
<td>5%</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>99%</td>
<td>1%</td>
</tr>
<tr>
<td>Soccer</td>
<td>99%</td>
<td>1%</td>
</tr>
<tr>
<td>Cricket</td>
<td>99%</td>
<td>1%</td>
</tr>
<tr>
<td>Volleyball</td>
<td>99%</td>
<td>1%</td>
</tr>
<tr>
<td>Basketball</td>
<td>99%</td>
<td>1%</td>
</tr>
</tbody>
</table>

According to results 37% of the population under investigation participated at a club level, which was mostly in netball.

In summary, the number of participants meeting the minimum requirement of 60 minutes PA on week days after school and on weekends was 53% and 56% respectively. This activity consisted mostly of running and ball games. In the sample under investigation 67% took part in some form of extra-mural activity. The most popular extra-mural sport was netball. This was followed by athletics. In addition to extra-mural participation, 37% took part at a club level.
5.6 RELIABILITY

To ensure for reliability the inter-observer agreement was assessed. To test the inter-observer agreement the researcher and a second assessor, qualified in human movement sciences and trained in assessing the FMS under investigation, viewed 10 randomly selected video footages for each FMS under investigation. Each assessment rubric was utilised to evaluate each of the 10 randomly selected videos for each of the FMS qualitatively assessed. The results indicate an overall inter-observer agreement of $r=0.82$.

To test the consistency between each FMS trial conducted on the same day the Pearson Correlation Coefficient was employed. Statistically significant ($p<.05$) correlations were found between all FMS. Only the throw for accuracy was found to have small correlations between trials. Additionally these correlations were found to be of large practical significance, indicating a high degree of reliability for all field tests conducted:

- Run: $r=0.83$ (large)
- Throw for distance: $r=0.92$ (large)
- Jump for distance: $r=0.84$ (large)
- Throw for accuracy: $r=0.27$ (small)
- Balance: $r=0.7$ (large)

Due to time constraints the testing protocol could not be conducted at the same school on a separate day in order to assess for the test-retest reliability between trial days.
5.7 SUMMARY

In this chapter the qualitative and quantitative results from the objectives set in order to accomplish the primary aim of this study were illustrated. Both the process and product score results were conveyed in terms of the statistical techniques employed to analyse the results. Within each process and product section a summary of the results are provided (refer to subheadings 5.2.5 and 5.3.7, pages 206 and 214 respectively). Furthermore anthropometric, demographic, SES, PA levels and menarche are discussed.

In order to interpret the implications of these aforementioned qualitative and quantitative results, a synthesis of empirical research findings and applying the theoretical framework of this study to the results is required. Consequently to follow is the final chapter of this study which will depict the discussion, summary, conclusions and recommendations based on the objectives set to meet the primary aim of this study, the results depicted in chapter 5 and the empirical research findings and theoretical framework of this study discussed in chapter’s 1 to 3.
CHAPTER 6: DISCUSSION, SUMMARY AND CONCLUSION

6.1 INTRODUCTION

Chapter 1 portrayed the problem statement and consequent formulation of the aim of this study, which was to investigate the FMS proficiency status of female learner’s age 9-to-12 years from selected lower SES communities within the Nelson Mandela Bay. This chapter aims to discuss the results described in chapter 5 against the background of the theoretical framework and the other empirical research discussed in chapter 2 and 3. Chapter 6 finally culminates in conclusions drawn and recommendations made for future investigations into the FMS proficiency status of children.

6.2 FUNDAMENTAL MOVEMENT SKILLS: QUALITATIVE RESULTS

One of the first objectives of this study was to determine and compare the FMS proficiencies of 9-to-12 year old girls in respect of the run for speed, standing long jump, throw for distance, catch, static balance and throw for accuracy qualitatively and or quantitatively. Consequently the following section commences with the qualitative FMS status results by discussing the quantitative process scores in respect of:

- Determining and comparing the FMS proficiencies of 9-to-12 year old girls in respect of the run for speed, throw for distance, standing long jump and catch process scores.
- Overall FMS proficiency status of the present study’s participants aged 9-to-12 years in terms of the BC and TGMD II approaches and how each compares to the FMS status of children in Australia, Brazil, USA and Hong Kong.
- Each BC variable score within the BC approach of the respective FMS under investigation and the possible influence this may have had on the overall FMS proficiency score.
- The value and implications of using the BC and TGMD II assessment protocols when evaluating the participants within this study and the
consequent process score results of the run for speed, standing long jump, throw for distance and catch.

6.2.1 Age Related Changes in FMS Proficiency Levels

As mentioned, one of the objectives of this study was to determine and compare the FMS proficiencies of 9-to-12 year old girls. Consequently investigating whether statistically and practically significant differences presented in the BC composite process scores between age groups of the present study’s participants is warranted.

Authors have indicated that as children age so there should be a progressive improvement in their FMS stage (Corbin, 1980:48-77; Espenschade & Eckert, 1980:139-160; Thomas, 1984:48-88; Roberton & Konczak, 2001; Malina et al., 2003:195-210; Malina, 2004; Haywood & Getchell, 2009:111-177; Gallahue, 2010:17-19). Whether this improvement is due to growth, development and maturational changes or improvement in motor skill ability due to motor learning is debatable and necessitates further investigation in terms of both quantitative and qualitative FMS proficiency results respectively. More specifically, anthropometric changes in children can affect their movement force and power production, hence increasing the FMS product scores. Additionally Haywood and Getchell (2009:119-122) indicated that the main rate limiters to movement attainment are strength and balance. Hence with an improvement in these variables with aging, the individual should be able to perform movements previously not possible and improve both their process and or product scores. However, researchers additionally indicate that motor learning is an important variable to consider as this additionally affects movement proficiency (Newell, 1991; Thelen, 2000). In the present study the catch was the only FMS process score to improve statistically significantly with age (df=131; f= 3.248, p=.02). This improvement was additionally of large practically significance between children aged 9 and 12 years old (d=0.81) (table 30, page 222). Two possible reasons are provided for the lack of improvement in the process scores, except for the catch process scores, of the participants under investigation.
Stating that a lack of motor learning may have been one of the primary factor affecting these participants FMS process status scores is validated by Newell’s (1991) and Thelen’s (2000) sentiments. More specifically according to the aforementioned authors task, environmental and individual constraints together with being exposed to an environment conducive to motor learning in order to obtain an attractor state is required to achieve proficient movement. As previously mentioned, the environmental and task constraints affecting the present participants was an absence of physical education classes and the fact that the participant’s teachers as opposed to physical education specialist were facilitating physical education and extra-mural participation. Studies by Amusa and Toriola (2006) and van Deventer (2004, 2009, 2012) on the poor physical education status within the South African population justifies these claims. Additionally, based on the questionnaire (pages 230-232) results from the participants under investigation, the lack of movements participants were exposed to could explain why only the catch improved as opposed to the other FMS assessed. Hence the specificity of training and cultural norms which presented within each school (primarily playing netball and ball games) could perhaps explain why only the catch process scores improved and not the run for speed, throw for distance and standing long jump. Studies have indicated that cultural norms and gender stereotyping do affect the motor skill acquisition of individuals (Thomas & French, 1985; Roberton & Konczak, 2001:102; Teixeira & Gasparetto, 2002).

An additional variable which may have affected the lack of FMS process score improvements in the present study’s participants are their overweight and obesity levels (a personal structural constraint according to Newell’s constraint theory). A trend noted in the present study was that 11 year old participants were found to have the highest overweight and obesity rates (table 33, page 224). Hence the lack of statistically and practically significant differences in the process scores identified could have been due to the fact that there was a decrease in FMS proficiency scores in the 11 year old group. Statistical significant differences between normal, overweight and obese participants were found for the run for speed (df=224; f=27.07; p=2.9E-11) and standing long jump (df=224; f=15.68; p=4.2E-07) product scores for the participants under investigation (table 35, 36 and 37; pages 225-226). These differences were furthermore found to be of medium to large practical significance
between the normal and obese participants for the run for speed (d=.61 to d=1.77) and standing long jump (d=.40 to d=1.33), consequently indicating the negative influence weight status had on these aforementioned FMS. Numerous studies have indicated that overweight and obesity can negatively influence particularly locomotor FMS proficiency results (Marchall & Bouffard, 1997; Beineiffe et al., 1999:443-455; Jinabhai et al., 2003:365; Okely et al., 2004; Riddiford-Harland et al., 2006:42-49; D'Hondt et al., 2009; Lubans et al., 2010; Truter et al., 2010; Cliff et al. 2011; Threethambal et al., 2012). This could possibly explain why only the catch as opposed to run for speed and standing long jump improved as participants aged.

Based on the lack of statistical and practical significant differences in the anthropometric variables effects on the FMS process score proficiency results (table 15, page 207), it can be concluded that the process scores were affected primarily by a lack of motor learning as opposed to changes in participants standing and seated heights and arm lengths.

6.2.2 Overall Fundamental Movement Skill Proficiency Results

As discussed in chapter 2 and 3, a significant portion of the empirical research relevant to this study was conducted internationally, with a lack of empirical research findings on the FMS status of children within the South African context. These non-South African studies hence formed the primary comparative foundation from which the results from chapter 5 of this study were compared to and subsequently deliberated. An additional aspect noted within the literature reviewed was that mastery or near mastery cut-offs where utilised when evaluating FMS proficiency process scores of participants and results were reported in terms of what percentage of participants performed the FMS proficiently. Hence in order for this study's findings to be compared to empirical research the more stringent BC approach was converted into a TGMD II score. As previously mentioned the logic behind employing the BC approach was due to the fact that FMS proficiency scores could be ranked on a scale of 1-to-3 and hence participants could be placed into either an initial, elementary or mature movement proficiency stage as opposed to merely receiving a ‘yes’ or ‘no’ score for the BC variable being present or not when only employing the criterion referenced TGMD II FMS assessment protocol. Consequently by employing
both the TGMD II criterion referenced assessment protocol the percentage of participants deemed proficient could be indicated and compared to international studies. Additionally by employing the BC approach it allowed for specific feedback on the stage of proficiency of the FMS under investigation and has ensured for baseline data that can be used in the future to facilitate the implementation of possible FMS interventions.

6.2.2.1 Overall proficiency scores in the present study

When taking into consideration the BC approach results for the aforementioned FMS the run for speed (94.71%) (figure 16, page 191), standing long jump (96.9%) (figure 21, page 196) and throw for distance (83.56%) (figure 25, page 200) composite BC scores indicated that most participants did not achieve mastery whereas the catch results (91.19%) (figure 29, page 204) indicated that most participants achieved mastery. Hence overall, the BC approach indicated that 3 out of the 4 FMS qualitatively investigated were performed at a poor mastery level.

Overall TGMD II results for the present study indicated that participants’ run for speed (100%) (figure 16, page 191) and catch (96.92%) (figure 29, page 204) FMS proficiency results were performed at a near mastery or mastery level whereas most of the participants’ standing long jumps (93.78%) (figure 21, page 196) and throw for distances (83.56%) (figure 25, page 200) process scores were performed least proficiently. Hence overall, and according to the TGMD II, 2 out of the 4 FMS investigated qualitatively were performed at a poor FMS proficiency level.

At face value, and when only taking into account the TGMD II results of this study and the sentiments of Pang and Fong (2009) in which specificity of training is required for FMS proficiency to transpire, it would seem as though the female learners under investigation in this study participated mostly in running and catching activities and less in standing long jump and throwing for distance activities. Closer examination of the sports primarily played in South African schools reveals that netball is a sport primarily played by female learners (Sport and Recreation South Africa, 2005:15). Netball consists of catching, sprinting type stop-start activities, vertical jumps and short distance throws with a large ball. Hence the present study's
results would seem to be indicative of the sporting cultural norms and the primary PA endeavours female learners participate in. These social norms may hence be filtering through to the physical activities female learners participate in during weekdays and weekends (page 231-232) and the physical education lessons and or sporting codes presented at South African schools. As previously mentioned, the influences of culture and or gender stereotypical sports on the movement proficiency of children have been noted in many empirical studies (Thomas & French, 1985; Teixeira & Gasparetto, 2002; Barnett et al., 2008:2137–2144; Spessato et al., 2013). It should be indicated that most empirical studies indicate that object-control skills are the most poorly performed FMS by female learners. In the present study’s case, however, the catch was proficient but the throw for distance was not. This indicates that specificity of FMS training and the size of a ball utilised in PA endeavours were factors possibly affecting the FMS performances noted. As most South African schools have a netball court and culturally female learners are expected to play netball the catching and running skill would be expected to be performed proficiently. A FMS in which a cricket ball (predominantly a male sport within South Africa) as opposed to a netball ball is expected to be thrown for distance and a standing long jump (which may predominate in more male dominated sports) is poorly executed by females can be expected. According to Newell (1991) these cultural, gender stereotypical sports, ball size and being female variables noted as influencing the present FMS proficiency scores of the female learners under investigation would equate to environmental, task and personal constraint which are inhibiting the holistic motor development of the learners at these South African schools. Belka (1983) would additionally agree with the argument that ball size affects the motor proficiency of the throwing ability of children. Lastly, and in terms of the dynamic systems theory (Thelen, 2000), this would equate to the poor management of FMS movement programs through neglecting to ensure for holistic FMS development by providing opportunities for all FMS to reach an attractor states.

Investigating international literature from Australia, Brazil, USA and Hong Kong and how the present study’s participants compared in terms of their FMS proficiency ability may provide further insight as into why the present study’s participants performed FMS at a poor FMS proficiency level.
6.2.2.2 International comparisons

When comparing the present study’s run for speed TGMD II results (100% participants viewed as proficient) (figure 16, page 191) to the results from each international study’s run for speed (as depicted in chapter 3, table 4 page 84 or refer to addendum 1), the present study’s participants were found to perform better than the Australian (Booth et al., 1999; Okely & Booth, 2004; Hardy et al., 2012; van Beurden et al., 2002) and Brazilian participants (Spessato et al., 2012). On the other hand, scores were found to be on par with Pang and Fong’s (2009) results in which 92% to 100% of the 167 Hong Kong participants aged 6-to-11 years performed proficiently in the run for speed and in Ulrich’s (2000) results in which 85% of 9-to-10 year old USA participants performed at a near mastery or mastery level.

Three possible explanations account for the proficiency score differences noted in the run for speed between the present study’s results and that of the international studies findings. Firstly, the differing assessment protocols employed and their inherent bias, secondly the use of a small or non-representative sample and thirdly the difference in the importance placed on physical education programs at schools may have caused the inconsistency in findings between the present study and the international study findings.

When comparing the Manual for classroom teachers (Walkley, 1996) and the Get Skilled Get Active Manual (Davy et al., 2000) used in the Australian studies to the TGMD II employed in the present study, the Hong Kong and USA investigations it becomes clear that less BC variables are assessed in the TGMD II, possibly indicating why the Australian studies results indicated poorer run for speed scores overall. In terms of the importance placed on FMS development in physical education systems, according to Pang and Fong’s (2009) FMS were integrated into the physical education system within the schools under investigation, and hence this could explain why there are higher proficiency results within the Hong Kong participants assessed when compared to the Australian studies. However, within the South African context, the opposite physical education scenario presents (Amusa & Toriola, 2006; van Deventer, 2004, 2009, 2012), hence not adequately explaining the similarly high proficiency results within the Hong Kong and South African
participants’ run for speed result. Perhaps an alternative explanation as to why Ulrich (2000) and Pang and Fong’s (2009) studies and the present study’s run for speed results indicated that most children performed at a near mastery or mastery level could be that, in comparison to the Australian studies, these studies employed convenience sampling and/or had a small number of participant as compared to the Australian and Brazilian investigations in which well over a thousand participants were tested. Furthermore, the Australian studies took measures to ensure for the analysis of a representative sample of the population.

Regardless of the similarities and dissimilarities between studies, when reviewing the overall run for speed results from the present study (when referring to the more stringent run for speed BC score which indicated that 93.78% of participants could not run proficiently) and the low percentage of participants performing the run for speed proficiently in the Australian and Brazilian studies, it would appear as though female participants between the ages of 9-to-12 years cannot run proficiently. These poorer scores would seem to be attributed to either placing minimal emphasis on FMS interventions and or physical education or employing teachers as opposed to physical education specialists to provided FMS training programs. This illustrates that sport management structures in schools have to cater for holistic FMS development in order for the FMS status of participants to improve and additionally that further research into the FMS proficiency attainment of learners is required.

According to the BC approach, 3.1% of participants were classified as proficient and 96.9% were classified as non-proficient standing long jumpers. The TGMD II classified 6.22% of participants as proficient and 93.78% of participants as non-proficient when employing the near mastery and mastery cut-offs for the standing long jump (figure 21, page 196). Hence most participants performed the standing long jump at a poor FMS proficiency level. Comparisons to the relevant international studies reviewed for the purposes of this study are difficult as none, except for Pang and Fong’s (2009) study, investigated the standing long jump proficiency levels. Instead the vertical jump proficiency scores were investigated (table 4, page 84 or refer to addendum 1). According to literature, the vertical jump is mastered before the horizontal jump as it requires vertical displacement of the COG as opposed to horizontal displacement, with the former being easier for children to master.
(Haywood & Getchell, 2009:126). Therefore, the vertical jump scores would be a reflection of the possible qualitative scores for the standing long jump. It can thus be deduced that as the vertical jump scores in the Australia and Brazil studies investigated indicated that most female learners performed the vertical jump at a poor proficiency level (12% to 62.5% of participants), had the standing long jump been assessed similarly low proficiency scores could have been expected. It would thus seem that overall the standing long jump is a FMS that most female learners between the ages of 9-to-12 years in the present study, Australian and Brazilian studies could not master.

According to the TGMD II and BC approach 16.44% and 6.22% (figure 25, page 200) of participants in this study were classified at a near mastery and mastery level for the overarm throw respectively. Hence 83.56% and 93.78% were classified as non-proficient overarm throwers by the TGMD II and BC approach respectively. Consequently, most participants in the present study could not throw a cricket ball overarm proficiently. Similarly low scores were reported in the international studies investigated. That is, only between 4.2% and 22.7% of female participants were found to be proficient throwers in the Australian and Brazilian participants aged 9-to-12 years (table 5 page 95 or refer to addendum 1). Ulrich’s (2000) USA study furthermore indicated that not more than 55% of 9-to-10 year olds could throw overarm proficiently. The present study and international studies throw for distance scores were found to be on par with empirical findings from other studies which indicate that females tend to perform the overarm throw at a low proficiency level (Thomas & French, 1985; Roberton & Konczak, 2001:102; Teixeira & Gasparetto, 2002; Larsen, 2003:1-138; Deli et al., 2006:18; Ziviani et al, 2009:262; Hume, et al. 2008:163; Puciato, 2010:67). Researchers are inclined to attribute low proficiency scores in FMS, particularly the overarm throw for distance in females, to the lack of opportunity to practice and or cultural practices. As previously mentioned the primary sport at school level of the South African participants in this study was Netball, which is predominantly a catching and throwing activity with a larger ball in comparison to the smaller cricket ball. Furthermore, it should be noted that there are biomechanical differences between an overarm throw for distance with a cricket ball compared to that of a shorter distance netball chest pass. This finding illustrates the role that specificity and variability (ensuring for a variety of movements and the utilisation of
different objects) of training play in movement skill attainment. Hence specificity of training, the lack of variability in training and sporting cultural norms can possibly explain the overall low overarm throw proficiency results in the present study, Australia, Brazil and the USA.

According to the BC 91.19% approach scores of the participants were classified as proficient and 8.81% were classified as non-proficient catchers in the present study (figure 29, page 204). In comparison, the TGMD II classified 96.92% of participants as proficient and 3.08% of participants as non-proficient when employing the near mastery and mastery cut-offs. In contrast to participants in the Australian and Brazilian studies, participants in the present study were found to be superior in their catching proficiency process scores. That is, in the Australian and Brazilian studies between 8.8% and 55.8% of participants were deemed proficient catchers (table 6, page 104 or refer to addendum 1). Differences noted between participant’s catching ability is difficult to explain as the BC variables assessed in the FMS assessment protocols in the Brazilian and Australian study were relatively on par. Furthermore, Netball is a sport also enjoyed by Australians. Hence, as depicted in the standing long jump results, further investigation into variables other than cultural norms and practices may explain the differences and or similarities noted between the present study’s and international studies results.

Possible other variables to consider when deliberating the FMS status of a group of participants is to take note of the possible confounding variables such as overweight and obesity levels, PA levels and anthropometric variables affect. Closer examination of the NSW SPAN studies from the year 1997 to 2010 illustrated interesting trends and their possible correlation to the poor FMS proficiency levels observed. As discussed in the SPAN 2010 report (SPAN, 2010) and Hardy et al. (2013), FMS trends assessed between the year 1997 and 2010 indicated statistically significant improvement from 1997 to 2004 and thereafter statistically significant decreases in certain FMS proficiency scores were observed between the years 2004 to 2010. To explain these FMS results, authors took note of other trends between 1997 and 2010. The prevalence of overweight and obesity in both girls and boys increased between 1997 and 2010. Interesting to note that overweight and obesity tended to have the most statistically significant relationship with the FMS proficiency
levels in all age groups assessed in the SPAN project, except for 7 year old participants in year 2 (SPAN, 2010:172-175), hence possibly providing strong evidence for the need to ensure that overweight and obesity levels in children is dealt with effectively. When reviewing the present study’s overweight and obesity results and their effect on the FMS under investigation it was firstly found that 24% of participants were overweight and 8% were obese (table 33, page 224). These findings are on par with Kelishadi’s (2007) sentiments that developing countries are showing the same overweight and obesity increases as developed countries. Furthermore, and as already mentioned, when identify statistical and practically significant differences between the overweight and obesity status of the present study’s participants to that of their FMS status statistically significant differences were found for the run for speed (df=224; f=27.07; p=2.9E-11) and standing long jump (df=224; f=15.68; p=4.2E-07) when comparing product scores to normal weight, overweight and obese participants (table 35 to 37, pages 225-226). More specifically, overweight and obese participants were found to be statistically and practically significantly slower in the run for speed and jumped shorter distances when compared to their normal weight peers. Consequently, it can be deduced that overweight and obesity was a confounding variable, other than cultural norms and gender stereotypes, affecting the FMS proficiency status of children in Australian, Brazilian, USA and the present study’s participants.

SES, rurality and cultural backgrounds had varying degrees of statistically significantly relationships to FMS proficiency scores of participants in the SPAN 2010 study (SPAN, 2010). That is, these statistically significant relationships were dependent on the age and FMS under investigation. In the present study, as lower and higher SES groups were not compared, the effect of SES on FMS could not be accessed directly. However, the PA levels of participants in the present study were investigated and hence comparisons between the SPAN 2010 study and the present study can be made. Overall, statistically significant downward trends in PA were noted between the year 2004 and 2010 in the SPAN investigation (SPAN, 2010). SES was additionally found to be statistically significantly related to PA levels with lower SES groups being less PA in comparison to higher SES groups. The trends noted in FMS proficiency were similar to the PA trend noted between 1997 and 2010 and hence may have been linked. Unfortunately PA and FMS status were not
assessed with statistical measures, and hence accurate conclusions could not be
drawn from the SPAN study (SPAN, 2010:7). Overall, the number of participants in
the SPAN 2010 study meeting PA guidelines varied from 40% to 60%, depending on
whether it was winter or summer. In the present study, it was found that only 45% of
participants met the recommended 60 minutes of daily PA on weekends, which is
somewhat on par with the low levels of PA depicted in the SPAN 2010 study. In the
present study due to a lack of direct PA measures, deductions as to the PA levels on
week days are not possible. However, regardless of this limitation what can be
added is that similarly to the SPAN 2010 investigation (SPAN, 2010:225), in the
present study teachers provided the physical education and extra-mural participation
to the participants under investigation. Additionally, physical education was not
priorities within the school system as the South African Department of Education has
not made physical education a standalone subject. Amusa and Toriola’s (2006) and
Van Deventer’s (2004, 2009, 2012) investigations into the quality of physical
education in the South African school system and the lack of employing physical
education specialists adds to the deduction that participants in the present study
were most probably not meeting the minimum PA daily requirements. Hence the lack
of PA in both the Australian SPAN (SPAN, 2010) investigation and the present study
could have been a confounding variable which affected the overall FMS proficiency
of the participants under investigation. With empirical research from Mckenzie et al.
(2004), Wrotniak et al. (2006:e1759) and Barnett et al. (2008) indicating that children
who are more PA tend to have higher FMS proficiency scores, this is a viable
deduction. Consequently, based on these abovementioned literature findings; a lack
of PA, overweight and obesity and the lack of quality FMS programs could have
resulted in decreased FMS proficiency in the Australian, Brazilian and present study.
However, the statistically significant correlations between these variables and the
FMS investigated were either not directly measured and or differed according to the
FMS or age group under investigation. Future investigations should hence focus on
direct measures of PA and assess the sport management structures in place and the
individuals providing the physical education sessions. As indicated by Hardy et al.
(2013) more emphasis should be placed on what actually happens in physical
education classes in schools and the actual FMS interventions provided as opposed
to only investigated SES, gender, PA levels, overweight and obesity and so forth
effects on FMS proficiency status.
6.2.3 The Value and Implications of employing the BC and TGMD II Approaches in the Present Study

In order to understand the consistency and inconsistencies noted in this study’s FMS proficiency results when using the TGMD II versus the BC approach assessments, a closer examination of the number and the definition of each of the BC variable and the objectivity within each BC variable requires further discussion.

The BC approach employed for the purposes of reviewing the run for speed in the present study deemed most participants as non-proficient runners (94.71%) whereas the TGMD II regarded all participants as proficient (100%) (n=227) (figure 16, page 191). Evaluating the qualitative aspects of each BC variables utilised to assess the run for speed can assist in explaining the above conflicting results. The BC run for speed approach assesses 9 BC variables whilst the TGMD II assesses 4 BC variables. An additional facet to consider when comparing the run for speed BC approach to the TGMD II is that the former FMS assessment protocol is more stringent as it not only has more BC variables but additionally has more objective cut-offs (angles measured via a Dartfish analysis). This lack of consistency in the number of BC variables assessed within each FMS was additionally noted in Okely and Booth’s study (1999:371) in which the authors found that certain FMS had less BC variables to assess when compared to other FMS, hence biasing results and making comparisons between studies difficult.

In contrast to the run for speed TGMD II and BC approach scores, the throw for distance, standing long jump and the catch scores were relatively on par. The same argument employed for the run for speed can be used to explain the similarities in results for these aforementioned FMS. On closer examination of the TGMD II and BC approach for the catch, throw for distance and standing long jump similar, less stringent objective critical BC variables (less angular measures) were assessed.

These consistencies and inconsistencies in results lead to an important implication to consider for future FMS investigations. More specifically, when comparing the run for speed to the catch, standing long jump and throw for distance BC and TGMD II assessment protocols, the inconsistency in results based on the presence or lack of
more objective measures and or the similarity or dissimilarity in the number of BC variables assessed, indicates that perhaps the more subjective assessments may be biasing results and there may be a need for researchers to investigate the creation of new FMS assessment protocols. As noted in a study by Cools’ et al. (2009:165), the lack of stringent FMS assessment protocols may be based on the fact that most movement assessment batteries analysing children are employed to identify developmental disorders as opposed to movement proficiency levels. An additional factor to consider when reviewing FMS assessment protocols according to Cliff’s et al. (2009) is that there may be gender bias present within assessment batteries that tend to favour male dominant movements such jumping and throwing as opposed to coordinative, balance and rhythm type assessments which favour female participants (which inherently are movement repertoires based on gender stereotyping activities in society). Lastly, and in terms of the BC approach and the need for updated FMS assessment protocols, the lack of longitudinal investigation supporting the BC approaches developmental stages direct research towards further investigation into this field of study (Burton & Miller, 1998:220). Consequently these aforementioned empirical findings indicate that overall a new FMS assessment battery which focuses on identifying proficiency levels as opposed to developmental disorders, that is gender neutral and that is longitudinally validated needs to be created and investigated.

Regardless of these aforementioned differences and limitations within the TGMD II and the BC approach and FMS assessment protocols in general, both protocols BC variables indicated that on average the present study’s participants performed poorly in the FMS under investigation. Investigating each FMS BC variables assessed with the BC approach may provide further evidence as to why participants performed poorly.
6.2.4 BC Variable Score for Each Fundamental Movement Skill Under Investigation

In addition to investigating and discussing the statistical and practically significant differences between each age groups FMS scores within the present study’s participants and providing the overall percentage of participants aged 9-to-12 years performing the FMS under investigation proficiently, it is important to discuss each BC variable’s mean and SD scores within each FMS. Through discussing each BC variable mean and SD scores the information can be used to direct and investigate the effectiveness of future FMS interventions which are aimed at improving the FMS status of the present study’s participants.

6.2.4.1 Run for speed BC variable differences

As illustrated in chapter 5 (figure 16, page 191), mean results for the BC run for speed variables from the BC approach indicated that participants, on average, performed at a stage 2 proficiency level. That is, at an elementary stage with a mean overall score of 2.30 (±0.35). Furthermore the elbow angle (1.8±0.48) was found to be least proficient and the flight phase (3±0) and knee-flexion recovery phase where found to be most proficient (3±0). Similar BC variable assessment results were depicted in the Horita’s (2008) study in which 162 males and females aged 8-to-11 years old from schools within the Action Schools BC Program from the Burnaby and Vancouver School District were assessed. According to Horita’s results (2008:63) participants performed worst in maintaining a constant elbow flexion between 75 to 105 degrees during the run (1.2±0.5). Take-off (2.2±0.5) and leg drive (2.2±0.7) scored the highest in female participants. That is knee extension of the support leg in the drive phase reached an angle of 150 to 165 degrees (but not above 165 degrees) and movement of limbs in the sagittal plane consisted of slight toeing out of the foot or crossing of the body’s midline (as opposed to being maintained in the sagittal plane). Similarly Okely and Booth’s (1999:367) assessment of the run for speed with the TGMD in 6-to-8 year olds indicated that the 8 year old females performed poorly in landing on the ball of the foot, maintaining a stable trunk with eyes focused forward, maintaining a bent elbow at 90 degrees and driving the arms and legs forward and back in opposition to each other.
The results in Okely and Booth’s (1999), Horita’s (2008) and the present study indicate that each group of participants investigated had similar yet slightly different BC variables performed at a proficient and non-proficient level. This hence supports the notion that baseline assessments with subsequent specifically targeted FMS interventions are needed when dealing with a group of children. A definite similarity noted between these studies was that arm action and foot action were performed at an initial or elementary level. According to Wickstrom (1983:52-55), in inexperienced children the foot contacts the ground with a full sole and hence limited flight is attained. This foot action inadvertently creates a breaking motion and consequently increases the time taken to cover a given distance. Furthermore Wickstrom (1983: 52-53) stated that participants performing the run for speed at an initial or elementary level tend to have their arms held abducted or ‘hook’ or swing the arms across the midline of the body. This can result in forces being displaced in the transverse plane and not forward and backward in the sagittal plane, hence not aiding in forward propulsion of the body during the run for speed and slower times (Payne & Isaacs, 1999:260). These types of movements can aid in explaining why run for speed product scores were poor in comparison to normative data in the present study and hence can direct future FMS interventions towards improving these particular biomechanical variables within the run for speed.

6.2.4.2 Standing long jump BC variable differences

According to literature, the standing long jump is one of the more difficult FMS to master due to the coordinative, balance, strength and COG displacement requirements (Haywood & Getchell, 2009:126). Furthermore most children only achieve a mastery level in the standing long jump by the age of 9 years (Horita, 2008:17).

Closer examination of the BC variables assessed in the present study can explain why the participants FMS proficiency score for the standing long jump were identified as poor (figure 27, page 202). On average, most female participants in the present study achieved an elementary level of FMS proficiency for the standing long jump (2.04±0.55). In the present study knee extension (1.84±0.6), trunk take-off action/angle (1.84±0.47) and landing balance/COG displacement forward and over
the feet (1.58±0.50) scored lowest in the standing long jump BC variables investigated within the present study’s participants. Hence even though participants crouched between 91 to 109 degrees in preparation for the jump (2.29± 0.52), taking advantage of the stretch reflex of the muscle spindles together with exerting maximum power up and through the legs to cause maximum knee and hip extension and an optimal take-off angle did not take place. Consequently this lack of full knee extension, the optimal take-off action/angle and landing correctly impeded standing long jump’s FMS proficiency levels and product scores attained within the present study’s participants (figure 27, page 202). According to Payne and Isaacs (1999:266) a limited preparatory crouch and corresponding arm swing can be expected from novice jumpers. Subsequently, limited extension of the body occurs and a shorter horizontal distance is achieved. Consequently, it can be concluded that participants employed a novice jumping style and hence a poor preparatory phase which resulted in a poor flight arm and leg action and subsequent landing with the COG forward and over the feet.

Horita (2008) found similar results but the preparatory leg position was found to be at an initial level for most participants as opposed to the present study in which most participants crouched at an elementary level. That is, most participants in Horita’s study (2008) crouched 110 degrees or more as opposed to 91 to 101 degrees in the present study. In the present study participants, on average, scored a 2.32 (±0.52) for the preparatory arm swing. More specifically most participants did not take full advantage of the arm’s contribution to force generation by extending the arms behind and high above the head before the powerful downward thrust in unison with the preparatory crouch. These findings are once more, comparable to Horita’s study’s (2008) participants in that an average score of 2 for the arm preparatory swing was achieved. In a study by Ashby and Delp (2006:1732) arm motion enhanced the standing long jump performance due to the increase in vertical and horizontal positions force generation and subsequent velocity attainment of the entire body before take-off. Hence the lack of arm swing in Horita’s (2008) study and the present study would have impeded overall subsequent FMS BC variable proficiency levels and possibly the product scores of the standing long jumps achieved.
An additional BC variable performed at an elementary level in the present study’s participants was the take-off angle (1.84±0.47). According to Wakai and Linthorne (2005:82), ‘a projection angle of 45 degrees is only appropriate if the magnitude of the projection speed generated by the jumper is the same for all projection angles’. In other words as the projection speed decreases, regardless of the projection angle at take-off, any jumps at 45 degrees or above will result in sub-optimal jumping distances achieved. For a jump to be successful the angle of take-off must be within 5 degrees of the optimal angle of take-off and the speed of the movement must be vigorous and powerful (Wakai & Linthorne, 2005:94). Hence participants in the present study would have had to have had a mature arm swing and preparatory crouch with a subsequent powerful thrust from the legs to exert a force into the ground hard enough to ensure for an adequate velocity before take-off, which did not occur.

Overall results indicate that the female participant in the present study and Horita’s (2008) study performed at a subpar level for the standing long jump. Additionally there were many BC variables which did not reach FMS proficiency status indicating the necessity for interventions focusing on these particular critical BC variables which result in improved performance of the standing long jump.

6.2.4.3 Throw for distance BC component differences

When reviewing the throw for distance BC variable process scores, participants performed poorly in trunk rotation (1.96±0.22), ensuring for a progressive whiplike coordination of the body (1.93±0.29) and releasing the ball at an adequate angle (1.60±0.91) (figure 27, page 202). These findings are similar to those noted in Teixeira and Gasparetto (2002:151-160) who studied the development of lateral asymmetry in the overarm throw by using Roberton and Halverson’s (1984) BC qualitative analysis on 71 girls and boys aged 4-to-10 years. In Teixeira and Gasparetto’s study humerus and forearm action and weight transfer were least proficient in girls. Arm preparation, trunk action and leg action were most developed in the girls assessed. However, these aforementioned proficient skills were still subpar when compared to the overall global index, hence indicating that girls possessed a poor overarm throwing ability. Overall findings indicated that girls aged
10 years were at an over-arm throwing level comparable to boys aged 4 years. Similarly to what was depicted in Teixeira and Gasparetto (2002) study, participants in the present study mostly employed a backward and upward arm movement at an intermediate level and limited hip and shoulder rotation (known as block rotation). Additionally the leg action’s score of 3 in the present study were comparable to that of Teixeira and Gasparetto (2002), indicating that most participants employed a contralateral step. However, the contralateral step was short in both the present study and Teixeira and Gasparetto (2002).

A similar study to that of Texiera and Gasparetto (2002) was conducted by Roberton and Konczak (2001:91-103) who found a relationship between outcome variables (horizontal ball velocity) and Roberton’s and Halversons (1983 In Roberton & Konczak, 2001:91-103) BC developmental level of a forceful over-arm throw. The study was based on a continuation of Roberton, Halverson and Erbaugh (1981 In Roberton & Konczak, 2001:91-103) in which 73 girls and boys aged 6-to-13 years old were assessed. Of the original study, only 39 children managed to complete the 7 year longitudinal study. The main findings for the BC variable assessments were (Roberton & Konzak, 2001:91-103):

- Roberton and Halverson (1984) BC approach accounted for 69-85% of the variance in velocity achieved.
- Trunk action came into play at age 13 years old. Younger children tended to employ block rotation.
- Step breadth became more important than just taking a step as the children aged. That is, for a successful throw to be achieved children had to step at least the width of half their body height.
- Humerus and forearm action accounted for most of ball velocity achieved.

What can be noted from Roberton and Konczak (2001:91-103), Teixeira and Gasparetto (2002:151-160) and the present study is that trunk action in female participants was poorly developed. Furthermore, humerus and forearm action tended to be least developed for female participants up to the age of 10 years old (Teixera and Gasparetto’s, 2002), which is in agreement with Roberton and Konczak (2001:91-103) findings in that the primary attractor state at younger ages or with more
inexperienced throwers was block rotation of the trunk, with the humerus being held oblique and no forearm lag.

In accordance with Roberton and Konczak’s study (2001), Stodden et al. (2006:423) additionally studied the correlation of ball velocities to Roberton and Halverson’s (1984 In Stodden et al., 2006:423) development sequence of the step and trunk action in 26 children aged 3-to-15 years old. Findings indicated that the stepping length and action could predict the stepping developmental level 85.4%. Lastly the biomechanical variables of the trunk correctly predicted the developmental level of throwing trunk action 93.8% of the time. Overall ball velocity increased with every progressive level increase in the BC approach. These results can be used to explain the present study’s throw for distance product scores as the stepping action, stride length and trunk whip-like action increased ball velocity in the Stodden’s et al. (2006) participants; all of which were at an intermediate level in the present study’s participants. Furthermore the used of block rotation and a lack of humerus and forearm action were found to account for most of ball velocity achieved in Roberton and Konczak (2001), which were additionally depicted in the present study’s results, and hence could explain the throw for distance product scores attained.

The primary limitation in comparative purposes for the Roberton and Konczak (2001: 91-103), Teixeira and Gasparetto (2002:151-160) and Stodden et al. (2006:423), studies is that distance achieved and overall proficiency level were not assessed. Instead the focus was on either which BC had the greatest effect on ball velocity achieved or the BC developmental asymmetries in left or right hand overarm throwing movements. Secondly the sample sizes were small and there was no mention of randomized sampling. Consequently future investigation should take into account process and product scores in order for more deductive conclusions to be drawn.

In summary, participants in the present study and in the aforementioned overarm studies indicated that females aged 9-to-12 years tended to employ block rotation, did not employ a stepping action or if a stepping action was employed was short and there was poor use of forearm and wrist release at follow-through. Based on Roberton and Konczak (2001), Teixeira and Gasparetto (2002) and Stodden et al.
executing these BC parts is a strong predictor of performance outcomes in the overarm throw, hence indicating that FMS interventions in the overarm throw are necessary for the present female participants under investigation in order to improve to a mature state.

6.2.4.4 Catch proficiency

Based on the BC results participants scored on average 2.84 (±0.45) out of a possible score of 3 for each BC variable assessed (figure 31, page 205) and consequently it was deduced that most participants in the present study could perform the catch proficiently. When comparing the present study’s results to that of the Australian findings (table 6, page 104) it can be noted that the percentage number of participants deemed proficient in the Australian studies investigated was poorer in comparison to the present study. This was possibly due to the fact that the assessment protocols employed in the present study and the Australian studies were different. As opposed to employing an underarm-throw-catch sequence, as employed in the present study, the manual for classroom teachers (Walkley et al., 1996) had participants catch a tennis ball thrown underarm from a distance of 10m and 15m for 8-to-10 and 11-to-12 year olds respectively. The difference in the catching protocols could hence have affected the overall results obtained. As previously discussed, Newell’s constraint theory (Newell, 1991) depicts that task constraints such as the equipment a participant uses or the motor skill a participant is required to execute can affect the motor skill proficiency of the skill.

In a study by Belka (1985:42-51) 30 randomly selected males and females aged 6, 8 and 10 years were assessed for their catching ability when different task constraints were manipulated. Children were required to catch 3 different ball sizes when an underhand chest pass was administered. Each child had to catch a ball from different heights of interception (chest, waist and knee heights) and each child was required to catch a ball from different horizontal distances. Findings indicated that the ball size had no influence on the catching ability of children. Consequently the authors concluded that the medium sized balls between 12.7 cm to 21.6 cm in diameter used did not have an effect on catching ability (Belka, 1985:48). However, in a study by Isaacs (1980 In Belka, 1985:42) balls bigger than 25.4 cm in diameter
were found to promote stopping the ball with fingers spread (immature hand movement). Additionally a very small ball made the catching task more difficult. When the distance of the catch was considered findings indicated that closer distances were easier. When the distance was increased to 3.96m and 5.49m children’s ability to catch decreased. Lastly when chest, waist and knee height passes were investigated; the chest height catches were found to be easiest to catch, with waist catches being moderate and knee catches being most difficult. However after the age of 10 years, chest and waist catches were the same. Hence the present study’s testing protocol can be deemed as easier than the Australian catching protocol as the ball was bigger (handball versus tennis ball), the distance was closer (3m versus 10m and 15m) and the trajectory of the ball allowed for possibly a more constant overhead catching position.

On closer examination of the present study’s protocol employed to assess the catching ability of participants, certain limitations were additionally noted. Van Waerelde, et al. (2004:49-60) conducted a study on 133 children aged 7-to-9 years in which the MABC’s validity as a test battery was assessed. Of particular interest to this review was the underarm-throw-catch test in which children had to throw a ball underarm against a designated point on a wall and catch it afterwards. In order to test the validity and reliability of the catching test, it was assessed against the gold standard test in which 80 ball catching trials in varied situations were administered. According to the authors the 80 ball catching test has been found to be a reliable scoring system (Van Waerelde et al., 2004:57). A significant but lower correlation was found between the gold standard test and the underarm-throw-catch test for the 9 year old children. The primary constraint identified was that the underarm-throw-catch test additionally assessed a child’s ability to throw underarm at a target accurately. Consequently having someone throw the ball to a child could make it a more valid test for testing catching ability per se. However, Van Waerelde et al. (2004:264) additionally noted that ball games have a high degree of variability and hence a standardised ball-catching test will always have inherent limitations.

In summary, the present study’s findings indicated that participants could catch proficiently. In contrast, studies which employed more challenging catching assessment protocols indicated that children could not catch proficiently and
additionally noted that performance plateaus can be expected in a catching test which is too easy for the participants to perform. Future studies should investigate the possibility of creating a catching protocol which will adequately differentiate catching ability as the present study’s protocol may have caused a ceiling effect in results and or indicated that participants are proficient catchers, which they might not have been.

6.2.6 Summary and Relevant Implications for the FMS Process Scores

Based on the qualitative results discussed in this section and in ensuring for that the first objective of this study is dealt with, which was to determine and compare the FMS proficiencies of 9-to-12 year old girls, the following is relevant:

- No process score improvements, other than for the catch, were noted in the FMS under investigation and hence as the participants aged so limited improvements in their movement proficiency transpired. It was deduced that environmental variables such as the lack of FMS programs and physical education within schools, the high overweight and obesity rates, the low PA levels and the sporting cultural norms were possible contributors to the poor improvements in the FMS scores in the present study’s participants. This was found to be on par with literature findings.

- Most participants in the present study could not perform the run for speed, throw for distance and standing long jump proficiently. More specifically these FMS were performed at an elementary stage of FMS proficiency. The catch was found to be the only FMS most proficiently performed. Two implications arise from these findings. Firstly, the present study’s participants necessitate tailored FMS interventions to improve the poorly performed FMS. Secondly, sporting cultural norms may be influencing the holistic development of movement repertoires, hence indicating that FMS interventions need to be gender neutral.

- When taking the BC variables into consideration within the run for speed; participants on average did not place the ball of the foot on the floor or fully extend the take-off leg to maximise force production for the flight phase of the run during ground contact of the drive off leg. Additionally participants did not maintain consistency in the elbow angle or keep arm movements in the
sagittal plane to prevent force being produced into the transverse planes during the run for speed. Hence, overall children performed the run for speed at an elementary level of FMS proficiency. The poor results were on par with those depicted in the Australian studies (Booth et al., 1999; Okely & Booth, 2004; Hardy et al., 2012; van Beurden et al., 2002).

- When taking the BC variables into consideration for the standing long jump; on average participants did not crouch deep enough to take advantage of the stretch recoil which is generated from a deeper crouch and the subsequent greater power production utilised to project the body into the air. The participants did not drive the arms back and high behind the body or thrust the arms forcefully forward in synchronisation with a deeper crouch. Lastly participants did not fully extend their bodies before take-off, did not lift the knees to a parallel position or keep the arms up and overhead during flight and lastly did not land with the body over the body’s COG. Hence, overall, participants performed the standing long jump at an elementary level of performance. These overall poor results were on par with those of Horita’s (2008). More empirical research on the standing long jump is required as studies tend to focus on the vertical jump process scores.

- When taking the BC variables into consideration within the throw for distance, on average participants used block rotation, did not employ a pronounced broad stepping contralateral foot action, released the ball high overhead and did not ensure for adequate follow-through once the cricket ball was released. Hence, on average, the participants in this study performed the overhand throw at an elementary level of FMS proficiency. This was found to be on par with Roberton and Konczak (2001), Teixeira and Gasparetto (2002) and Stodden et al. (2006:423).

- When taking the BC variables into consideration within the catch, on average, most children could maintain their eyes fixed on the ball, adjust the body to catch the ball, catch the ball with the palms facing up and provide a ‘give’ on contact with the ball by stretching the arms out to catch the ball and progressively bending the elbows on contact with the ball. Hence, overall, participants performed the catching action at a mature level of FMS proficiency. These results were better than those depicted in the Australian studies (Booth et al., 1999; Okely & Booth, 2004; Hardy et al., 2012; van
Beurden et al., 2002). This was thought to be primarily due to the type of assessment protocol employed.

In terms of comparing the present study’s FMS process score results to that of Australian, Brazilian, USA and Hong Kong studies; the differences or similarities noted between the present study and FMS proficiency results of others were found to be explained by the following:

- The different number of BC variables assessed within the NSW Manual for Classroom Teachers (Walkely et al., 1996), the NSW Get Skilled Get Active Manual (Davis et al., 2000), the TGMD II (Ulrich, 2000) and the BC approach employed within the present study. The implication hereof would be that future investigations should employ a standardised FMS assessment protocol which allows for international comparisons.

- The population groups investigated in terms of age and SES and the representativeness of the samples varied. Consequently comparisons between the present study and Australian, Brazilian, USA and Hong Kong studies were compromised. The results of 5-to-16, 9-to-16 and 3-to-10 year old FMS proficiency scores were collated, hence possibly biasing results towards either the younger participants (who may not have had the necessary strength, balance and co-ordination to perform FMS proficiently) or the older children FMS scores (Booth et al., 1999; Hardy et al., 2012; Spessato et al., 2012). Future studies should hence focus on providing year by year comparisons as opposed to only overall group percentage scores.

- The focus placed on physical education in school and the individuals providing the physical education classes (trained versus untrained individuals) varied (Pang & Fong, 2009; SPAN, 2010; Hardy et al., 2013). Studies in which participants performed better were those in which the individuals under investigation were exposed to quality FMS programs which were integrated into the school curriculum, validating the need to encompass such practices in the South African school setting.

- Although not directly assessed within each FMS study discussed, the specificity of training (possibly due to sporting cultural norms) and the lack of variability in training explained either by sporting cultural norms and or lack of
qualified instructors may have affected the FMS status result differences noted within and between the studies. Empirical research findings tend to attribute differences in FMS proficiency status to these factors (Thomas & French, 1985; Roberton & Konczak, 2001:102; Teixeira & Gasparetto, 2002) hence making this a viable deduction. Consequently future investigations should focus on these aforementioned variables when evaluating or putting in place FMS interventions.

- Base on the present study's and that of empirical research findings, overweight and obesity statistically and practically significantly affected locomotor FMS proficiency scores. Consequently studies should take into account this confounding variable as it can affect FMS status indirectly.

Lastly the main implications derived from the literature reviewed and the comparisons thereof to the present studies results are:

- It should be noted, that although there are benefits to utilising the TGMD II and the BC approach, FMS assessment tools necessitate revision as the different number of BC variables assessed and the difference in objectivity present within the qualitative assessment of a respective FMS may be resulting in biased findings and additionally difficulties for comparative purposes between studies. This fact was highlighted when comparing the run for speed BC approach and the TGMD II results (figure 16, page 209). Future investigations into FMS assessment protocols should employ longitudinal study designs which are internationally comparable FMS assessment protocols.

- The lack of consistency in statistically and practically significant findings between SES groups, PA levels, gender and age with FMS proficiency status and the differences noted in which BC variables are proficient and non-proficient within each FMS assessed within the present study and in empirical research findings indicates that each group of children investigated is unique. More specifically unique in terms of their task, personal and environmental constraints and the motor learning experiences they are exposed to. Consequently baseline FMS assessments are warranted and subsequent individualised FMS programming is justified.
Most empirical studies do not consider the actual FMS programs implemented to facilitate the participants being assessed. Hence more emphasis has to be placed on the actual FMS programs in the physical education curriculum (if any are present) within studies as physical education pedagogical approaches may be different within each group of investigated participants. The different approaches to teaching FMS may possibly explain why so many inconclusive findings prevail within empirical research findings.

In conclusion, the FMS proficiency process scores of the participants under investigation were, on average, performed at a low mastery and an elementary FMS proficiency level. Additionally, the participants under investigation did, on average, not improve with age. A closer examination of the product scores for these respective skills may provide more empirical research findings on the effect that PA and growth, maturation and development may have had on the FMS under investigation.

### 6.3 FUNDAMENTAL MOVEMENT SKILLS: QUANTITATIVE RESULTS

The following section deliberates the next set of objectives created to meet the primary aim of this investigation. As opposed to discussing the process scores conferred thus far, this section concentrates on the objectives which primarily focus on the quantitative product scores for the FMS under investigation which are:

- To determine and compare the FMS proficiencies of 9-to-12 year old girls in respect of the run for speed, throw for distance, standing long jump, balance and throw for accuracy quantitatively.

- To describe and compare anthropometric measurements such as weight, height (standing and sitting), BMI, arm span and leg length in respect of 9-to-12 year old girls as well as to determine the effect thereof on FMS proficiency.

- To describe and compare extra-mural PA participation status of 9-to-12 year old girls as well as to determine the associations thereof with FMS proficiency.

- To identify whether menarche has begun, consequently identifying the level of maturation and its association with FMS proficiency.
As previously mentioned, product and process scores are influenced by task, personal and environmental variables (Newell, 1991) as well as by exposure to motor learning situations which allow for a motor skill attractor state to emerge (Thelen, 2000). Based on empirical research findings discussed thus far, different variables affected the process scores more statistically and practically significantly than others. Hence an investigation into the product scores of the participants under investigation in this study may provide further insight into their current FMS status.

6.3.1 Run for Speed

The sprint is a complex skill that requires the integration and coordination of the entire kinetic chain (Grimshaw et al., 2006:254-260). The primary goal of the sprint is to cover a given distance in the quickest amount of time. A mature sprinting action consists of all forces being exerted in the sagittal plane, consequently resulting in no rotatory abducted movements in the anterior or transverse plane whilst sprinting. Through maintaining movement in the sagittal plane a proficient runner wastes no energy in the transverse plane, synchronises the upper and lower body movements efficiently, maintains a stable torso at an angle of nearly 90 degrees perpendicular to the ground, can successfully lift the non-support leg to a parallel position to the ground and can fully extend the support leg at take-off (Corbin, 1980:62). As already discussed in the qualitative section of this chapter, most participants within this study were placed at an elementary stage of FMS proficiency according to the BC approach for the run for speed (figure 23, page 215). Consequently, investigating whether the product scores yielded similarly poor results in the run for speed in comparison to South African and international studies warrants further investigation.

In the present study the mean speed attained for the 20m sprint was 4.53 seconds (±0.41 seconds) (table 16 and page 209). The mean time for the 40m sprint was 8.61 seconds (±0.89 seconds) (table 17, page 209). Furthermore no statistically or practically significant differences were noted between age groups and their respective speed attainments for the 20m sprint (df=332; f=0.72; p=.541) and the 40m sprint (df=332; f=0.62; p=.603). Hence based on these results, as participants aged so their ability to run faster did not improve.
Sprint tests are usually employed to assess talent identification in children and hence limited normative data on the ‘average’ child is available. Additionally, different sprinting tests are employed nationally and internationally. More specifically either a 40m or 50m or a 30 yard or 50 yard sprint test will be employed, resulting in comparisons between sprinting times being difficult (Tomkinson, Hamlin & Olds, 2006:326). Normative data for sprinting performance tends to only furthermore be collected for children aged 11 years and older and this limitation seems to particularly prevail in the female population group and in the South African context on a representative South African sample. These aforementioned limitations extend to the 20m standing start which was calculated in the present study and comparisons are hence difficult.

In terms of the 40m standing start sprint, at least one South African and one Australian study could be found for comparative purposes. As can be noted in table 50 below, the 12 year old participants run for speed time of 8.61 seconds (±0.89 seconds) in the present study was slower than the 12 year old girls from the Australian study conducted in 1994 (Australian Fitness Norms, 1994:7) and the South African study conducted by Du Randt in 1996 (2000).

Table 50: Studies on the 40m sprint

<table>
<thead>
<tr>
<th>Study conducted</th>
<th>Timing device</th>
<th>n</th>
<th>Times recorded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present study’s 12 year old participants</td>
<td>Brower System</td>
<td>48</td>
<td>8.61±0.89 seconds</td>
</tr>
<tr>
<td>Australian norms for the 40m sprint (Australian Fitness Norms, 1994:7)</td>
<td>Stop watch</td>
<td>341</td>
<td>The mean time recorded was 7.58 seconds. Running for 9 seconds placed an individual in the 5th percentile. Running for 8.50 seconds placed an individual in the 20th percentile. Running 6.50 seconds placed an individual in the 90th percentile.</td>
</tr>
<tr>
<td>South Africa norms for the 40m sprint (du Randt, 2000)</td>
<td>Stop watch</td>
<td>71</td>
<td>12 year olds achieved a running speed of 7.10 seconds for the 40m sprint.</td>
</tr>
</tbody>
</table>
As noted by authors in the Australian study (Australian Fitness Norms, 1994:5) the normative data created ‘was never meant to be a definite survey of sport related fitness levels’ and ‘the data came from a number of schools throughout Australia but their selection did not follow any strict sampling procedure’. Hence the representativeness of the data is questionable. Furthermore, due to the lack of information provided on the Australian samples assessed, it is difficult to discuss the differences between the present study’s results and that of the Australian results based on SES and ethnicity. However, what could be noted was that the Australian sample was made up of mostly Caucasian participants whereas in the present study only black girls were assessed. Differences in ethnicity and motor performance have been established in Armstrong’s et al. (2011:1015) study on 10295 South African girls’ and boys’ physical fitness level. Findings indicated that there were differences (although not significant) between white and black girls physical performance. That is, in comparison to white girls, black girls performed less proficiently in general. The different ethnic groups assessed may hence explain why the participants in the present study performed poorer in comparison children in Australia as ethnic differences in performance seem to present. However further investigation into differences between international ethnic groups is required to confirm this statement. An additional explanation is that Australia is a developed country and the participants under investigation in the present study were from lower SES groups and a developing country. Consequently differences in scores could be attributed general differences in sporting infrastructure and support in place between the participants under investigation. Literature has indicated that lower SES children do tend to perform poorly in comparison to their wealthier peers (Półtorak, 2009:35-45; Puciato, 2010:66-70). Lastly the Australian study’s sprint times were recorded with a handheld stopwatch and the present study’s participants run for speed was assessed with the Brower system. According to authors Lindstrom (2004) the running speed of a fully automatic timing (FAT) device can be converted to that of a handheld time by firstly subtracting 0.4 from the running speed recorded with the FAT and then rounding the score up to the nearest tenth second. If this is applied to the present study’s participants running times then their 40m sprint would have taken 8.2 seconds, which would still have been poorer than the Australian scores depicted in table 50 and would have placed the participants in the 20th percentile for achieving a mean score of 8.61 seconds (±0.89 seconds). As the Australian studies did not
assess the movement proficiency of the participants under investigation, comparing the present study’s process scores to that of the Australians is not possible. As the present study’s participant’s process scores were poor (figure 23, page 215) and did not improve statistically or practically significantly with aging, this could explain the poor running times achieved.

When comparing the present study’s sprinting times to a study conducted in South Africa (du Randt, 2000) the participants in the present study additionally performed poorly in comparison. du Randt’s study investigated a representative sample of South African children from 7 provinces. As the present study’s participants are not a representative sample of the South African population and consequently this could have affected the results. Du Randt’s study was conducted in 1996 and the present study was conducted in the year 2010. Another variable to consider whilst comparing du Randt’s 1996 study to the results of the present study is the possible effect that secular changes in overweight and obesity which may have had an effect on children’s running speed results. Tomkinson et al. (2006) investigated the secular trends in anaerobic performance from 1960 to 2002 in 156153 children and adolescents aged 6-to-17 years across 180 countries. Findings among countries varied with overall outcomes indicating that speed remained unchanged (Tomkinson et al., 2006:319-320). Authors found this secular change surprising as in a separate study the authors investigated the secular changes in aerobic performance and identified a decrease in performance between the year 1958 and 2003 (Tomkinson & Olds, 2007). The authors concluded that anaerobic performance was related to the secular changes in height, weight and maturation (children becoming larger and stronger) whereas secular changes in aerobic performance were attributed to increases in overweight and obesity rates. The authors surmised that increased fat mass affects aerobic performance more than anaerobic. More specifically, the authors believed that high BMI values would have less of an effect on anaerobic performance as it mostly only requires 1 maximal exertion whereas aerobic performance requires successive movements over time. After investigating empirical research on the effects of obesity on FMS, it seems less likely that anaerobic performance would not be affected by overweight and obesity. Empirical research has shown that high BMI values affect running and sprinting together with cardiovascular performance (Marchell & Bouffard, 1997:230-232; Okely et al., 2004;
Riddiford-Harland et al., 2006; Lubans et al., 2010:1019-1035). In the present study the differences in the run for speed times between normal, overweight and obese participants was found to be statistically and practically significant (table 36 and 37, page 226), indicating that overweight and obesity had a negative effect on running times. Obesity’s effect on FMS was furthermore noted in Riddiford-Harland et al. (2006), Wrotniak et al. (2006:e1759) and Truter et al., (2010). A well-known reality globally and within South Africa is that overweight and obesity rates are on the incline (de Onis & Blissner, 2000:1033-1034; Armstrong et al., 2006; Somers et al., 2006; Kelishadi, 2007:62; Rossouw et al., 2012:3-7). Hence, the noted decline in run for speed results between the year 1996 (du Randt, 2000) and the present study’s findings in the year 2010 could be associated with secular increases in overweight and obesity. In the du Randt study (2000) a handheld timing device was additionally used. However, when applying the conversion formulae depicted in Lindstrom (2005) du Randt’s participants still outperform the present study’s participants’ results. Lastly an additional explanation for the difference in performance between du Randt’s (2000) and the present study’s findings could be the possible discrepancies in physical education between provinces within South African (Deventer, 2004, 2009, 2012). However, as both samples included lower previously disadvantaged children and each were most likely exposed to poor quality physical education this does not seem like a plausible argument. Consequently when taking the aforementioned debate into consideration the fact that high overweight and obesity rates were depicted in the present study could be the most plausible explanation. However, as du Randt (2000) did not measure overweight and obesity status this is not conclusive.

Based on the literature reviewed in the run for speed product scores it can be concluded that further investigation into the anaerobic and aerobic trends with a larger representative sample of South African children is necessary for a more definitive conclusion to be drawn. Additionally, more empirical research on the run for speed norms for South African children is also required, as presently there is a lack of empirical research on this matter.
6.3.2 Standing long jump

The standing long jump requires lower body strength and the integration of coordinated movements between the upper and lower body (Wickstrom, 1983:65). As the standing long jump requires lower body strength to be executed correctly, most children only start to master the skill when they are 9 years old (Horita, 2008:17). In the present study the mean jumping distance achieved was 123.30cm (±19.22cm) (table 18, page 210). After applying the Scheffe’s and Cohen’s d assessments for statistical and practical significance respectively, statistically and medium to large practically significant differences presented between the jumping for distance achieved and most age groups. Hence as participants aged, so their jumping ability improved.

The only other South African study found which assessed the standing long jump distance scores was by Armstrong et al. (2006). As mentioned, this study represented 5 provinces within South Africa and according to the authors, as the study originated in the Western Cape, results were more representative of the Western Province (Armstrong, 2006:79). Table 51 identifies the mean and SD for black South African girls aged 9-to-12 years from Armstrong’s et al. (2006:1010) study.

Table 51: Armstrong et al. (2006) standing long jump scores for black girls

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>Distance Jumped (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>289</td>
<td>137.4 (±21.6)</td>
</tr>
<tr>
<td>10</td>
<td>354</td>
<td>146.4 (±21.4)</td>
</tr>
<tr>
<td>11</td>
<td>388</td>
<td>154.4 (±21.7)</td>
</tr>
<tr>
<td>12</td>
<td>404</td>
<td>159.3 (±21.5)</td>
</tr>
</tbody>
</table>

Source: Armstrong et al. (2006:1010)

The present study’s participants were found to perform generally poorer than the participants in the Armstrong (2006) study. When comparing the weight and height measures of the present study with that of Armstrong et al. (2006) minimal differences were noted, however, overweight and obesity rates were much higher in the present study when compared to Armstrong’s et al. (2006) study. As previously mentioned, the overweight and obesity status of participants in the present study had
a statistically and practically significant effect on jumping scores, justifying weight status as a plausible cause for poorer standing long jump product scores.

When comparing the present study’s to those of normative data created for 228229 7-to-18 year old European girls from 23 countries between 1981 and 2003 using the Eurofit test battery the present study’s participants placed into the 10th to 25th percentile for their scores (Armstrong & van Mechelen, 2008:116-117) within each age group (table 18, page 219). Consequently an overall poor performance in comparison to the European girls in the 90th percentile scoring 176cm, 187cm, 199cm and 207cm for 9, 10, 11 and 12 year olds respectively. It should be noted that according to the authors there was a secular decline in standing long jump performance noted over these years and hence the collation of results would perhaps overestimate standing long jump performances in the year 2007. As the present study’s participants were investigated in the year 2010 perhaps had the norms been updated the present study’s participants would not have performed as poorly.

The present participants standing long jump scores also compared poorly to Korean and New Zealand children. This Hong and Hamlin (2005) study investigated the difference in health related components of South Korean and New Zealand 11-to-12 year old males and females. The study investigated data from 2000 and 2001 and secular trend changes from the year 1984. As can be noted in the table 52 below, Korean girls jumped further than New Zealand girls and both groups jumped further than the 11 and 12 year old participants in the present study.

Table 52: Standing long jump results for Korean and New Zealand children

<table>
<thead>
<tr>
<th>Age</th>
<th>Korea</th>
<th>New Zealand</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>156.5 ±19.4 (n=94)</td>
<td>156.1±28.9 (n=42)</td>
<td>0.064</td>
</tr>
<tr>
<td>12</td>
<td>171.5 ±16.5 (n=80)</td>
<td>160.1 ± 27.3 (n=50)</td>
<td>2.674</td>
</tr>
</tbody>
</table>

Source: Hong & Hamlin (2005:1342)

According to the authors, South Korea is a developing country which had been experiencing improved economic growth. Hence there may have been an improvement in children’s dietary intake. Additionally the South Korean girls were found to have a lighter body mass when compared to the New Zealand girls. The
authors surmised that the improved power-to-weight ratio would result in better distances jumped. Consequently the differences noted between South Korean and New Zealand children may have been due to diet and genetic make-up. Lastly the South Koreans used the standing long jump in their annual fitness test and hence there may have been a learning effect. Environmental influences and the amount of PA within each country were additionally thought to be contributing factors. New Zealand children were found to be less PA due to less scheduled PA at school and access to television and computer games. The same factors affecting the results depicted in Hong and Hamlin (2005) study can hence be used to explain the differences between the Australian (Armstrong & van Mechelen, 2008), the present study’s and Hong and Hamlin’s (2005) results. More specifically dietary changes, genetic make-up, specificity of training and PA levels.

In contrast to the Australian, South Korean and New Zealand standing long jump’s being better than the present study’s participants; the children assessed by Ara, Moreno, Leiva, Guita and Casajus (2007) were found to perform poorer in comparison to the present study’s participants. More specifically the participants in the present study performed better (123.30cm±19.30cm) in comparison to the PA and non-PA participants scores depicted in table 53 for the 1068 Spanish male and female participants aged 7-to-12 years assessed.

Table 53: Jump scores for PA and non-PA girls aged 7-to-12 years (Ara et al., 2007)

<table>
<thead>
<tr>
<th>Physical fitness results</th>
<th>PA</th>
<th>Non-PA</th>
<th>Significance (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jump performance</td>
<td>120.14±26.12</td>
<td>115.50±25.06</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td>(n=374)</td>
<td>(n=184)</td>
<td></td>
</tr>
</tbody>
</table>

These results are surprising as the Spanish children partook in 80 to 90 minutes of physical education per week as compared to the participants in the present study who had no access to additional physical education classes. The possible explanation is the inclusion of 7 and 8 year olds, which may have biased results towards the younger children who did not necessarily have the growth, maturation and development advantages compared to 9-to-12 year old children. An additional explanation is the fact that Ara’s et al. (2007) study employed randomized multi-stage proportional-cluster sampling technique from a total of 64116 schools in the
region of Aragon Spain. Hence this was a more representative sample of children as compared to the present study’s sample which was recruited via convenience sampling methods.

In conclusion, on average results indicated that the participants in the present study performed poorly in the standing long jump product scores when compared to national and international studies. Genetic make-up, dietary and PA habits, testing protocols employed, assessing different age spans and different numbers of participants, physical education systems in place and the environmental factors within each environment were used to explain these discrepancies. Consequently in order to identify exactly what caused the differences between studies each of these factors would have to be considered.

6.3.3 Throw for Distance

According to literature throwing tends to be a difficult FMS for girls to master (Teixeira & Gasparetto, 2002:151-160). In order for an overarm throw to be successful, a whiplike/-successive wind-up motion of the body from the stepping action to the final release of the ball is required to take maximum advantage of the elastic properties of the body and the amount of time available to exert force (Corbin, 1980:70). This whiplike motion should commence after the foot placement of the contralateral leg. Subsequently, there should be a successive movement of the hips, then the trunk, the shoulder, the upper arm, the forearm and finally the hand and wrist (Wickstrom, 1983:106-109). The forearm should lag behind the entire body during the successive wind-up motion and then during the follow-through phase the ball should be released with the forearm moving from supination into pronation with subsequent wrist flexion. This successive release allows for the transfer of energy from the lower limb to the upper limb and into the ball. As previously discussed in the qualitative section of this chapter, the participants in this study, on average, performed the throw for distance at a poor mastery (96.9%) and elementary level of FMS proficiency (Figure 25, page 216). Hence most participants did not successfully achieve the ‘wind-up’ and whiplike motion as depicted Espenshade and Eckart (1980:151-154), Wickstrom (1983:106-109), Roberton and Halverson (1984:106-
In the present study, the average throwing distance achieved was 17.95m (±4.44m). After applying the Scheffe’s and Cohen’s $d$ assessments for statistical and practical significance respectively; statistical and medium to large practically significant differences presented between the throwing distance and most age groups (table 19, page 211). Hence as participants aged, so their throwing for distance product scores improved.

Comparisons between the throwing distances achieved by the participants in the present study and that of other studies is difficult as most other studies assessing throwing were either assessing the velocity of release, the movement sequence of the overarm throw itself, differences in motor performance between normal and obese children or interventions effect on improving the throwing performance (Stroot & Oslin, 1993; Roberton & Konczak, 2001; Riddiford-Hartland et al., 2006). The only South African study identified for comparative purposes was by Armstrong’s et al. (2006). The mean cricket ball throw for distance for the black South African girls was found is depicted in table 53.

Table 53: Armstrong et al. (2006) cricket ball throw for black girls

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>Distance Jumped (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>290</td>
<td>13.7 (±5.1)</td>
</tr>
<tr>
<td>10</td>
<td>356</td>
<td>17.7 (±5.1)</td>
</tr>
<tr>
<td>11</td>
<td>382</td>
<td>20.1 (±5.1)</td>
</tr>
<tr>
<td>12</td>
<td>404</td>
<td>22.3 (±5.0)</td>
</tr>
</tbody>
</table>

Source: Armstrong et al. (2006:1010)

As previously mentioned, the primary reason for the difference noted in the scores between Armstrong et al. (2009) and the present study’s results is thought to be due to the fact that testing was conducted in the Western Cape. In comparison to the Western Cape, the Eastern Cape has much higher poverty and lower education rates and poorer sporting infrastructure (Makiwane & Dan, 2010). Hence, perhaps it could be expected that children from the Western Cape would perform better than those from the Eastern Cape.
As previously mentioned in the qualitative section of this chapter, the process scores of the throw for distance showed no statistical or practically significant improvements with aging (figure 26, page 201). However, as can be noted, the product scores had a medium to large practically significant increase between age groups in the throw for distance (table 19, page 211). The primary denominator thought to contribute to these inconsistencies in results is the role that anthropometric variables and physical education had on the throw for distance product and process scores respectively. All the anthropometric variables had an effect on the throw for distance product scores after applying the Pearson correlation coefficient (table 25, page 200) and these correlations were of small to medium practical significance. According to Grimshaw et al. (2006) throwing distances achieved are related to limb length, as this provides a lever arm advantage. More specifically linear velocity is the product of rotational velocity and its radius of rotation. Consequently an increase in lever arm length will increase the velocity achieved. A larger muscle additionally may positively affect throwing distances as more force can be exerted over a given time.

In the Riddiford-Harland et al. (2006:42-49) study the effect of obesity on children’s upper and lower limb functionality was assessed. Obese children performed better in the upper body tasks when compared to their non-obese matched peers. The authors inferred that this was due to obese children being larger and taller than their age matched peers and hence this provided a definite advantage in terms of force production. Furthermore, according to the authors, research has indicated that obese children have larger muscle mass when compared to non-obese peers, providing them with an added advantage. Although Riddiford-Harland et al. (2006) found relationships between overweight and obesity and the throwing distances achieved, non-significant findings were established in the present study’s findings (table 35, page 225) indicating that perhaps the effect of overweight and obesity on upper body FMS product scores is not always a positive one. What can be noted from the effect of anthropometry on the throwing distances achieved is that mass had a small correlation to the distance thrown and hence in the present sample limb length’s effect on throwing distances were larger than that of mass (table 25, page 216).
In conclusion and based on the literature reviewed on the throw for distance product scores further investigation into a representative sample of South African children is necessary for a more conclusive findings to be drawn about the product scores of the throw for distance in the girls in the present study. However, it can be concluded that the participants in the present study did not perform well in comparison to other South African studies and this validates the need for further investigation and interventions.

6.3.4 Balance Errors

The mean error in the 60 second stork-stand was 12.78±4.56 errors (table 20, page 212). Furthermore no statistical or practically significant difference were found between age groups.

Studies on balance and aging are controversial. According to Hardy et al. (2009:2) a ceiling affect in balance may be observed due to it being a skill that is developed from a young age. Research tends to indicate that children should be able to statically balance on one leg by the age of 3-to-5 years (Gallahue, 2010:19). Balance is additionally a rate limiter to most movement and is hence a skill that is practiced often. Nevertheless, according to Overlock (2004:17) static balance tasks necessitate experience and practice for optimal performance. The only studies in which the same protocol was used as in the present study was by Saar’s (2008) on Estonian children aged 10-to-11 years and Wilezewski et al. (1996:113-126) on 494 Polish boys and 494 Polish girls from urban and rural areas respectively.

Saar’s (2008) investigated the PA levels and motor abilities of 525 Estonian girls and boys aged 10-to-17 years. Estonian children aged 10-to-11 years achieved a score of 10.5 errors (±3.0 errors, n=56) and children aged 12-to-13 years achieved an average balance score of 7.3 errors (±1.9 errors, n=68). In Saar’s (2008) study the Eurofit physical fitness test battery was employed to assess motor ability, convenience sampling was use to recruit participants and PA was examined with a PARQ. The primary differences noted between the present study and Saar’s (2008) study is that the Estonian sample population was exposed to physical education classes which took place 2-to-3 times a week. Participants in the present study did
not have access to weekly physical education classes. Consequently this may explain why the Estonian participants were better than the present study’s participants’ balance scores. The need for practice when static balance is concerned was established in Williams (1983:270), Hatzitaki et al. (2002) and Overlock (2004:5). As Sensorimotor information, musculoskeletal responses and a combination of the visual, vestibular and somatosensory inputs allow for postural control and consequently balance, it is thought of as a skill that requires practice and learning.

Wilezewski’s et al. (1996:113-126) results for the 11 and 12 year old Polish girls from urban and rural areas respectively are depicted in table 54.

Table 54: Wilezewski’s et al. (1996:113-126) results on 494 Polish boys and 494 Polish girls from urban and rural areas

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>Balance Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban 11 year olds</td>
<td>51</td>
<td>12.12 (±6.8)</td>
</tr>
<tr>
<td>Urban 12 year olds</td>
<td>54</td>
<td>11.6 (±5.0)</td>
</tr>
<tr>
<td>Rural 11 year olds</td>
<td>55</td>
<td>3.6 (±2.4)</td>
</tr>
<tr>
<td>Rural 12 year olds</td>
<td>47</td>
<td>4.5 (±3.5)</td>
</tr>
</tbody>
</table>

As can be noted the present study’s participants performed worse (table 20, page 212) than both the urban and rural participants from Poland. As previously mentioned in chapter 3 the authors surmised that the differences between the urban and rural girls performance was due to the fact that the girls from rural areas had to participate in farming duties and travel far distances to get to school whereas girls in urban areas spent more time participating in sedentary leisure activities. In the present study participants were not exposed to physical education and or adequate extra-mural participation, hence the lack of practice experienced in the urban group could explain why the present study’s participants performed poorly. As the participants assessed in the present study were not from rural areas but from previously disadvantaged areas it can be assumed that PA endeavours to get to school and or work in a farm type environment would not have transpired in the present group of participants as did in Wilezewski’s et al. (1996:113-126) results.
An additional factor which may have affected balance error scores in the present study’s participants is anthropometric changes which occurred with aging. Table 26 page 217 and addendum 21 identifies the anthropometric correlations to balance. Only the balance of 12 year olds was significantly correlated to anthropometric measures. These correlations were additionally found to be of medium to large practical significance ($r=.335$ to $r=.439$). As discussed in chapter 2 of this study, balance is the ability to maintain the COG within the base of support and maintain a state of equilibrium and steadiness. Any change in height, weight or limb variations will alter an individual’s COG and require readjustments in the manoeuvring of the body to maintain the COG within its base of support (Overlock, 2004). During the onset of PHV in adolescents changes in body dimensions can cause the COG to rise and an individual’s balance proficiency to decrease (Balyi & Hamilton, 2004). This could explain why specifically the balance proficiencies of 12 year olds’ were stifled. However, the participants in Saar’s (2008) and Wilezewski’s et al. (1996:113-126) studies would have been experiencing the same types of anthropometric changes due to being in middle childhood. Variables other than just anthropometric changes are hence causing the poor balance results in the present study’s participants. As the physical activity levels in the present study were poor, the overweight and obesity levels were high and there was a lack of physical education classes and extra-mural participation it can be deduced that these may have been the primary factors affecting the balance scores of the participants under investigation.

Wickstrom (1986:44) indicated that the inability to balance is indicative of an abducted arm position in many FMS and is hence frequently a rate limiter to achieving mastery in a given FMS. In the present study perhaps the lack of balance could be seen as a rate limiter causing many of the participants to perform skills at an elementary level with regards to the stalk-stand test, standing long jump, run for speed and throw for distance tests. Overlock (2004:1-101) investigated static and dynamic balance and their relationship to FMS proficiency in the standing long jump and kicking. Children aged 5-to-9 years old were evaluated. Results indicated that a significant moderate relationship was present between static balance and FMS and additionally that static balance could explain 20% of the variance experienced in motor skill performance. Furthermore, results indicated that 8% and 13% of static balance could explain the variance in jumping and kicking performance respectively.
Consequently the poor balance scores depicted in the present study’s participants could have played a role in the overall poor FMS proficiency scores.

In conclusion, the participants under investigation within this study performed poorly in the stalk-stand balance test in comparison to Estonian and Polish children. The participants’ poorer ability to balance may explain why many were placed into an elementary level of performance for the run for speed, standing long jump and throw for distance. The lack of balancing ability may furthermore be due to the lack of physical education focusing on improving static balancing type activities. As established in the run for speed, standing long jump and throw for distance, normative data based on a representative sample of South African participants is required for static balance tests in order for more conclusive deductions to be made.

6.3.5 Throw for Accuracy

Most activities require some degree of accuracy. That is, most sports and recreational activities require throwing at a target or a team member.

The participants aged 9-to-12 years in the present study could successfully hit a target with a ball thrown from a distance of 2m (8.69 points±0.61) (table 21 and 22, page 213). It was furthermore observed that a practically significant difference was noted only between the 9 and 12 year old groups and no other age group, indicating that although most children could throw accurately from a 2m distance at this age, elder participants were more accurate. When participants were required to throw from a distance of 4m, the mean score dropped to 6.73 points (±1.58). Additionally large practical significant differences were noted between most age groups ability to hit a target from 4m. That is, younger participants were less accurate than their elder peers when the target was increased to 4m.

The improvement with aging in throwing for accuracy has been depicted in empirical research findings (Sullivan et al., 2008). This improvement in performance is often attributed to practice and specificity of training (Hore, Watts, Tweed & Miller 2006; Sullivan et al., 2008). Perceptual-motor skills such as depth perception, perception of movement and visual acuity are variables which can affect accuracy (Wickstrom,
1983: 102; Williams, 1983:108-114) and hence practice and training with the specific throw for accuracy task is justified and can explain poor results in throwing for accuracy and or lack of improvements.

The fact participants accuracy decreased with an increase in distance from the target is furthermore on par with literature findings. Targets which are further away or smaller tend to affect children’s ability to hit the target accurately. As perceptual-motor skill demands increase with targets further away this may explain why the present participants' performance decreased with an increase in distance.

Further investigation into a representative sample of South African children is required in order for more comprehensive conclusions to be drawn as presently there is a dearth of information on the throwing for accuracy ability of children. More specifically studies seem to focus on either the effects of task demands on the throwing accuracy of a motor skill (Moore, Reeve & Pissanos 1987), generating normative data from throwing balls into a basket (Garner, 1979) or identifying critical elements which makes a throwing for accuracy task possible (Hore et al., 2006).

6.4 DEMOGRAPHIC VARIABLES

Thus far the FMS qualitative and or quantitative results of the run for speed, throw for distance, standing long jump, catch, static balance and the throw for accuracy have been discussed, compared to empirical research findings and the findings thereof compared to the theoretical framework of this study. In order to substantiate the confounding variables such as growth, maturation and development, overweight and obesity and PA levels possible influence on the above qualitative and quantitative results and in order to meet the primary aim of this study, the following objectives are discussed and deliberated in the following section of chapter 6:

- To describe and compare anthropometric measurements such as weight, height (standing and sitting), body mass index (BMI), arm span and leg length in respect of 9-to-12 year old girls as well as to determine the effect thereof on FMS proficiency.
- To describe and compare extra-mural PA participation status of 9-to-12 year old girls as well as to determine the associations thereof with FMS proficiency.
To identify whether menarche has begun, consequently identifying the level of maturation and its association with FMS proficiency.

6.4.1 Standing Height, Seated Height, Arm Span and Leg Length

The mean standing height of participants was 141.20cm±8.79cm. The mean seated height was 70.89±4.11cm. Statistically and medium to large practical significant differences (P<.05; d>.2) were present for standing and seated heights when comparing the different age groups (table 27 and 28, page 220), indicating that as participants aged so their standing and seated height increased. The mean arm span was 150.14cm±10.12cm. Statistical and large practically significant differences (P<.05; d>.2) were also noted between age groups (table 30, page 222). Lastly the mean leg length was 70.31cm±5.53cm. Statistically and large practically significant differences (P<.05; d>.2) were furthermore noted between age groups, indicating that overall, the participants were increasing in height, arm length and torso and leg length as they aged. Figure 33 illustrates the age related mean value changes in these aforementioned anthropometric variables.

![Figure 33: Anthropometric mean values at 9-to-12 years of age](image-url)
The present participants fall within the chronological age group known as middle childhood and adolescence (Cronin & Mandich, 2005:199-212). These findings are hence on par with literature in that the transition between childhood to adolescence is governed by many hormonal changes; growth, maturation and developmental fluctuations and the onset of PHV and subsequently menarche (Balyi et al., 2005). Consequently the statistically and large practically significant changes noted in the present study's participants anthropometric variables can be expected.

These findings are also on par with Armstrong's et al. (2006:1005) South African data in that, as participants aged, so statistically significant variations occurred in their height and weight measures. According to Armstrong's et al. (2006) statistically significantly differences in actual height between ethnic groups were present (p=.01). More specifically black participants were found to be the shortest in stature and white children the tallest. When the authors accounted for SES, these differences became non-significant in girls (Armstrong et al., 2006:1012). Such a finding justifies the impact that SES may have on the FMS proficiency of children and consequently the focus on investigations on children from lower SES areas.

Changes in standing and seated height, arm span and leg lengths are inter-individual and are affected by genetic differences in growth, development and maturation (Balyi et al., 2005:3). That is the peak in growth, also known as PHV, commences at different chronological ages and is based on whether a child is an early, average or late maturer. According to Balyi et al. (2005:3-5) the average onset of PHV for girls is between 10-to-12 years. Due to the cross-sectional study design employed in the present study, it cannot be deduced when PHV occurred in the participants under investigation as a longitudinal study is necessitated to record the height changes for each participant to be able to infer the exact onset of PHV. However, according to Balyi et al. (2005:17) PHV occurs 12 months before the onset of menarche and research by Jones, Griffiths, Norris, Pettifor, & Cameron (2009) indicates that the median menarchal age for black females in South Africa is 12.4 years. As most participants in the present study had not yet commenced menarche (table 42 page 229) many of the participants could have been experiencing PHV changes. This statement is substantiated by the findings that only 12 year olds balance performance in the present study was significantly and practically affected by the
anthropometric variables under investigation (table 26, page 217) and that most anthropometric changes affected the FMS product scores under investigation (chapter 5, pages 214), possibly indicating that most of the 12 year old girls were experiencing their PHV.

Variations in the growth rate of limbs and height were furthermore identified in the present study’s participants. As can be noted from the results, torso length (as indicated by seated height) accounted for more of the growth changes in standing height than leg length (table 27 and 31, pages 220 and 222). In contrast to infant growth, according to Berk (2012:176-177) during puberty the hands, legs and feet accelerate in growth before the torso increases in growth. Subsequently the torso accelerates in growth and accounts for most of the height changes in puberty.

As mentioned, most of the anthropometric changes between age groups affected the FMS under investigation to some degree in the present study’s findings indicating the role that growth, maturation and development had on particularly FMS product scores in the present study’s participants (chapter 5, page 214). However the process scores were not statistically or practically significantly correlated to the anthropometric variables under investigation (chapter 5 page 206). When comparing the present study to that of empirical research the findings seem to justify the need for further research directed towards longitudinal investigations which include assessing the effects of anthropometry on FMS process and product scores throughout the lifespan. More specifically, Eunice’s (2008) investigation the relationship between motor skill performance and anthropometric measures of body segments in 60 males and females aged 3-to-5 years was assessed. Twelve (12) FMS were assessed with the TGMD II. Limb length, height and weight were found to have a positive significant relationship to object-control and locomotor skills. According to the author thigh and hand length were the best predictors of locomotor scores whereas foot and thigh length were the best predictors of object-control skills. In the present study no statistical or practically significant correlation was found. The differences noted between the present study and that of Eunice’s may have three possible explanations. Firstly, the different age groups being assessed in which different growth related changes and neural maturation occur and hence the possible differing affects this may have had on FMS proficiency scores. Secondly the
environmental stimulation within each study may have been different with the younger children perhaps being placed in an enriched motor learning environment and the present study’s older participants in comparison not, consequently resulting in the lack of motor learning in the present study’s participants. Thirdly rate limiters such as balance and strength may have been mastered quicker due to the levelling off of growth related changes in the 3-to-5 year olds, thus providing an opportunity for augmented motor skill learning and ensuring for results to produce statistically significant improvements in the 3-to-5 year old children. Although it is difficult to explain the controversial findings an implication, what can be deduced from these findings is that conclusive conclusions cannot be made without more empirical research on the effect of anthropometric variables on process scores, which seems to be lacking within the South African context and in international studies. Additionally, and as mentioned, these investigation would have to be longitudinal studies in order to deduce which variables effect product and process scores more significantly as children age across the lifespan.

6.4.2 Mass and Body Mass Index

Within the present study, large statistically and practically significant differences in mass related changes as participants aged were noted (table 29, page 221). These statistically and practically significant differences (P<.05; .2) in weight changes are on par with Armstrong’s et al. (2006:16) study on South African 6-to-13 year old males and females. With aging, increases in mass can be expected due to the maturation of bodily systems through hyperplasia and hypertrophy (Malina et al., 2003:41-77). Additionally and in terms of female weight gain in adolescence, menarche and hormonal changes can affect weight gain as secondary sex characteristics develop (Freedman et al., 2003:2). Hence the statistically significant changes in weight as participants aged can be expected.

Although weight gain is normal in middle childhood and adolescents due to growth, maturation and developmental changes, it is important to consider the composition of fat and muscle mass in the weight gain as children age. BMI is the indirect measure of adiposity in children and adults and is calculated as follows: weight/height\(^2\) = kg.m\(^2\) (Cole et al., 2005:1). BMI can hence be used as a warning sign for excess fat
mass weight gain. In the present study, and according to the CDC and IOTF BMI cut-offs, 23% to 24% of the participants were overweight respectively and according to both cut-offs up to 8% were obese. Figure 34 depicts the percentage values of participants found to be overweight and obese in Canada (Willms, 2003), South Africa (Armstrong, et al. 2006), Spain (Ara et al. 2007) and Australia (SPAN, 2004; Hume et al. 2008) in comparison to the present study’s findings.

![Studies Investigating Overweight and Obesity Status](image)

**Figure 34:** Overweight and obesity rates in Canada, Australia, Spain and South Africa

On closer examination of figure 34 and when comparing the present study’s overweight and obesity rates to other South African and international studies, it would seem as though the present study’s participants’ overweight and obesity status is on par with the increasing overweight and obesity epidemic in developed countries.

Armstrong’s et al. (2006:52-63) South African study employed IOTF cut-offs to identify the percentage of overweight and obesity rates. Findings indicated that 12.12% and 4.55% of black girls were overweight and obese respectively. When all ethnic groups (white, coloured and black) were combined 17.9% and 4.9% of participants were rated as overweight and obese respectively. As can be noted, the present study’s participants had higher overweight and obesity rates than that of
Armstrong and colleagues 2006 investigation. According to the authors a larger portion of the results was representative of the Western Province identified data (Armstrong, 2006:79). As previously mentioned, the Eastern Cape has been established as one of the poorest provinces within South Africa (Makiwane & Dan, 2010). Although findings on the influence of SES on overweight and obesity rates are controversial there tends to be a correlation between lower SES and higher rates of overweight and obesity (Wang & Lobstein, 2001:1129-1136). Hence the higher rates of overweight and obesity in the present study in comparison to that of Armstrong’s et al. (2006) study could be attributed to the fact that the present sample was from a previously disadvantaged area and from a different cultural background. In addition to SES, education levels have been correlated to higher overweight and obesity rates (Willms, Tremblay & Katzmarzyk 2003:671). Within South Africa, the Eastern Cape has one of the poorest matric pass rates (Makiwane & Dan, 2010) consequently possibly contributing to the differences in overweight and obesity rates in the present study and that of Armstrong and colleagues. Lastly methodological bias could have skewed results due to the fact that convenience as opposed to randomised sampling was employed in the present study and the sample size was smaller than that of the Armstrong’s et al. (2006) sample (227 versus 4684 participants respectively), hence possibly affecting the representative of the results.

The present study’s findings seemed to correlate more to the increasing overweight and obesity rates depicted in international studies. In a study by Willms et al. (2003:668-672) 7-to-13 year old Canadian boys’ and girls’ prevalence for overweight and obesity was investigated between the years 1981 to 1996. This was done through collecting BMI data from the 1981 Canadian Fitness and the 1996 National Longitudinal surveys. The IOTF cut-offs were used to classify participant as overweight or obese. A disturbing trend was established in that the occurrence of overweight increased from 11% to 33% and 13% to 27% in males and females respectively. Additionally, obesity increased from 2% to 10% in males and 2% to 9% in females. Findings indicated a correlation between children’s overweight and obesity rates and higher family’s income, a father with a better education and more siblings living in the same household. Overall findings depicted a threefold increase in overweight and obesity rates between the years 1981 to 2003. These increases were prevalent regardless of SES, geographic region or demographic
characteristics. According to the authors, culture was the primary contributor to weight status as BMI was found to change by geographic region in the Canadian children as opposed to SES.

Another international study illustrating the upward trend in overweight and obesity rates was concluded by Hume et al. (2008) who found that 33% of females aged 9-to-12 years from selected lower SES groups within Melbourne Australia were classified as overweight or obese. In the present study, 32% of participants were classified as overweight or obese. The similarities between Hume et al. (2008) and the present study’s overweight and obesity rates could be attributed to the similar sample sizes employed and the fact that participants were from a lower SES. Additionally, both studies employed convenience sampling and the IOTF cut-offs. Similarly, high overweight and obesity rates were noted in the NSW survey, which was conducted on a randomly selected sample of 5518 children aged 5-to-16 years from 45 Primary and 45 High Schools (SPAN, 2004). According to the survey, which employed the IOTF cut-offs, ‘almost a quarter of students aged 5-to-16 years were overweight or obese’ and ‘boys and girls aged 9-to-12 (years 4 and 6) had some of the highest rates – up to 33%’ (SPAN, 2004:3-4). In accordance with these findings, Ara et al. (2007) cross-sectional study on 1068 Spanish male and female participants aged 7-to-12 years indicated that 31% and 6% of participants were overweight and obese respectively. Consequently, based on these empirical research findings, it can be concluded that the participants under investigation in the present study were exhibiting the same upward trend in overweight and obesity rates as those of developed countries.

In the present study, it should be noted that increases in overweight and obesity rates (although not statistically significant between age groups) were accompanied by increases in PA levels (in which statistical and practical significant differences were found between age groups) as participants aged (table 43, page 230). This seemingly contradictory increase in overweight and obesity rates even though PA levels were increasing in participants are findings similarly indicated in the SPAN survey in NSW in which FMS proficiency, PA and nutritional intake of students were investigated (SPAN, 2004). To the authors surprise even though PA rates increased, overweight and obesity rates additionally increased. The authors attributed the gains
in fat mass, regardless of increased caloric expenditure through improved PA participation, to increased caloric consumption. More specifically, participants were increasing their intake of soft drinks and confectionary foods with aging, consequently increasing their caloric intakes and subsequent fat mass gains (SPAN, 2004:16). Another surprising finding in the present study was that overweight and obesity rates were highest in the 11 year old groups when compared to other age groups (although this was not a significant difference). This increased weight gain in 11 year olds can be attributed to the onset of culturally related implications with ‘coming of age’, menarche and the related hormonal changes and or the management of sport within schools. Participants aged 11 years may have been expected to do more house chores and cooking due to ‘coming of age’. The cultural expectations of black girls at home was indicated in Walter’s (2011:785) study in which it was found that black participants decreased PA habits were attributed to having to do house chores. The onset of menarche and the subsequent weight gain due to hormonal changes coupled with poor nutritional habits (as noted in the SPAN 2004 study) may have furthermore resulted in weight gain particularly occurring in the 11 year old groups. According to Berk (2012:198) during the onset of puberty there is an increase in calorie intake among girls due to hormonal changes. This natural increase in calorie intake transpires during the period of adolescence where the unhealthiest intake furthermore occurs, compounding the possibility of increasing overweight and obesity levels. Lastly, and in terms of the sporting structures within the present study’s school systems, older participants may have received more physical education and extra-mural participation than the younger participants, hence resulting in the 12 year old groups presenting with lower overweight and obesity rates when compared to the 11 year old group of participants in this study. In order to adequately address the overweight and obesity status of participants in the present study and to find out exactly what has caused the high overweight and obesity levels future investigations should take into account the caloric intake of participants, directly assess their PA levels and FMS status and take into account the possible influence of menarche on caloric intake and PA endeavours. This investigation should furthermore be a longitudinal study so as to track the developmental changes which occur and their subsequent effect on PA and caloric intake.
Even though high levels of overweight and obesity were noted in the present study, South Africa is faced with a double burden in that on the one hand there is an overweight and obesity epidemic presenting within South African youth but on the other hand there are high rates of underweight and stunting. Studies have indicated that stunting, underweight and wasting levels are on par with overweight and obesity levels in developing countries. In the present study, and according to the CDC cut-offs, 4% of participants were classified as underweight for their age group. Jinabhai et al. (2003:365) investigated the health status of South African participants aged 8-to-12 years from the National Food Consumption Survey conducted in 1994 and primary data from a rural community based study in 1995. A total of 25193 Kwazulu-Natal participants aged 8-to-11 years took part. Moderate stunting varied between 2.9% to 40.2% and mild stunting ranged from 31.4% to 75% based on the WHO definition of -2Z scores height-for-age. Larger degree of underweight levels were reported by Puckree, Naidoo, Pillay & Naidoo (2011) in their analysis of 120 randomly selected children aged 10-to-12 years from 6 selected schools in the eThekwini Kwazulu Natal area. The authors additionally employed the WHO cut-offs to classify children’s nutritional status. According to the results 66% of children were underweight. As mentioned, in the present study only 4% of participants were deemed underweight and hence a substantially less number of children were underweight in the present study as compared to the findings by Puckree et al. (2011). The discrepancies between studies may be explained by the sample under investigation. Puckree and colleague’s sample population only had 20% black participants with the remaining participants being Indian. Secondly, Jinabhai et al. (2003) and Puckree et al. (2012) studies were largely representative of Kwazulu-natal children from mostly rural areas. As mentioned earlier, Willms et al. (2003) found that cultural factors within a geographical area played a more important role in nutritional status as opposed to SES. Consequently a closer examination of the cultural habits and the infrastructure of each area would assist in explaining the differences in nutritional status noted in participants. Furthermore the use of different classification systems (WHO cut-offs versus CDC cut-offs employed in the present study) may have contributed to inconsistent results. Future investigations should focus on employing high quality study designs and samples that are a representative sample of the South African population. Additionally, the dietary intake of participants together with direct PA measures and cultural influences should be considered when
assessing or intervening to decrease overweight and obesity rates in children. However, regardless of these consistencies and inconsistencies in study results what should be noted is that the present study’s participants presented with high overweight and obesity rates, which are on par with developed countries overweight and obesity rates, indicating the need for interventions.

6.4.3 Socio-economic Status

In the present study 31% of participants’ parents were not employed (table 41, page 229). As can be noted in figure 35, the unemployment rate within South Africa fluctuated between 21.9% and 26.7% between the year 2006 and 2012 (South African Unemployment Rate, 2012). The highest unemployment rate reported in the country thus far and before the year 2012 was reported to be 30.2% in March 2003. Consequently the results depicted by the participants seem to be on par with the highest unemployment statistics presented within South Africa up until the year 2012.

![South African Unemployment Rate Graph](source: www.tradingeconomics.com | Statistics South Africa)

Figure 35: Percentage of South African Labour Force Unemployed (South African Unemployment Rate, 2012)

According to the quarterly unemployment rate, 4.7 million people in South Africa were unemployed in quarter 2 of 2013 (Quarterly Labour Force Survey South Africa, 2013:xii) and according to Banerjee et al. (2007:8) South Africa has one of the highest unemployment rates when compared to the United States, United Kingdom, Spain, France, Greece, Poland, Latin America and other African countries hence
these two statements further validate the results depicted by the students in the questionnaires filled out. Lastly further validation for the unemployment statistics depicted by the participants in the present study is provided by the fact that only quintile 1-to-3 schools were included in this study. A quintile is a poverty ranking system employed by the government to assist in fund distribution among schools (Hall & Giese, 2006:37). The poorest schools are in quintile 1-to-3 and the least poor schools are in quintile 4-to-5. As participants in the present study came from quintiles 1 to 3 and these schools are deemed as low income schools it can hence be expected that the participants’ parents in this study would fall within a high unemployment rates.

The effect of SES on motor development has been varied, with studies indicating no affect to significant affects. It would be expected that higher SES children would perform FMS better; however, access to technology, which tends to promote sedentary behaviour, may be resulting in children from higher SES engaging in less PA endeavours (Kelishadi, 2007:63). In contrast, participants from lower SES may participate in less PA endeavours due to lack of basic infrastructure, nutritious food and lack of quality physical education and extra-mural activities. In the present study participants’ quantitative and qualitative FMS proficiency results on average compared poorly to other South African and international studies. Based on the fact that the schools under investigation where rated as quintile 3 or below, it can be assumed that the participants under investigation had limited access to good quality sporting infrastructure, restricted access to nutrient dense food, no physical education classes and limited quality sport instruction.

The SPAN study conducted in 2004 found correlations between SES and motor skill ability in the NSW sample of 5500 children aged 5-to-16 years. Furthermore Półtorak (2009:35-45) found that environmental factors had large statistically significant influences on motor skill ability in adolescents from rural and urban areas. More specifically, children from a single child family, from a family with a larger monthly net income, who had parents with a secondary education and who had parents who were either white collar or blue collar workers tended to perform motor skills better. The Puciatos’ (2010:66-70) study on 524 children aged 5-to-16 years found varied significant relationships between motor skills and SES. However, overall findings
indicated that higher SES participants performed better due to parents having higher education level, better living conditions and certain cultural practices which were positively orientated towards leaner physiques. Hence based on empirical research findings, the SES of the participants under investigation could have affected their overall low FMS proficiency status. However in order to verify this fact, future investigations into the FMS status of participants should compare lower, middle and upper SES groups.

It should be noted that SES cannot be the only contributing factor to the low FMS proficiency scores in the schools under investigations. A R90 million Mass Participation (Mass Participation Program, 2010) was put in place at the schools under investigation to facilitate the increased participation in sport participation. The primary factor which seemed to affect the success of the program was the poor management of the implementation thereof. Hence, it is important to ensure that the qualified service providers are put in place to facilitate schools as regardless of how much money is put into a project, the poor management thereof will not ensure for the success thereof.

6.4.4 Physical Activity

The FMS proficiency’s link to increased levels of PA has been established (Barnett et al. 2008; Lubans et al., 2010:1019-1035). More specifically, children who possess proficient FMS tend to be more PA and visa versa. Being PA, according to Mchunu and Le Roux (2010:85-87), increases the likelihood of children being more motivated, psychologically healthy and having an overall feeling of wellbeing. It is hence beneficial to promote increased levels of PA in children by ensuring that they have proficient FMS. In terms of ensuring for proficient FMS, research has shown that the type of PA is important as opposed to merely being PA. More specifically, PA should be catered towards improving FMS development through structured and planned activities. According to Pang and Fong (2009), the primary reason behind why most participants in their study performed FMS at a proficient level was due to the fact that physical education was focused specifically on FMS interventions. In a systematic review on the FMS interventions in youth by Morgan, Barnett, Cliff, Okely, Scott, Cohen & Lubans (2013) the primary conclusion drawn was that
‘developmentally appropriate FMS learning experiences delivered by physical education specialists or highly trained classroom teachers significantly improve FMS proficiency in youth’. Based on these aforementioned literature findings, consequently of importance to this study was the types of PA children were participating in. More specifically, the specificity and variability of training and the amount of time spent practicing a motor skill and their possible association with the FMS proficiency status of the participants under investigation.

In terms of children’s PA during the school day, on average, 1 to 2 breaks are provided in which children can be PA. According to Walter’s (2010), 30 minutes of PA is the recommended amount of time children are meant to obtain during school hours. It can be assumed that the type of PA children participate in tend to be reliant on the main sporting cultural norms within the country and hence school, and the infrastructure available within the school (Mchunu and Le Roux, 2010). Within the present study, the participants formed part of the Mass Participation program in which infrastructure and coaching support was made available for children to participate in soccer, volleyball, athletics, cricket and basketball (Mass Participation, 2010). Although, as previously mentioned, the success of the implementation thereof is questionable. In terms of the FMS under investigation, of interest to the present study was the amount of time participants perceived themselves as participating in running and ball games. Cycling and swimming activities were added to identify extra-mural activities other than FMS that children may have be participating in. It was additionally important to identify the main sporting activities children participated in after school as according to literature findings certain FMS would indirectly be played whilst children participate in these activities (O’ Conner, 2000).

Within the present study, interestingly, of the 167 children who filled in the PARQ questionnaire, 50% of participants played for less than an hour after school and 50% played for more than an hour after school (figure 43, page 230). This activity consisted mainly of ball and or running activities (figure 44, page 231). Hence based on these results it would seem as though most children would have met the minimum recommendations of 60 minutes PA a day during the school week if in addition each participated in a minimum of 30 minutes moderate-to-vigorous activity at school, as depicted by Walter’s (2010). However, in order to make accurate
deduction about the PA endeavours participants in the present study partook in during the week days before and after school, direct PA assessments are required.

During weekends 45% of participants perceived that they participated in less than 60 minutes PA on weekends and 55% believed they participated in more than 60 minutes of PA on weekends. Hence, it would seem that, on weekends, 45% of participants did not meet the recommended PA guidelines of 60 minutes per day. This fact possibly indicates the positive role that the school environment provides in ensuring for the increase in PA as during week days participants perceived themselves as being more PA than on weekends.

The week-day participation within the present study’s participants seems to be in contrast to the Kids South African Report Card’s (Healthy Active Kids, 2010:4) findings which illustrated that up to 70% of high school children were inactive and an even larger percentage of primary school children were deemed inactive. According to the report card South African children received C-minus for their PA levels. Naidoo et al. (2009) found similarly low participation rates during the investigation of the effect of a nutrition and physical activity (NPA) intervention on the PA and nutritional habits of 256 primary school grade 6 pupils from four Kwazulu Natal schools. The intervention took place over a 6 month period. PARQ’s were used to identify pre- and post- PA levels. Pre-tests indicated that only 20% of children participated in exercise more than 5 times per week. After the intervention this increased to 43%. A similar concern about the low PA levels in children was raised by Mchunu and Le Roux (2010) in their investigation as to the reason why secondary school black children did not participate in more PA. The sample consisted of 249 grade 9-to-12 adolescents from 4 Durban high school townships, stratified randomly in terms of age and gender. A structured questionnaire was employed to identify the factors affecting youth’s participation in PA endeavours. Lack of facilities, political structures which excluded black learners from sport and focused on white learners, negative social influence, poor self-image and poor economic conditions were found to be the primary constraints to increased PA. Poor economic conditions, differences in black and white children’s PA and SES was additionally illustrated in McVeigh, Norris and de Wet’s (2004) investigation into the link between SES and PA in 381 South African children aged 9 years. Results indicated that the link between SES and PA in South
African children was statistically significant. According to the authors (McVeigh et al., 2004:982) ‘white children were found to be more active than black children, more likely to participate in physical education classes at school and watched less television than black children’. These studies hence indicated that black participants tend to participate in less PA and do not normally meet the recommended level of 60 minutes moderate-to-vigorous PA daily, possible indicating that the present study’s participants may have over-estimated their PA levels during week-days. As previously mentioned, direct PA level assessments are more accurate than PARQ assessments (Telford et al., 2004; Wrotniak et al., 2006:e1759; Mcziza et al., 2007).

South African studies have also indicated that as children age, so their PA levels decrease. Walters (2010) conducted a study on 112 South African children aged 8-to-12 years from selected disadvantaged areas within the Nelson Mandela Bay District. In addition to utilizing a PARQ, Walters incorporated an ActiGraphaccelerometer to evaluate PA in girls and boys during the school day. Children were assessed for 5 days during school hours (8.00 to 14.00) from Monday to Friday. Data was only included if children had 4 days’ worth of records. It was found that 53% of girls did not meet the minimum of 30 minutes of moderate-to-vigorous PA recommendations during the school day (Walter, 2010:787). As children aged so their PA decreased. That is, in grade 6 children were 50% less active than children in grade 3. During recess, boys were found to be significantly more active than girls. The overall findings indicated that in school activity resulted in 58% of the targeted 60 minutes of PA. In the present study, PARQ results indicated that as children aged so their PA levels increased statistically and practically significantly (table 43, page 230). Once more, the use of a PARQ as opposed to direct assessments may have influenced the PA results in the present study.

It would thus seem as though, based on empirical research findings in South Africa, most children and adolescents are not meeting the recommended daily PA recommendations. Females seem to be meeting these recommendations less than males and as children age so their PA decreases. The differences noted between these aforementioned South African studies and the present can be attributed to the methodology employed to compile these results. The South African report card is based on a review of literature from 2004 to 2010 whereas Walters (2010), Frantz
(2010) and the current study employed the PARQ (which consisted of different questions) and or direct measures of PA. Additionally the use of cross-sectional designs, non-randomised selection, small sample sizes, and different age groups (primary versus high school children) could explain the discrepancies in PA between the current study and others. Furthermore, with the current lack of physical education in schools, to surmise that children would meet their recommended level of PA during school hours may be a bit ambitious (van Deventer, 2004, 2009, 2012). Regardless of the possible shortcomings in employing the PARQ assessment for the purposes of identifying participants’ PA levels and endeavours, the information provided by the participants under investigation can be used to possibly explain the FMS status depicted in the results.

The most often participated in PA on weekends was running (53%) and ball games (56%) (table 46 and 47, page 231 and 232). Of the extra-mural activities participated in, 41% of participants indicated that netball was the activity they most often participated in, followed by athletics (22%). In terms of activities such as soccer, cricket, basketball, volleyball, gymnastics, ballet, hockey, tennis and swimming constituted no more than 1% of the extra-mural PA participation. Based on the FMS under investigation (namely the run for speed, standing long jump, throw for distance, catch, static balance ability and throw for accuracy) and based on the PA results above, it would seem that the primary denominator which could explain the FMS proficiency results in the present study when reviewing PA is that netball was the most often played sport. More specifically as netball was the primary sport played by the female learners under investigation it could possibly explain why catching was the most proficient FMS as opposed to the run for speed, standing long jump and throw for distance when utilising the more stringent BC approach. The fact that most participants indicated that running and ball game activities were what they participated in most during the week and weekends may additionally explain the proficient catching ability, however, it cannot explain poor throw for distance activities (which is additionally a ‘ball’ game type activity). Although participants indicated that they participated in mostly running activities during week days and weekends, most participants were deemed as poor runners when reviewing the BC composite scores (figure 23, page 198). It would hence seem as though the primary denominator to consider is not only what type of and how much PA children participate in but instead
to evaluate the FMS interventions and physical education in place. As the primary aim of this investigation was to identify the FMS proficiency status of female learners aged 9-to-12 years, direct measures of PA, the physical education systems in place and the qualifications of the service providers of these aforementioned activities were not conducted. Consequently, future investigations into the PA levels and endeavours of participants should additionally assess the individuals providing these services and the pedagogical approach employed when facilitating these aforementioned activities.

Based on the empirical research findings and the present studies PA results it can be deduced that interventions are needed to improve the current sports management systems in place, physical education training and FMS interventions at the schools under investigation to improve the quality of PA participants in the present study are partaking in.

6.4.5 Menarche

A total of 10% of participants in this study had started menarche, none of whom were 9 years old and most of whom were 12 year olds (table 42, page 229). Research by Jones et al. (2009) found that the median menarcheal age for South African black females was 12.4 years. Authors additionally noted that menarcheal age for South African girls decreased from 14.5 years to 12.4 years between the year 1956 and 2004. Jones et al. (2009) study was based on a review of five empirical research studies on menarcheal age in South African between 1956 and 2004 and included an investigation into the onset of menarche in a separate study on urban South African girls born in Soweto in 1990. Although the participants and that of Jones et al. (2009) are based on a non-representative sample of South African children, there are similarities in menarche onset. In a study by Danubio and Sanna (2009:91-112) African countries mean menarcheal aged tended to be later than that of middle East, American and European countries. Additionally girls at higher altitudes were reported to start menarche at age 16 years. Variables such as climate, altitude, living in a rural versus urban area, nutrition, health status, educational level, income, profession of parents and the number of siblings in a family were found to be associated with menarcheal age. Similar arguments were documented in a study by
Bagga and Kulkarni (2000) in which 366 Maharashtrian Indian girls aged 9-to-16 years mean menarchal age was determined. Mean menarchal age was determined to be 12.62±1.05 years. SES, dietary habits and the effects of PA levels on the age of menarchy were additionally assessed. Girls from higher SES, who were better nourished and who were heavier, taller and less active tended to commence menarche earlier (Bagga & Kulkarni, 2000:55-57). Consequently it can be concluded that participants in the present study may have commenced menarche from age 12 years but this would be dependent on the environmental factors noted in Bagga and Kularni (2000) and Danubio and Sanna (2009:91-112). To ascertain menarcheal age a longitudinal study would have to be employed and hence findings within the present study are limited to the cross-sectional design employed.

The primary reason for measuring menarche in the participants under investigation was to identify the onset of maturation within the female sexual system and additionally to infer the possible onset of PHV, which occurs 12 months after the onset of menarche. In so doing the possible effect that these two variables may have had on the FMS proficiency results under investigation would have been identified. Walter (2010:786-787) found that girls in grade 6 (12 years old) exhibited the lowest PA levels (with nearly 90% of girls not meeting the minimum recommended 30 minutes of in school PA) when compared to their younger grade 3-to-5 peers (9-to-11 year olds). One of the possible explanations provided was the onset of puberty. As only 10 participants had commenced menarche statistical measures to find out whether participants with menarche differed in their PA and FMS proficiency results could not be conducted. However, as previously mentioned, as most participants had not commenced menarche it indicates that many were still going to or busy experiencing their growth spurt. This fact was highlighted by the significant affect that anthropometric changes had on the balance scores of the 12 year old participants under investigation in the present study. Consequently, a future investigation into the onset of PHV and menarche and their role in the FMS proficiency status of adolescents is warranted.
6.4.6 Summary and relevant implications for the FMS product scores

Based on the quantitative results discussed in this section the following is relevant in terms of the objectives set to meet the primary aim of this investigation:

- Based on the literature reviewed in the run for speed product scores the participants in the present study performed poorly in comparison to South African (du Randt, 2000) and Australian norms (Australian Fitness Norms, 1994:7). Additionally, no age related improvements were noted in the product scores. Future investigation into the anaerobic and aerobic trends with a larger representative sample of South African children is necessary for a more definitive conclusion to be drawn.

- On average results indicated that the participants in the present study performed poorly in the standing long jump product scores when compared to South African (Armstrong et al., 2006) and international studies (Hong & Hamlin, 2005:1342). Age related improvements were noted between age groups and this was found to be on par with literature findings. In terms of the literature reviewed it is important to consider genetic make-up, dietary habits, PA habits, testing protocols employed, age spans assessed, physical education systems in place and the environmental factors within each environment in order to explain the discrepancies between studies FMS results. Consequently in order to identify exactly what caused the differences between studies, each of these factors would have to be considered.

- Although the throw for distance product scores compared poorly to a South African study (Armstrong et al., 2006), further investigation into a representative sample of South African children is necessary for a more conclusive findings to be drawn about the throw for distance product scores. Age related improvements were noted between age groups and this was found to be somewhat on par with literature findings.

- Participants in the present study performed poorly in the stalk-stand balance test in comparison to Estonian (Saar, 2008) and Polish (Wilezewski’s et al., 1996:113-126) girls. Normative data based on a representative sample of South African participants is required for static balance tests in order for more conclusive deductions to be made. No statistically or practically significant changes occurred in balance as children aged. This finding was somewhat on
par with literature findings as studies tend to indicate that either children are proficient at balancing on one leg as it is a skill that necessitates mastering in many FMS (Hardy *et al.*, 2009:2) or that specificity of training is required for the static balance on one leg to transpire (Overlock, 2004). In the present participants case it would seem as though lack of motor learning or the changes in anthropometric variables resulted in the poor balance related changes noted.

- In the present study, participants improved their ability to throw accurately as they aged. The improvement with aging in throwing for accuracy has been depicted in empirical research findings (Sullivan *et al.*, 2008). Normative data based on a representative sample of South African participants is required for throwing for accuracy in order for more conclusive deductions to be made.

- Most of the anthropometric changes between age groups affected the FMS product scores under investigation to some degree indicating the role that growth, maturation and development (page 214, addendum 21). This was found to be on par with literature findings which indicated that anthropometric variables do affect FMS product scores (Balyi *et al.*, 2005). However, in the present study anthropometry had no effect on the participants FMS process scores under investigation. It was deduced the lack of motor learning as opposed to anthropometric effects on how movement is executed was the cause.

- The overweight and obesity rates of the present sample were more on par with the increasing overweight and obesity rates in developed countries (Willms *et al.*, 2003:668-672; SPAN, 2004; Kelishadi’s, 2007; Hume *et al.*, 2008). Overweight and obesity had an effect on the running and standing long jump product scores in the present sample. This was found to be on par with literature findings indicating that lower body activities are more affected by overweight and obesity than upper body activities (Riddiford-Harland *et al.*, 2006; Wrotniak *et al.*, 2006:e1759; Truter *et al.*, 2010).

- The participants in the present study came from quintile 3 and below schools. Based on the questionnaire results, 31% of participants’ parents were unemployed. This was on par with the high unemployment rates depicted in Statistics South Africa (Quarterly Labour Force Survey South Africa, 2013:xi). Additionally these high unemployment rates could have explained the poor
FMS proficiency results. A direct comparison between SES would be required to make such a claim, however, based on the overall poor FMS results for the participants under investigation, this would be a justified claim and on par with literature findings (Półtorak, 2009:35-45; Puciatos, 2010:66-70).

- The investigated participants did meet the recommended daily levels of PA on weekdays however on weekends less participants met the recommended PA levels of 60 minutes, possibly indicating the positive role the school may have in facilitating increased PA. For conclusive findings to be made direct measures of PA so as to ascertain that moderate-to-vigorous PA is being participated in during school and after school hours is required for more conclusive deductions to be made.

- Children did not participate in a repertoire of movements to allow for holistic FMS development, as denoted in their overall poor FMS proficiency product and process scores. This finding was supported by the fact that most participants indicated that they took part in mostly netball, running and catching type activities. This could explain why only the catch was proficient and improved statistically and practically significantly with aging.

- In alignment with the PA levels and participation of the present study’s participants, as physical education was not a stand-alone subject in the schools investigated, teachers who were not trained in providing physical education lessons were the only service providers of physical education and or extra-mural participation; further justification is provided for the need for interventions to accommodate for these confounding factors. There was furthermore a lack management of the sporting codes within schools and a lack of equipment to facilitate FMS acquisition.

- A total of 10% of participants in this study had started menarche, none of whom were 9 years old and most of whom were 12 year olds (table 42; page 229). This was on par with literature findings in South Africa (Danubio & Sanna, 2009:91-112). This indicates that the onset of PHV, which occurs 12 months before the onset of menarche, could have prevailed. The possible onset of PHV was indicated by the significant affect that anthropometric changes had on the balance scores of only 12 year old participants under investigation.
6.5 CONCLUSION

In section 6.2.6 and 6.4.6 the main qualitative and quantitative summary and implications derived from empirical research findings and the theoretical framework of this study are discussed.

In sequential order and in alignment with the objectives 1-to-4 indicated in chapter 1 of this study, the following points address the main conclusions drawn for the objectives created in order to meet the primary aim of this study:

1. In alignment with the aim of this study which was to identify the FMS status of the participants under investigation, the catch was the only FMS performed proficiently whereas the run for speed, standing long jump and throw for distance were performed at non-proficient levels when referring to the more stringent BC approach results. In terms of meeting the first objective and identifying differences in movement proficiency between age groups, the statistical analysis revealed that participants on average did not improve in their ability to perform their FMS process scores with aging. More specifically, only the catch BC composite process scores improved statistically and practically significantly with aging whereas the run for speed, standing long jump and throw for distance did not. In terms of the product scores the throw for distance, standing long jump and throw for accuracy improved statistically and practically significantly with aging. The run for speed and balance product scores did not improve statistically or practically significantly with aging.

2. In terms of the second objective pertaining to the status of participants’ anthropometric measures and anthropometry’s effect on the FMS under investigation; weight, standing and seated height and arm span increased statistically and practically significantly with age indicating that as participants aged so growth, development and maturational changes were occurring. These anthropometric measures affected the FMS under investigation statistically and practically significantly. The practical significance varied between small to large and differed according to the age group under investigation. Of particular interest was that balance in 12 year olds was statistically and practically significantly affected by anthropometric changes and that the run for speed and standing long jump were statistically and
practically significantly affected negatively by the overweight and obesity status of participants. Furthermore overweight and obesity rates identified in the present sample was found to be more on par with the increasing overweight and obesity epidemic in developed countries. These findings hence illustrate that anthropometry affects in particular FMS product scores. No statistical or practical differences were noted between anthropometry measures and the FMS process scores of participants.

3. In terms of meeting the third objective set for the purposes of this study it was surmised that most participants met the recommended 60 minutes of PA daily if each participant additionally partook in the recommended 30 minutes of in school moderate to vigorous PA depicted by Walter (2010). On weekends this percentage dropped to only 45% of participants meeting the recommended 60 minutes of PA daily. As participants aged so their PA levels increased statistically and practically significantly. The fact that most participants partook in mainly netball, running and ball game activities was a significant finding as this indicated the association between the type of PA being participated in and the overall FMS proficiency process score results with only the catch being performed proficiently and improving statistically and practically significantly with age.

4. In terms of meeting the last objective it was identified that only 10% of participants had commenced menarche. The age related differences were additionally found to be of statistical and practical significance indicating that most of the older participants had commenced menarche. This finding was significant as it indicated that most participants may have been experiencing PHV changes which according to literature commences before the onset of menarche. This claim was supported by the fact that statistical and medium to large practical significant differences in anthropometric changes were occurring as participants aged. This claim was additionally justified due to the fact that most participants aged 12 years balance errors were statistically and practically significantly affected by most anthropometric variables.
The implications drawn from completing objectives 1-to-4 for the participants under investigation are as follows:

1. The participants investigated within this study are in need of FMS interventions as the participants’ process scores were performed on average non-proficiently and their process and product scores when compared to other South African and international empirical research findings illustrated that the participants in the present study performed. The differences in proficiency levels between FMS indicates that the PA and or sporting endeavours participants are partaking in are not diversified and hence are not catering for holistic movement development. Consequently the FMS interventions put in place should be diversified FMS interventions and gender neutral with a focus on the teaching pedagogical approach implemented as opposed to focusing only on increasing PA levels.

2. Anthropometric variables did affect the FMS product scores and hence should be considered when creating FMS interventions. More specifically by catering interventions to the differing sizes between or within age groups of participant and making a FMS training activity either more difficult or less difficult depending on the individuals’ size related changes as participants age, possibly overcoming anthropometry’s influence on FMS proficiency scores may be achieved. The fact that anthropometric variables did not affect the process scores of the participants under investigation highlights the need for an environment conducive to motor learning in order for process scores to improve. Consequently, although anthropometric changes and the subsequent possible improvement in strength (a rate limiter to many movements) and limb lengths (which result in possible lever arm advantages) affected the FMS product scores of the participants under investigation positively, these changes did not affect the way in which the movements were executed. The high overweight and obesity rates in the present study’s participants indicates the need for interventions strategies which in addition to improving FMS proficiency levels decrease overweight and obesity rates. This is particularly important due to the negative correlation overweight and obesity rates had on the running and jumping skills of the participants under investigation.
3. The fact that week day PA was higher than weekend activity illustrates the possible positive role of the school environment on PA levels but additionally the need for interventions with the target in mind of increasing both week day and weekend PA levels. When evaluating the participants PA levels and endeavours it highlights the need for interventions which focus on not only increasing PA levels but which additionally cater for a diverse repertoire of FMS specifically targeting the BC variables found to be subpar in the present study’s participants.

4. When reviewing the number of participants which had commenced menarche and the fact that anthropometric variables were affecting the FMS product scores of the participants under investigation it becomes clear that these are two important confounding variables to consider when putting in place FMS interventions.

6.6 RECOMMENDATIONS

Based on the review of the aforementioned summaries and implications drawn from empirical research findings and the theoretical framework of this study and based on the conclusions drawn from the objectives set, the recommendations for future studies have been identified as:

- A repeat of the present study which investigated the FMS status of children aged 9-to-12 years old but which is derived from of a larger representative South African sample and includes either or:
- A larger repertoire of FMS focusing on both product and process scores in a sample of males and females and in different SES and ethnic groups.
- Direct PA assessments during school and out of school hours which takes into account not only the type and amount of PA but additionally the manner in which PA endeavours are delivered (pedagogical approach) and the qualifications of the individuals delivering the PA services. The teaching approach and motor learning programs implemented to improve FMS should be a particular focus when investigating the efficacy of FMS interventions put in place.
- A longitudinally based assessment which caters for the growth, maturation and developmental changes which occur as children age, furthermore focusing particularly on the role that menarche plays in female learners PA endeavours, weight status and FMS proficiency results.

- A study which focuses on the development of a new FMS assessment protocol which focuses specifically on creating percentile rankings for FMS proficiency BC composite scores for a representative sample of the South African population which includes different ethnic and SES groups and males and females and which is additionally internationally comparable.

- A qualitative study which investigates the effect of cultural norms and gender stereotypes on male and female learners’ FMS proficiency status. Through interviewing the children, the key role players in providing the PA opportunities to children at schools and the parent’s perceptions on the PA endeavours their children should be participating in this research aim can possibly be realised.
REFERENCES


South Wales School Students: Prevalence and Sociodemographic distribution. 


Van Deventer, K.J. 2009. Life Orientation in the Foundation Phase (Grades R-3): A survey in Selected Western Cape Primary Schools. 31(2): 147-162.


Addendum 1: Summary of fundamental movement skill status studies investigated

<table>
<thead>
<tr>
<th>Study</th>
<th>Place</th>
<th>Sample</th>
<th>Assessment Tool</th>
<th>Overall scores for participants</th>
<th>Specific scores for FMS under investigation for female participants</th>
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<tbody>
<tr>
<td>Booth et al. (1999); SPAN (2010:169-170)</td>
<td>New South Wales (NSW) School Physical Activity and Nutrition (SPAN) Survey in 1997</td>
<td>A proportional stratified randomly selected sample of 5518 students aged 9-to-16 years (year 4, 6, 8 and 10)</td>
<td>Manual for Classroom teachers (1996). Reporting mastery and near mastery scores.</td>
<td>Overall near mastery or mastery was found to be at or below 40% for boys and girls in all the age groups assessed, indicating that a low level of proficiency prevailed in the participants assessed (Booth et al., 1999).</td>
<td>- Mastery of sprint was: 25.7% and 29.9% for year 4 and 6 (9-to-12 years old) respectively (SPAN, 2010:193).</td>
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<td>- Mastery of overarm throw was: 4.2% to 10.5% for year 4 and 6 (9-to-12 years old) respectively (SPAN, 2010:196)</td>
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<td>- Mastery of catch: 8.8% and 13.1% for year 4 and 6 (9-to-12 years old) respectively (SPAN, 2010:197).</td>
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<td>Okely &amp; Booth (2004); SPAN 2004; SPAN (2010:193)</td>
<td>2004 SPAN survey in NSW</td>
<td>Overall 18 schools participated in the study and 1288 girls and boys aged 6-to-8 years old (year 1 to 3) took part.</td>
<td>Get Skilled: Get Active (2000). Reporting mastery and near mastery scores.</td>
<td>Overall, only 35% of boys and girls in the sample investigated displayed mastery or near mastery levels. This was slightly lower than the FMS proficiency level in the NSW 1997 survey (Okely &amp; Booth, 2004:369).</td>
<td>- Mastery of sprint was: 9.8% and 15.3% for year 4 and 6 (9-to-12 years old) respectively (SPAN, 2010:193). In year 3 (8 years old) 19.2% had mastery and near mastery scores (Okely &amp; Booth, 2004:362)</td>
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<td>- Mastery of overarm throw was 3.8% to 9.7% for year 4 and 6 respectively (SPAN, 2010:196); In year 3 a total of 3.7% achieved a mastery and near mastery score for throw (Okely &amp; Booth, 2004:362)</td>
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<td>- Mastery of catch: 21.1% and 35.8% in year 4 and 6 respectively (SPAN, 2010:197); 45.8% for year 3 for near mastery and mastery (Okely &amp; Booth, 2004:362)</td>
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<tr>
<td>Hardy et al., (2012:e392); SPAN (2010:169-170)</td>
<td>2010 SPAN survey in NSW</td>
<td>Sample size was 6197 students aged 7-to-15 years old in year 2, 4, 6, 8 and 10</td>
<td>Get Skilled: Get Active (2000). Reporting mastery and near mastery scores.</td>
<td>When averaging these scores only 32.8% and 43.15% of girls and boys aged 9 years could perform the aforementioned FMS at a proficient level. The low prevalence of FMS mastery continued in the female population up until year 10 (15 years old) with only 53.8% of female adolescents exhibiting advanced FMS. Males improved significantly with 69.3% male adolescents exhibiting advanced FMS (SPAN, 2010, 6-11; 168-203).</td>
<td>SES correlation to FMS proficiency was assessed. Girls from a lower SES were twice as likely to have lower FMS scores. Girls were additionally found to have double the chance of being inactive if they did not possess proficient locomotor skills.</td>
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<td>- Overall 89% were non-proficient overarm throwers in year 4 (Hardy et al., 2012:e392). Year 4 and 6 (9-to-12 years old) was 44% to 57.7% who were at a near mastery and mastery level. Mastery was 3% to 7.3% for year 4 and 6 respectively (SPAN, 2010:196).</td>
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<td>- Overall 88% were non-proficient sprinters for all age groups (SPAN, 2010:169-170). For year 4 and 6 was 40.6% to 44.4% displayed mastery and near mastery scores. Mastery for the sprint was 17.5% and 25.2% for year 4 and 6 respectively (SPAN, 2010:193).</td>
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<td>- Between 21% and 80% were proficient catchers in year 2-to-10. For year 4-to-6 was 43.3% to 58% who were at a mastery and near mastery level. At a mastery level was 23.2% and 37.8% for year 4 and 6 respectively (SPAN, 2010:197).</td>
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Addendum 1: Summary of fundamental movement skill status studies investigated

<table>
<thead>
<tr>
<th>Study</th>
<th>Country/Region</th>
<th>Participants</th>
<th>Scores Reporting</th>
<th>Performance Level</th>
<th>Additional Notes</th>
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<tr>
<td>van Beurden et al. (2002), MIGI (2003)</td>
<td>Australia</td>
<td>A total number of 1045 students participated. That is, 515 participants aged 9 years (year 3 students) and 530 participants aged 10 years (year 4 students)</td>
<td>Get Skilled: Get Active (2000). Reporting mastery and near mastery scores.</td>
<td>Only 47% of the boys and girls assessed achieved near mastery and mastery scores for the FMS investigated (21.3% achieved mastery and 25.7% achieved near mastery level) (van Beurden et al., 2002:246).</td>
<td>Year 3 girls: 33.8% achieved near mastery and mastery scores for the sprint, 22.4% for the overarm throw and 34.2% for the catch (van Beurden et al., 2002:245).</td>
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<tr>
<td>Spessato et al. (2012)</td>
<td>Porto Algere metropolitan city of Brazil</td>
<td>1248 participants aged 3-to-10 year</td>
<td>TGMD II reported as composite scores for Locomotor and object control skills</td>
<td>Only 8% and 3% of boys and girls respectively performed above average and 23% and 15% of boys and girls respectively performed averagely. Overall 69% and 82% of boys and girls performed below average TGMD II norms indicating an overall low level of FMS proficiency (Spessato et al., 2012:4).</td>
<td>Only overall composite scores provided and not the percent of participants who performed at a near mastery and mastery level. Gender differences were found with boys outperforming girls in object control and locomotor skills.</td>
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<td>Pang and Fong (2009)</td>
<td>Hong Kong</td>
<td>76 females and 91 males (M: 7.6 years) Hong Kong participants from 6 local primary schools</td>
<td>TGMD II reported as composite scores for Locomotor and object control skills</td>
<td>Only 2% of participants scored below average, 47% were average and 60% were rated as above average (Pang &amp; Fong, 2009:125)</td>
<td>Each FMS was broken down into its BC variables and the percent of participants who performed each variable correctly was established and reported in percentage terms.</td>
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</table>
Addendum 2: Details pertaining to the Brower System

The image below illustrates which components make up the Brower system. The Brower Timing system is battery operated equipment that utilizes a basic single beam infrared system to record run for speed times. It contains non-volatile memory, has a storage capacity for recording 126 athletes’ results, allows for nine splits per athlete, and contains 150 hours battery life and a five mile radio range (Brower, 2010). The CML5MEM is a handheld liquid crystal display unit which is used to view run for speed times. Additionally IRD-T175 and IRE photocells, which are units that communicate via infrared beam lenses, are employed for testing purposes (Brower, 2010). The IRD-T175 required antenna’s to communicate with the IRE.

Source: Brower system (2010)

As depicted in figure x, the Brower Timing System was set-up as follows:

- The two upper sections of each tripod ‘leg’ were retracted. This resulted in the photocell beams being 0.7m from the ground and in alignment with participants' hips.
- The IRD-T175 and IRE photocells pair was placed parallel and 1.5m perpendicular to one another so as to ensure that the infrared beams were aligned and connected.
- A pair of photocells was placed at the starting, 20m, 40m and 50m marks. The photocells set-up at the 50m mark was a dummy pair so as to account for participant slowing down towards the end of their run.
- The speed of each run was measured in seconds to the nearest millisecond.
# Addendum 3: Running for speed body component assessment protocol

<table>
<thead>
<tr>
<th>Critical element</th>
<th>Description of movement pattern</th>
<th>Measuring notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm swing</td>
<td>1 = Stiff short swing with varying degrees of elbow flexion or remain extended (they do not participate in the running action).&lt;br&gt;2 = Arm swing increases but moves along the oblique plane and may or may not cross the body's midline.&lt;br&gt;3 = Arms swings through a large arc, vertically in opposition to the legs. Wrists reach up to shoulder level and back to hip.</td>
<td>Measured via visual observation.</td>
</tr>
<tr>
<td>Shoulder position</td>
<td>1 = Arms held in an abducted position throughout the arm swing (horizontally and laterally rather than vertically).&lt;br&gt;2 = Arms move from abducted to adducted position throughout the arm swing (horizontal swing is reduced on backswing). Flying action&lt;br&gt;3 = Arms are held in adducted position throughout the arm swing</td>
<td>Measured via visual observation.</td>
</tr>
<tr>
<td>Elbow position</td>
<td>1 = Varying degrees of elbow flexion (either too extended (&gt;105°) and/or to flexed (&lt;75°).&lt;br&gt;3 = Elbow flexion and extension is between 75° - 105°.</td>
<td>Measured between midpoint of shoulder/deltoid position &amp; midpoint of wrist at two points during arm action: flexion and extension of shoulder.</td>
</tr>
<tr>
<td>Arm-leg opposition</td>
<td>1 = No arm and leg opposition&lt;br&gt;3 = Arms swing in a vertical position in opposition to the legs</td>
<td>Measured via visual observation during full speed.</td>
</tr>
<tr>
<td>Foot Action</td>
<td>1 = Flat feet or tip-toe.&lt;br&gt;2 = Heel-toe.&lt;br&gt;3 = Feet land on metatarsal arch/nearly under center of gravity.</td>
<td>Measured via visual observation.</td>
</tr>
<tr>
<td>Flight phase</td>
<td>1 = No observable flight phase (legs do not extend fully in the air or time off the ground is minimal). Limited range of movement.&lt;br&gt;3 = Definite flight phase with the supporting leg moving from flexion to complete extension by take off.</td>
<td>Measured via visual observation.</td>
</tr>
<tr>
<td>Hip Flexion Recovery</td>
<td>1: Hip flexion of forward driving leg is &gt;120&lt;br&gt;2: Hip flexion of forward driving leg is between 106-120&lt;br&gt;3: Hip flexion of forward driving leg is =&lt;105</td>
<td>In side view the hip flexion of the swing leg measured between the thigh and body in the first frame that shows the support leg taking off.</td>
</tr>
<tr>
<td>Knee Flexion Recovery</td>
<td>1: Flexion at knee is &gt;105&lt;br&gt;2: Flexion at knee is between 91- 104&lt;br&gt;3: Flexion at knee is =&lt;90</td>
<td>In side view the degree of the swing leg is measured between the hip and ankle in the first frame that shows leg contacting the ground.</td>
</tr>
<tr>
<td>Knee extension of support leg</td>
<td>1: Angle at knee joint is &lt;149&lt;br&gt;2: Angle at knee is between 150 to 164&lt;br&gt;3: Angle at knee joint is &gt; =165</td>
<td>In side view the degree of knee flexion of the support leg is measured between the hip and ankle in the first frame that shows the support leg taking-off.</td>
</tr>
</tbody>
</table>
Addendum 4: Assessing the reliability between the Brower and Smartspeed photocell systems

The Brower and Smartspeed Timing Gate system were set-up utilizing the exact same set-up protocol depicted for the run for speed set-up utilized for this study (refer to point 4.4.1.1.4 to identify the 50m run for speed set-up). The following dimensions were employed when setting up the Brower and Smartspeed system:

- The two upper sections of the tripod ‘leg’ were retracted for each Brower system’s photocell. This resulted in the photocell beams being 0.7m from the ground.
- The Smartspeed system tripod base was fully extended which resulted in the beam being 2m from the base of the floor.
- The Brower system was placed directly underneath the Smartspeed system and the beams were aligned directly underneath each other so as to ascertain that the Brower and Smartspeed system were at exactly the same points on the run for speed set-up (the starting line, 20m, 40m and 50m points along the 50m fiberglass measuring tape).
- The CML5MEM handheld liquid crystal display unit of the Brower system was used to identify the running speeds to the nearest millisecond.
- The Smartspeed’s IPAQ Pocket PC PDA handheld unit was used to identify running speeds to the nearest millisecond (refer to the Fusion Sport website, http://fusionsport.com/products/Smartspeed-timing-gate-system, for details pertaining to the hardware and software components of the Smartspeed timing system).

The following procedure was implemented to assess for the correlation coefficient between the two systems:

- Five participants were requested to run three times. The first attempt was a practice trial and the subsequent two attempts were recorded.
- Each participant was requested to commence the run with a standing stance, one foot in front of the other.
- Once the tester said go each participant had to run for speed as fast as they could.
- Each participant was expected to complete a 50m maximal run for speed twice; each run completed one after the other with a 3 minute rest in between trials.
- Both running times were recorded using the Brower and Smartspeed Timing Gates to the nearest millisecond.
### Critical elements

<table>
<thead>
<tr>
<th>Description of movement pattern</th>
<th>Measuring notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preparatory Crouch</strong></td>
<td></td>
</tr>
<tr>
<td>1 = Inconsistent in terms of leg flexion &gt; 110°</td>
<td>Measure via visual observation. Measure flexion of the knee between the hip and ankle in the first frame before heels have left ground.</td>
</tr>
<tr>
<td>2 = Deeper and more consistent/observable 91-109°</td>
<td></td>
</tr>
<tr>
<td>3 = Deeper and consistent. &lt;90°</td>
<td></td>
</tr>
<tr>
<td><strong>Take off Arm Action</strong></td>
<td></td>
</tr>
<tr>
<td>1 = No observable swing/held rigidly at sides/move in opposition to the legs (acts as break)/ arms extended backward in winged position. Arms do not initiate jumping action.</td>
<td>Measure via visual observation.</td>
</tr>
<tr>
<td>2 = Limited back swing as arm flex upwards with minimal abduction, reaching incomplete overhead extension. Arms initiate jumping action.</td>
<td></td>
</tr>
<tr>
<td>3 = Arms move high and backwards with full overhead extension.</td>
<td></td>
</tr>
<tr>
<td><strong>Knee Extension (during take off)</strong></td>
<td>Measure angle between hip and ankle in the first frame before feet have left the ground.</td>
</tr>
<tr>
<td>1 = Limited extension &lt;140° and or feet leave asymmetrically.</td>
<td></td>
</tr>
<tr>
<td>2 = Observable extension 140° - 159° and both feet leave ground symmetrically.</td>
<td></td>
</tr>
<tr>
<td>3 = Complete extension of knees &gt; 160° and both feet leave symmetrically.</td>
<td></td>
</tr>
<tr>
<td><strong>Hip Extension (during take off)</strong></td>
<td>Measure angle between shoulder, hip and knee in the first frame before feet have left the ground.</td>
</tr>
<tr>
<td>1 = Limited extension of hips &lt;170°</td>
<td></td>
</tr>
<tr>
<td>2 = Observable extension 170° - 179°</td>
<td></td>
</tr>
<tr>
<td>3 = Complete hip extension &gt; 180°</td>
<td></td>
</tr>
<tr>
<td><strong>Take off Trunk Extension</strong></td>
<td>Measure angle between horizontal line drawn up from hips and between hips and shoulders in the first frame before feet have left the ground.</td>
</tr>
<tr>
<td>1 = Slight or no forward lean. Trunk moves in vertical direction with little emphasis on length of jump (&gt;60°)</td>
<td></td>
</tr>
<tr>
<td>2 = Observable forward lean with observable emphasis on horizontal distance. (44° - 60°)</td>
<td></td>
</tr>
<tr>
<td>3 = Definite forward lean with main emphasis on horizontal distance. (&lt; 45°)</td>
<td></td>
</tr>
<tr>
<td><strong>Flight Arm action</strong></td>
<td>Measure via visual observation.</td>
</tr>
<tr>
<td>1 = During flight, arms move sideward-downward or rearward-upward to maintain balance (windmill action).</td>
<td></td>
</tr>
<tr>
<td>2 = Arms move out to side to maintain balance during flight/assume high or middle guard position.</td>
<td></td>
</tr>
<tr>
<td>3 = Arms held high throughout jumping action.</td>
<td></td>
</tr>
<tr>
<td><strong>Flight Leg Position</strong></td>
<td>Measure via visual observation.</td>
</tr>
<tr>
<td>1 = No observable flexion of hips and knees</td>
<td></td>
</tr>
<tr>
<td>2 = Observable flexion of hips and knees</td>
<td></td>
</tr>
<tr>
<td>3 = Definite flexion of hips and knees</td>
<td></td>
</tr>
</tbody>
</table>
| Landing Arm action | 1 = Arms move to maintain balance. Arms may abduct and medially rotate (parachute landing).  
2 = Arms move outwards and lower from flight position but end out to the front of the body or behind the body.  
3 = Arms lower or extend from extended position overhead, reaching forward forcefully at landing. | Measure via visual observation |
|-------------------|-------------------------------------------------------------------------------------------------|-----------------------------|
| Landing Leg action | 1 = No knee extension. Resembles more of a catch.  
2 = Knees and hips extend simultaneously for two-foot landing.  
3 = As hips flex first, knee extend forward for landing (body weight is forward on landing). | Measure via visual observation |
| Landing Balance   | 1 = Body falls back on landing or steps forward or lands on one foot at a time.  
2 = Balance maintained by landing on both feet simultaneously (flat) with body weight not landing forward on landing.  
3 = Balance is maintained by landing on both feet simultaneously as body weight is forward on landing. | Measure via visual observation |
## Addendum 6: Throw for distance body component assessment protocol

<table>
<thead>
<tr>
<th>Critical elements</th>
<th>Description of movement pattern</th>
<th>Measuring notes</th>
</tr>
</thead>
</table>
| Preparatory arm swing             | 1 = No backswing/ action mainly from the elbow  
2 = Arms swing upward, sideward and backward to a position of elbow flexion (elbow and humeral flexion)  
3 = Shoulders rotate vigorously forward while the forearm is forced backward and downward until nearly horizontal. Aligning the arm with shoulders. | Measure via visual observation.      |
| Contralateral leg movement (execution phase) | 1 = Feet remain stationary with only upper body movement.  
2 = Steps forward with one leg on the same side as the throwing arm.  
3 = Forward step is with contralateral/opposition movement/pushes off the back leg and steps with the opposite foot in the direction of the intended line of flight. | Measure via visual observation.      |
| Trunk rotation (execution phase)   | 1 = No trunk action or forward backward movement. Trunk remains perpendicular in direction of the intended line of flight. If trunk action does occur, it accompanies the forward twist of the arm by first extending and then flexing at the pelvis.  
2 = Upper trunk rotation or total trunk “block” rotation. Both spine and pelvis rotate away from the intended line of the ball flight and then simultaneously begin forward rotation, acting as a “block” with forward motion of arm.  
3 = Definite rotation of trunk away from the intended line of the ball flight and then forward rotation of the pelvis in the direction of the intended line of flight of the ball, exposing a frontal plane view of the trunk. | Measure via visual observation.      |
| Ball follow-through (execution phase) | 1 = Follow-through is forward and downward.  
2 = Arms swing forward and high over shoulder with arm fully extended and the follow-through remains forward and downward motion.  
3 = The throwing elbow leads with elbow extension with forearm pronation and wrist flexion. The body continues in a forward motion and the throwing arm crosses the body to the opposite side of the throwing arm. | Measure via visual observation.      |
| Angle of release (execution phase) | 1 = Throw flat (< 25° or above 56)  
2 = Observable incline (25° - 34°).  
3 = Definite incline (>35° and <55 degrees). | Measure via visual observation. Measure from the shoulder joint perpendicular to the horizontal plane |
| Coordination of body               | 1 = Rigid, limited range of motion  
2 = Most segment actions are coordinated (dead wrist) with minimal muscle tension.  
3 = Well coordinated action of the leg drive, hip rotation, spinal rotation, arm and forearm/hand action. No observable muscle tension. | Measure via visual observation.      |
## Addendum 7: Catch body component assessment protocol

<table>
<thead>
<tr>
<th>Critical elements</th>
<th>Description of movement pattern</th>
<th>Measuring notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preparatory phase</strong>&lt;br&gt;Arm action</td>
<td>1 = Minimal response to adapt to the flight of the ball. Arms extended forward with no flexion of elbows (straight arms).&lt;br&gt;2 = Observable adjustment of arms to the flight of the ball.&lt;br&gt;3 = Arms are held relaxed at the sides with the forearms raised in the front of the body and the elbows semi-flexed pointing downwards to meet the ball.</td>
<td>Measure via visual observation. Focus on flexion &amp; position of elbows</td>
</tr>
<tr>
<td><strong>Reception phase</strong>&lt;br&gt;Arm action</td>
<td>1 = Catch resembles a scooping action/move under object/no “give” on contact/ body traps the ball&lt;br&gt;2 = Arms trap the ball/encircle the ball/hugging against chest/Arms move upwards towards the face&lt;br&gt;3 = Arms “give” on contact with the ball to absorb the force of the ball. Ball is brought down and towards the body rather than towards the face</td>
<td>Measure via visual observation. Focus on elbow flexion and move towards the body. Measure angle between horizontal line drawn to the chest from flight path on the ball.</td>
</tr>
<tr>
<td><strong>Reception phase</strong>&lt;br&gt;Hand action</td>
<td>1 = Hands not utilized.&lt;br&gt;2 = Hands are cup shaped but utilized in poorly timed and uneven motion&lt;br&gt;3 = Hands are cup shaped and utilized in well-timed, simultaneous motion.</td>
<td>Measure via visual observation.</td>
</tr>
<tr>
<td><strong>Reception phase</strong>&lt;br&gt;Body action</td>
<td>1 = No adjustment in response to the ball’s flight path/limited until ball contact/uses body to trap ball&lt;br&gt;2 = Awkward/delayed adjustment. Trunk and arms move late in relation to the ball’s flight while the head remains erect, creating a rushed movement to the ball. Tendency to fight to remain balanced.&lt;br&gt;3 = Proper/timed adjustment. Feet, trunk and arms all move to adjust to the ball path flight. Ball caught in controlled fashion that is not rushed. Feet are astride.</td>
<td>Measure via visual observation. Focus on position of the feet.</td>
</tr>
</tbody>
</table>
Addendum 8: Summary of BC approach and TGMD II definitions of mastery and near mastery

BC Assessment Protocol (McClenaghan & Gallahue, 1978; Corbin, 1980; Wickstrom, 1983; Robertson, 1986; Horita, 2008; Haywood & Getchell, 2009)

Stage Assessment

Mature Level

Composite BC score and BC Variable Score (Mean and SD)

Elementary

Percentage of participants performing at a proficient level

Initial

80% of BC Variables performed proficiently (O’Conner, 2000)

Mature Proficiency Assessment

Near Mastery: All Except 1 BC Variable Present

Percentage of participants performing at a near mastery and mastery level

Mastery: All BC Variables Present

FMS Assessment

TGMD II (Ulrich, 2000)

BC Variable Present

BC Variable not Present

Percentage of participants performing at a near mastery and mastery level
Kindly please complete the following questionnaire by filling in the information or by marking with a “X” where relevant. The information that you provide will be used for research statistics only. Your name will be kept confidential.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Year</th>
<th>Month</th>
<th>Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Today’s date</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Surname</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>First name</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>How old are you?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Date of birth</td>
<td>Year</td>
<td>Month</td>
<td>Day</td>
</tr>
<tr>
<td>6</td>
<td>What is your home language?</td>
<td>Eng</td>
<td>Afri</td>
<td>Xhosa</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other: Specify</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>In which suburb do you live?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Which school do you attend?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>In which grade are you?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>What type of home do you reside in?</td>
<td>House</td>
<td>Townhouse</td>
<td>Flat</td>
</tr>
<tr>
<td>11</td>
<td>How many people are presently residing in the same house as you? (including yourself)</td>
<td>2</td>
<td>3</td>
<td>More than 4</td>
</tr>
<tr>
<td>12</td>
<td>How many people residing with you are currently employed?</td>
<td>1</td>
<td>2</td>
<td>More than 3</td>
</tr>
<tr>
<td>13</td>
<td>In which professions are the people mentioned in 12 employed?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>How often do you participate in school sport activities after school?</td>
<td>Never</td>
<td>2 x per week</td>
<td>More than 2 x per week</td>
</tr>
<tr>
<td>15</td>
<td>Which of the following school sport activities do you participate in after school? (Mark with a “X”)</td>
<td>Athletics</td>
<td>Swimming</td>
<td>Tennis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Netball</td>
<td>Hockey</td>
<td>Ballet/ Dancing</td>
</tr>
<tr>
<td>Question</td>
<td>Options</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Which of the following sport activities do you participate in at club level? (Mark with a “X”)</td>
<td>Athletics, Swimming, Tennis, Netball, Hockey, Ballet/Dancing, Gymnastics, Other (specify): Soccer, Volleyball, cricket, basketball</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much time do you spend per day after school playing?</td>
<td>Never, Less than 1 hour, Between 1-2 hours, More than two hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If you play after school, which of the following do you do? (Mark with a “X”)</td>
<td>Run around, Ball games, Ride a bicycle, Swim, Other (specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much time do you spend playing during the weekends?</td>
<td>Never, Between 1-2 hours, More than two hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have you started your menstruation?</td>
<td>Yes, No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If yes, What year?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How sure are you?</td>
<td>Very Sure, Sure, Not Sure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What month?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How sure are you?</td>
<td>Very Sure, Sure, Not Sure</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PLEASE RETURN THE QUESTIONNAIRE TO YOU CLASS TEACHER THANK YOU FOR YOUR CO-OPERATION
Addendum 10: Test dates and time schedule for the testing days based on break times

Day 1: Jump, arm span, throw for accuracy, balance and catch were tested on day 1.

<table>
<thead>
<tr>
<th>School</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>23\textsuperscript{rd} of November, testing at school 1 (Monday)</td>
<td>25\textsuperscript{th} of November, testing at school 2 (Wednesday)</td>
<td>27\textsuperscript{th} of November, testing at school 3 (Friday)</td>
</tr>
</tbody>
</table>

Day 2: Height, run, body mass and throw for distance were tested on day 2.

<table>
<thead>
<tr>
<th>School</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 2</td>
<td>24\textsuperscript{th} of November, testing at school 1 (Tuesday)</td>
<td>26\textsuperscript{th} of November, testing at school 2 (Thursday)</td>
<td>31\textsuperscript{st} of November, testing at school 3 (Tuesday)</td>
</tr>
</tbody>
</table>

School 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:50 to 09:50:</td>
<td>9 year olds</td>
</tr>
<tr>
<td>Break at 09:50 to 10:10</td>
<td></td>
</tr>
<tr>
<td>10:20 to 11:20:</td>
<td>10 year olds</td>
</tr>
<tr>
<td>11:20 to 12:20:</td>
<td>11 year olds</td>
</tr>
<tr>
<td>12:00 to 12:25:</td>
<td>BREAK</td>
</tr>
<tr>
<td>12:30 to 13:30:</td>
<td>12 year olds</td>
</tr>
</tbody>
</table>

School 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:45/9 to 10:</td>
<td>9 year olds</td>
</tr>
<tr>
<td>10 to 11:15:</td>
<td>10 year olds</td>
</tr>
<tr>
<td>11:15 to 12:00:</td>
<td>BREAK</td>
</tr>
<tr>
<td>12 to 1:</td>
<td>11 year olds</td>
</tr>
<tr>
<td>1 to 2:</td>
<td>12 year olds</td>
</tr>
</tbody>
</table>

School 3

<table>
<thead>
<tr>
<th>Time</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 to 10:</td>
<td>9 year olds</td>
</tr>
<tr>
<td>10:15 to 11:15:</td>
<td>10 year olds</td>
</tr>
<tr>
<td>11:30 to 12:30:</td>
<td>11 year olds</td>
</tr>
<tr>
<td>12:45 to 13:45:</td>
<td>12 year olds</td>
</tr>
</tbody>
</table>
Addendum 11: Approval letter from the department of education to conduct research

DEPARTMENT OF EDUCATION

EDUCATION SUPPORT PROGRAMMES 46 Park Drive, St. Georges
Park, Port Elizabeth, 6001 REPUBLIC OF SOUTH AFRICA
+27 (041) 508 8300 (041) 508 8307
Reference/Enquiries: DR. J.M. JANSEN

2 JUNE 2010

Ms S Kahts
Faculty of Human Movement Sciences
Nelson Mandela Metropolitan University
Private Bag 77000
PORT ELIZABETH 6030

Dear Ms Kahts

FUNDAMENTAL MOVEMENT SKILL PROFICIENCY OF 9-TO-12-YEAR-OLD GIRLS IN THE NELSON MANDELA BAY DISTRICT

Permission is hereby granted to conduct the above-mentioned research. The approval of research is however subject to the following conditions:

- All the arrangements concerning your research should be done by you and the Department of Education should not be responsible for costs involved.
- Your involvement in the schools should be negotiated with the principal to ensure minimum disruption of teaching time.
- The principal, educators, learners and parents are under no obligation to assist you with your research project.
- The schools, principal and educators should not be identifiable from the results of your research project.
- All information from the schools and the Department of Education should be treated as highly confidential.
- A copy of this letter should be submitted to the principal of the school where the intended research is to be conducted.
- A copy of the treatise on completion of the research must be submitted to the District Office, Education Support Programmes at the above address.

We trust that you will be successful in this interesting busy research.

Yours faithfully

[Signature]

DR. J.M. JANSEN
DCES: EDUCATION SUPPORT PROGRAMMES

Cc. Prof R du Randt
Dr. Ntsiko  
District Director: Nelson Mandela Bay  
Department of Education  

Re: REQUEST FOR PERMISSION TO CONDUCT A RESEARCH STUDY IN THE NELSON MANDELA BAY DISTRICT PRIMARY SCHOOLS  

Dear Dr. Ntsiko  

My name is Samantha Kahts and I am a Biokinetics Intern and Masters student at the Nelson Mandela Metropolitan University (NMMU). I am conducting research on the fundamental movement skill (FMS) proficiency of nine-to-twelve year old girls (grade 4-6) in the Nelson Mandela Bay District. This study will be conducted under the supervision of Professor Rosa Du Randt (NMMU, South Africa).  

I have received clearance from the Human Movement Science (HMS) Department’s Research Committee and the Faculty of Health Sciences Research Technology, Innovation (FRTI) to proceed with the data collection phase of my study. I have also been granted ethics approval for the study, reference number: H10 HEA HMS 007. Additionally the research proposal has been discussed with the representatives of the Eastern Cape Sport, Recreation, Arts and Culture Department; namely Mr. Buma Laman, Mr. Nandla Takayi and Mr. Sithembiso Magengelele. This has been done collaboratively with a representative of the Department of Education, Miss Tobeka Matroos.  

In order to achieve the aims of the research, I seek your consent to approach a number of Nelson Mandela Bay District schools to seek participants for my research study.  

Please let me know if you would like a copy of my proposal, which clearly outlines the anthropometric measurements that I will be measuring as well as the tests that I will be conducting in order to identify their FMS proficiency. The questionnaire to be completed by the parents/legal guardian, consent and assent forms to be used in the research process, as well as a copy of the ethics approval letter are included in the detailed proposal document.
I have attached my abstract as a summary of my research for you to review.

Upon completion of the study I will provide the Department of Education with a copy of the completed research report.

I trust that my request will meet your favorable consideration.

Yours sincerely

Samantha Kahts
Researcher
Tel: 073 3076 212

Prof. R. Du Randt
Supervisor
Tel: (041) 504-2499
Dr. Jansen  
Deputy Chief Education Specialist: Nelson Mandela Bay  
Department of Education

Re: REQUEST FOR PERMISSION TO CONDUCT A RESEARCH STUDY IN THE NELSON MANDELA BAY DISTRICT PRIMARY SCHOOLS

Dear Dr. Jansen

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Yours sincerely

Samantha Kahts
Researcher
Tel: 073 3076 212

Prof. R. Du Randt
Supervisor
Tel: (041) 504-2499
Addendum 14: Abstract provided to representatives representative of the Eastern Cape Department of Sport Recreation, Arts and Cultures and the Eastern Cape Department of Education

Abstract

The goal of the study is to identify the fundamental movement skill (FMS) proficiency of lower socio-economic status nine-to-twelve-year old girls in the Nelson Mandela Bay District. The research objectives are to identify the status of FMS proficiency for the age cohorts nine, ten, eleven and twelve and to compare these age cohorts with one another with respect to their FMS proficiency.

A descriptive-exploratory-contextual study design, employing quantitative assessment techniques, will be utilized in this study. Consequently a process- and product-orientated approach will be employed to analyze FMS and outcome variables, respectively.

It is envisioned that up to 300 participants that meet the specified inclusion and exclusion criteria will be included in this study. Convenience sampling techniques will be employed.

Data will be collected by means of: (1) anthropometric measurements namely; standing and seated height, weight, arm span and leg length; (2) FMS tests: 20 and 40 meter sprint to assess running biomechanics and speed, standing broad jump to judge jumping proficiency and lower body power, a throw for distance assessment to judge throwing proficiency and the distance the ball is displaced, an underarm catch-throw test to assess catching proficiency, a stork-stand test to assess static balance and a throw for accuracy task to appraise participants ability to throw accurately at a target; (3) short questionnaire to assess demographic information, age at menarche and physical activity level.

Microsoft Excel® and Statistica® were used for descriptive and inferential statistical analysis. In the case of significant ANOVA results, the Scheffe post hoc test was used for pairwise comparisons. Statistical significance was set at p=<.05 and practical significance (Cohen’s d) was set at r=>.2. Pearson Correlation Coefficient identified statistical and practical correlations between 2 variables and chi square was applied to indicate differences in frequency distribution tables. Cramer’s V values were applied to determined practical significance in the case where statistical significant differences were identified between sets of frequency distributors.
Authorization from the Human Movement Science Department’s (HMS) Research Committee, Faculty of Health and Sciences Research Technology and Innovation (FRTI) Committee and the Research Ethical Committee – Human (REC-H) has been attained. Additionally the Eastern Cape Department of Education and the Eastern Cape Department of Sport, Recreation, Arts and Culture have been approached for clearance.
Addendum 15: Request letter provided to each principal

The Principal

Re: REQUEST TO CONDUCT RESEARCH AT YOUR SCHOOL

Dear Mr. January

My name is Samantha Kahts and I am a Biokinetics Intern Masters student at the Nelson Mandela Metropolitan University (NMMU). I am conducting research on the fundamental movement skill (FMS) proficiency of nine-to-twelve year old girls in the Nelson Mandela Bay District under the supervision of Professor Rosa du Randt (NMMU, South Africa), the Head of the Human Movement Science Department, at NMMU. The Provincial Department of Education has given approval to approach schools for my research. This study has also met the requirements of the NMMU Research Ethics Committee (Human). The following approval number was received from them to conduct the research: H10 HEA HMS 007.

I hereby invite you to consider participating in the research study.

Aim and objective of the research:

The primary aim of the study is to identify the FMS proficiency of nine-to-twelve year old girls in the Nelson Mandela Bay District.

The objectives are as follows:
1. To determine the following anthropometric measurements from the girls concerned: weight, height (standing and sitting), body mass index, arm span and leg length.
2. To determine the following FMS proficiencies in each age cohort nine, ten, eleven and twelve: balance, running, jumping, catching and throwing.
3. To identify biographical information and extra-mural physical activity participation status.
4. To identify whether menarche has begun, consequently identifying the level of maturation.
5. To determine the relationship between extra-mural physical activity status and the FMS competencies.
Significance of Research Project:

The research will be significant in the following ways:

- The data collected can be compared to national and international normative data.
- The current FMS proficiency status can be identified.
- The need for intervention can be recognized and substantiated if justified.
- The impact of intervention programs can be assessed. For example at present a Mass Participation Program is being implemented by the Department of Sport, Recreation, Arts and Culture (Eastern Cape) at selected schools targeted for the research.

Benefits of the Research:

- Dissemination of results to the Eastern Cape Department of Education and the relevant schools.
- The results could be used to inform curriculum development in the Life Orientation Program as how to restructure the physical development components so as to assist the child to optimize her potential, be it for excellent performance purposes or merely maintaining her health within optimal health levels.

Research Plan and Method:

Should you grant permission for the study to be conducted at your school, informed consent from the relevant parents/legal guardians and assent from the girls to be involved in the study, will be sought. Only those parents/legal guardians and girls who respond positively will be involved in the study.

Data will be collected by means of: (1) anthropometric measurements namely, standing and seated height, weight, arm span and leg length; (2) FMS tests: 20 and 40 meter sprint to assess running biomechanics (to identify the maturity of the movement patterns used) and speed, standing long jump to judge lower body power and the maturity of movement patterns used, stork stand for balance and a catching and throwing task to appraise accuracy and the maturity of the movement patterns and a (3) short questionnaire to assess demographic information, age at menarche and physical activity level.

The execution of the FMS will be videotaped for the purpose of analyzing the competency of the skills. The measurements and testing will be done by nine trained testers and ten Human Movement Science Post- and or Under - graduate students. The videotaping of the FMS will be done by two trained assistants. All assistants will be under my supervision.

All information collected will be treated as confidential and neither the school nor individual learners will be identifiable in the reports that are written. The results will be made available to the Principal of the school as soon as they have been analyzed and a report compiled. Participants may withdraw from the study at any time without penalty. Te role of the school is voluntary and you as the School Principal may decide to withdraw the school’s participation any time.

School involvement:

- Arrange for informed consent to be obtained from the participants’ parents/legal guardian.
- Obtain informed consent from the participants.
- Arrange a time with your school for data collection to take place.

Attached for your information are copies of the Parent/Legal guardian Information and Consent Form as well as the Participant Information Statement and Consent Form.
Invitation to Participate

If you would like your school to participate in this research, please complete and return the attached form.

Once again thank you for taking the time to read this information. You positive consideration of the request to participate in this research project will be much appreciated.

Thank you for taking the time to read this information. Your positive consideration of the request to participate in this research project will be much appreciated.

Yours sincerely

Samantha Kahts                    Prof. R. du Randt
Researcher                       Supervisor
Tel: 073 3076 212                Tel: (041) 504-2499
Principals Consent Form

I, ......................................................... (name) give consent for you to approach the female grade 4,5 and 6 learners at ................................................... school to participate in the research project which involves the assessment of their anthropometric measurements and fundamental movement skill competencies.

I have read the project information statement explaining the purpose of the project and understand that:

- The role of the school is voluntary.
- I may decide to withdraw the schools participation at any time without penalty
- Female learners from grade 4-6 will be invited to participate and that permission will be sought from them as well as from their parents/legal guardians.
- Only participants who consent and whose parents consent will participate in the project.
- All information obtained will be treated in strictest confidence.
- The learner’s names will not be used and individual participants will not be identifiable in any written reports about the study.
- The schools will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty
- A report of the findings will be made available the Principal of the school.
- I may seek further information on the project from Samantha Kahts at 073 3076 212 or at samkahts@hotmail.com.

Principal’s Signature ................................................................

Date..........................................................................................

This form will be collected from the school in three days time.
Dear Parent

Re: DETERMINING THE FUNDAMENTAL MOVEMENT SKILLS PROFICIENCY OF 9-TO-12-YEAR-OLD GIRLS IN THE NELSON MANDELA BAY DISTRICT

I, Samantha Kahts, am currently studying towards a Masters Degree in Human Movement Science at the Nelson Mandela Metropolitan University.

My research concerns the fundamental movement skill (FMS) competencies of 9-to-12-year-old girls at Primary Schools in the Nelson Mandela Bay District. The aim is to determine the FMS proficiency of the selected primary schools in the NMMU Bay District.

In order for the study to be a success, I request that your daughter participates in the anthropometric measurements and FMS tests of this research study. I would be grateful if you would consent to your daughter participating in this study.

The measurements and test will be conducted in August on two succeeding days. Your daughter will be tested for a maximum of an hour and a half. The following will be tested:

<table>
<thead>
<tr>
<th>Day 1:</th>
<th>Day 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight</td>
<td>Jumping</td>
</tr>
<tr>
<td>Standing height and Sitting height</td>
<td>Balance</td>
</tr>
<tr>
<td>Run</td>
<td>Catching</td>
</tr>
<tr>
<td>Throw for Distance</td>
<td>Throwing for Accuracy</td>
</tr>
<tr>
<td></td>
<td>Arm Span</td>
</tr>
</tbody>
</table>

The execution of all the activities will be explained to your daughter on the day of testing. There is no possible risk of injury. Please advise your daughter wear appropriate non-slip sport shoes and comfortable sport light shorts and T-shirt.
If your daughter experiences any pain or discomfort during the testing, she must immediately inform the person testing her.

The research is significant as:

- Your daughter’s results will contribute to my effort of establishing the current status of FMS competencies of Nelson Mandela Bay District girls aged 9-to-12 years old. Whilst neither you nor your daughter will receive feedback on her individual results, the overall research will culminate in a summary report that will be forwarded to the Education Department: Eastern Cape, Nelson Mandela Bay District and your school principle.
- It will contribute to identifying baseline data that can be utilized to analyse health and skill related fitness.

Participation is completely voluntary, and you have the right to withdraw your daughter (and your daughter has the right to withdraw herself) at any time. Confidentiality will be maintained at all times. Although the results of the study will be made public, no child or any of the school’s names will be identifiable in these reports. A summary report of the findings will be made available to the relevant schools involved in the study.

If you would like to know further information or are unclear of anything, please feel free to contact me via e-mail: samkahts@hotmail.com or telephonically on 073 3076212.

Your co-operation and your daughter’s participation is valued and appreciated. Should you agree to your daughter’s participation in the research, you and your daughter are kindly requested to complete the attached informed consent/assent forms respectively? Please fill in the required information where relevant, providing your initials in the appropriate blocks on the right hand side of the page and sign the consent form at the end of the document. Your assistance will be needed by your daughter to complete and sign the assent form.

Please return the consent and assent forms to your child’s class teacher within two days of receipt thereof.

Thank you in advance.

Yours sincerely

Samantha Kahts
Researcher

Prof R. du Randt
Promoter
Addendum 18: Consent form provided to each parent

DECLARATION BY PARENT/LEGAL GUARDIAN

I, _____________________________, (I.D. number ________________) in the capacity of parent/legal guardian of ____________________________ (name and surname) hereby confirms as follows:

(Please initial Against each Paragraph)

1. My daughter was invited to participate in the above mentioned research study, which is being undertaken by Samantha Kahts, a Masters Intern Biokinetics student, under the supervision of Prof Rosa du Randt, Head of Department of Human Movement Science in the Faculty of Health Sciences, Nelson Mandela Metropolitan University.

2. This research aims to determine the fundamental movement skill proficiency of girls nine-to-twelve years old of the Nelson Mandela Bay District. The information will be used as part of the requirements for a Masters in Human Movement Science. The results of the study may be presented at scientific conferences or in specific publications.

3. Furthermore, it is important that you are aware of the fact that the ethical integrity of the study has been approved by the Research Ethics Committee (Human) of the university. The REC-H consists of a group of independent experts that has the responsibility to ensure that the rights and welfare of participants in research are protected and that studies are conducted in an ethical manner. Studies cannot be conducted without REC-H’s approval.Queries with regard to the rights of a research subject can be directed to the Research Ethics Committee (Human), Department of Research Capacity Development, PO Box 77000, Nelson Mandela University, Port Elizabeth, 6031.

If no one could assist you, you may write to: The Chairperson of the Research, Technology and Innovation Committee, PO Box 77000,
4. I understand that I will need to complete the consent form and return to the researcher on completion. In addition, my daughter will be required to participate in the anthropometric measurements and fundamental movement skill assessment activities as previously mentioned.

5. My daughter’s identity will be kept confidentially will not be disclosed in any discussion, description or scientific publication by the researcher.

6. My daughter’s participation is voluntary. My decision whether or not to allow my daughter to participate, or my daughter’s decision whether or not to participate, will in no way affect her present or future school career or lifestyle.

7. No pressure was exerted on me to consent to my daughter’s participation and I understand that I may withdraw my daughter, or she may withdraw at any stage without penalization.

8. Participation in this study will not result in any cost to my daughter or myself.
Addendum 19: Assent forms provided to each participant

ASSENT FROM PARTICIPANT (your daughter is to sign)

I HEREBY AGREE TO PARTICIPATE IN THE ABOVE-MENTIONED RESEARCH PROJECT IN WHICH THE FOLLOWING WILL BE MEASURED

2. My ability to perform various skills such as balance, running, jumping, throwing for distance and accuracy and catching.
3. I am aware that my participation in this project is voluntary and that I can withdraw at any time without any negative effects on my present and future school career or lifestyle.

Signed at __________________________ on __________________________ 2010
Name of participant: __________________________ Grade ______
Name and surname of parent: __________________________
Signature of parent/legal guardian: __________________________

Please return the assent form to your class teacher within three days or receipt thereof.
Addendum 20: Anti-plagiarism pledge

‘I understand that copying material without giving credit to the source is plagiarism, a form of theft, which will receive a grade of zero and be subject to disciplinary action’.

‘I certify that all words not in quotations marks, or not cited regarding the source, are my own’.

Signature: _______________________

Date: _______________________


Addendum 21: Correlations between each age group’s anthropometric variables and their FMS product scores

Run for speed correlations

Correlation between anthropometric variables and the 40m running speed for 9 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.277</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.281</td>
</tr>
<tr>
<td>Mass</td>
<td><strong>0.398</strong></td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.257</td>
</tr>
</tbody>
</table>

Correlations in bold are statistically significant (p<0.05)

Correlation between anthropometric variables and the 40m running speed for 10 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.044</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.061</td>
</tr>
<tr>
<td>Mass</td>
<td><strong>0.265</strong></td>
</tr>
<tr>
<td>Arm Span</td>
<td>-0.062</td>
</tr>
</tbody>
</table>

Correlations in bold are statistically significant (p<0.05)

Correlation between anthropometric variables and the 40m running speed for 11 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.063</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.098</td>
</tr>
<tr>
<td>Mass</td>
<td><strong>0.473</strong></td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.020</td>
</tr>
</tbody>
</table>

Correlations in bold are statistically significant (p<0.05)

Correlation between anthropometric variables and the 40m running speed for 12 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>-0.269</td>
</tr>
<tr>
<td>Sitting height</td>
<td>-0.138</td>
</tr>
<tr>
<td>Mass</td>
<td>0.236</td>
</tr>
<tr>
<td>Arm Span</td>
<td>-0.161</td>
</tr>
</tbody>
</table>

Correlations in bold are statistically significant (p<0.05)
Standing broad jump correlations

Correlation between anthropometric variables and the standing broad jump for 9 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>-0.070</td>
</tr>
<tr>
<td>Sitting height</td>
<td>-0.072</td>
</tr>
<tr>
<td>Mass</td>
<td>-0.180</td>
</tr>
<tr>
<td>Arm Span</td>
<td>-0.164</td>
</tr>
</tbody>
</table>

Correlations in bold are statically significant (p<0.05)

Correlation between anthropometric variables and the standing broad jump for 10 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.077</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.142</td>
</tr>
<tr>
<td>Mass</td>
<td>-0.138</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.167</td>
</tr>
</tbody>
</table>

Correlations in bold are statically significant (p<0.05)

Correlation between anthropometric variables and the standing broad jump for 11 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.041</td>
</tr>
<tr>
<td>Sitting height</td>
<td>-0.025</td>
</tr>
<tr>
<td>Mass</td>
<td>-0.469</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.032</td>
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</table>

Correlations in bold are statically significant (p<0.05)

Correlation between anthropometric variables and the standing broad jump for 12 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.179</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.065</td>
</tr>
<tr>
<td>Mass</td>
<td>-0.238</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.107</td>
</tr>
</tbody>
</table>

Correlations in bold are statically significant (p<0.05)
Throw for distance correlations

Correlation between anthropometric variables and the throw for distance for 9 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>-0.13</td>
</tr>
<tr>
<td>Sitting height</td>
<td>-0.13</td>
</tr>
<tr>
<td>Mass</td>
<td>-0.03</td>
</tr>
<tr>
<td>Arm Span</td>
<td>-0.08</td>
</tr>
</tbody>
</table>

Correlations in bold are statically significant (p<0.05)

Correlation between anthropometric variables and the throw for distance for 10 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.05</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.11</td>
</tr>
<tr>
<td>Mass</td>
<td>0.05</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Correlations in bold are statically significant (p<0.05)

Correlation between anthropometric variables and the throw for distance for 11 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.20</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.21</td>
</tr>
<tr>
<td>Mass</td>
<td>-0.03</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Correlations in bold are statically significant (p<0.05)

Correlation between anthropometric variables and the throw for distance for 12 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.07</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.11</td>
</tr>
<tr>
<td>Mass</td>
<td>0.03</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Correlations in bold are statically significant (p<0.05)
Balance correlations

Correlation between anthropometric variables and the balance for 9 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.127</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.257</td>
</tr>
<tr>
<td>Mass</td>
<td>-0.009</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.087</td>
</tr>
</tbody>
</table>

**Correlations in bold are statically significant (p<0.05)**

Correlation between anthropometric variables and the balance for 10 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.209</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.100</td>
</tr>
<tr>
<td>Mass</td>
<td>0.177</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.038</td>
</tr>
</tbody>
</table>

**Correlations in bold are statically significant (p<0.05)**

Correlation between anthropometric variables and the balance for 11 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.102</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.092</td>
</tr>
<tr>
<td>Mass</td>
<td>0.121</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.092</td>
</tr>
</tbody>
</table>

**Correlations in bold are statically significant (p<0.05)**

Correlation between anthropometric variables and the balance for 12 year olds

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing height</td>
<td>0.439</td>
</tr>
<tr>
<td>Sitting height</td>
<td>0.329</td>
</tr>
<tr>
<td>Mass</td>
<td>0.335</td>
</tr>
<tr>
<td>Arm Span</td>
<td>0.399</td>
</tr>
</tbody>
</table>

**Correlations in bold are statically significant (p<0.05)**