INTERRELATIONSHIPS AND ASSESSMENT CRITERIA OF GROSS MOTOR SKILL DEVELOPMENT AND OBESITY OF PRESCHOOL CHILDREN IN POTCHEFSTROOM

Dorita du Toit, BA, BA Hons, MA

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Promotor: Dr. A.E. Pienaar

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SUMMARY

INTERRELATIONSHIPS AND ASSESSMENT CRITERIA OF GROSS MOTOR SKILL DEVELOPMENT AND OBESITY OF PRESCHOOL CHILDREN IN POTCHEFSTROOM

In the holistic development of the young child, optimal gross motor development has an important influence on optimal physical, perceptual, cognitive, language, affective-social and normative (behavioural) development (Kapp, 1991; Gallahue & Ozmun, 1998), and is therefore considered to be essential in the preschool years. The goal of this dissertation was to present the results of much-needed recent research on gross motor development of a group of children living in an urban area in South Africa, by 1) determining the current levels of gross motor development, 2) assessing the prevalence of and the influence of overweight and obesity on gross motor development, 3) establishing the relationship between overweight and obesity, gross motor development and gender, 4) determining the relationship between quantitative and qualitative assessment results of the one leg balance, and 5) investigating the occurrence of gender differences in gross motor development, in a group of 3-6 year old children living in Potchefstroom. These aims were addressed by structuring the dissertation in eight chapters, Chapter 1 constituting the introduction and statement of the problem, Chapter 2 a review of relevant literature, Chapters 3 to 7 constituting 5 research articles addressing the specific aims of the study, and Chapter 8 including the summary, conclusions and recommendations.

For each of the 5 research articles, the participants were 3-6 year old children ($N = 514$) who lived in Potchefstroom and had been enrolled in the movement development program (MDP) presented by movement developmentalists of the Potchefstroom University for Christian Higher Education (P.U. for C.H.E.). Descriptive statistics (Chapter 3-7), practical significance based on effect sizes (Chapter 4 and 5), 2 way frequency tables and Pearson Chi-square as well as the Phi for two-way tables (Chapter 6), and t-values, degrees of difference and p-values (Chapter 7) were used.
The current levels of gross motor development of preschool children in Potchefstroom (Chapter 3) were determined by testing a total of 462 3-6 year old children (215 males and 247 females) on 8 gross motor tasks, and comparing the results to norms and criteria as found in the literature. The 3, 4 and 5 year olds compared favourably to their counterparts in all the tests except for balance walk and catching, standing long jump in the 4 year olds and throwing in the 5 year old group. The 6 year old group scored lower than the norms and criteria in all the tests except for standing long jump, indicating alarming implications for school readiness.

Chapter 4 and Chapter 5 examined the prevalence of and the differences in the quantitative and qualitative execution of four gross motor tasks (standing long jump, hopping, one leg balance and catching) between groups of overweight and obese (O) and nonobese (NO) boys, and girls, respectively. In the male study, 17 O-participants and 49 NO-participants were compared, while 13 O-participants and 54 NO-participants were used in the female study. Differences of practical significance (medium or large effects) in favour of nonobese groups were found in all the quantitative and qualitative tests among the male participants, while similar differences were found in only the quantitative tests for the one leg balance and all the qualitative tests among the female participants. A prevalence of overweight and obesity of 16.35% was found among the boys and 11.81% among the girls. The results indicated that O-children of the ages 3-6 years generally compare poorly to NO-children in relation to gross motor proficiency.

In Chapter 6, the one leg balance ability of 514 subjects was quantitatively and qualitatively assessed using valid norms and criteria found in literature. A positive relationship of statistical significance \( (p \leq 0.05) \) was established between the quantitative and qualitative scores of the one leg balance in every age group. A relatively large percentage (44.10%) of 3 year olds scored well above the average level for their age in both types of assessment, indicating that the norms and criteria used might not be appropriate for 3 year olds. Relatively large percentages (25.27% - 27.47%) of the 6 year olds scored below the average level for 5 year olds in the qualitative assessment, suggesting developmental balance delays or disorders. These findings indicate that a
quantitative and qualitative assessment should be combined to assure a more accurate assessment.

The results of Chapter 7, involving 221 male and 243 female participants, showed significant gender differences in hopping and balancing on the right leg in favour of the females in the 3 year old group, and in the standing long jump and throwing for distance in favour of the males in the 5 and 6 year old groups, indicating that separate norms should be used for the different genders when assessing standing long jump and throwing for distance in 5 and 6 year olds.

In the light of the findings of these studies, recommendations presented in Chapter 8 for the assessment and structuring of a programme for the optimal development of gross motor skills in preschool children, living in urban areas in South Africa, include that: 1) special attention should be given to the optimal development of gross motor skills of 6 year olds in a structured gross motor development programme, 2) obesity should be addressed even in the preschool years, and activities for the specific skills shown to be related to overweight and obesity (balance skills and catching in boys and girls and standing long jump in boys) should also be specifically emphasized in these children, 3) both a quantitative and a qualitative assessment should be used specifically in the one leg balance assessment and is recommended for other fundamental motor assessments, and 4) separate norms should be used for the assessment of the standing long jump and throwing for distance in 5 and 6 year olds, and more emphasis should be placed on ball skills in girls, and co-ordination skills of boys in the structuring of a movement development programme.

**Key words:** Gross motor development, preschool children, obesity, quantitative, qualitative assessment, genders.
OPSOMMING

INTERVERBANDE EN EVALUERINGSKRITERIA VAN GROOTMOTORIese ONTWIKKELING EN OBESITEIT VAN KLEUTERS IN POTCHEFSTROOM

Optimale vroeë grootmotoriese ontwikkeling speel 'n kardinale rol in die holistiese ontwikkeling van die kind en word veral in die kleuterjare belangrik geag, aangesien dit optimale fisieke, perseptuele, kognitiewe, taal-, affektiewe en normatiewe (gedrags-) ontwikkeling beïnvloed (Kapp, 1991; Gallahue & Ozmun, 1998). Die doel van hierdie proefskrif is om die resultate van onlangse navorsing, waaraan daar 'n dringende behoefte is, in grootmotoriese ontwikkeling van 'n groep kleuters in 'n stedelike gebied in Suid-Afrika aan te bied, deur 1) die bepaling van die huidige vlakke van grootmotoriese ontwikkeling, 2) die ondersoek na die voorkoms en die invloed van oorgewig en obesiteit op grootmotoriese ontwikkeling, 3) die bepaling van die verband tussen oorgewig en obesiteit, grootmotoriese ontwikkeling en geslag, 4) die bepaling van die verband tussen die kwantitatiewe en die kwalitatiewe toetsresultate van die eenbeenstand, en 5) die ondersoek van die voorkoms van geslagsverskille in grootmotoriese ontwikkeling, in 'n groep 3-6 jarige kinders in Potchefstroom. Hierdie doelwitte is aangespreek in die vorm van agt hoofstukke; met Hoofstuk 1 wat die inleiding en probleemstelling aanbied, Hoofstuk 2 wat die literatuuroorsig bevat, Hoofstuk 3 tot 7 wat in die vorm van 5 navorsingsartikels die spesifieke doewitte aanspreek, en Hoofstuk 8 wat die samevatting, gevolgtrekkings en aanbevelings insluit.

Vir die doel van elkeen van die vyf artikels is proefpersone in die 3-6 jarige ouderdomsgroep (N = 514) gebruik wat in Potchefstroom woon en wat ingeskryf was vir die bewegingsontwikkelingsprogram wat deur Kinderkinetici van die Potchefstroomse Universiteit vir Christelike Hoër Onderwys (PU vir CHO) aangebied word. Beskrywende statistiek (Hoofstukke 3 tot 7), praktiese betekenisvolheid gebaseer op effekgroottes (Hoofstukke 4 en 5), tweerigting frekwensie tabelle en Pearson Chi-kwadraat asook die Phi vir tweerigting tabelle (Hoofstuk 6), en t-toetse (p ≤ 0.05) (Hoofstuk 7) is vir data analise gebruik.
Die huidige vlakke van grootmotoriese ontwikkeling van kleuters in Potchefstroom (Hoofstuk 3) is bepaal deur die evaluering van 8 grootmotoriese take (staande verspring, hop, huppel, eenbeenstand, balansloop, vang, gooi, "jumping jacks") by 'n totaal van 462 kleuters (215 seuns en 247 dogters), waarna die resultate met norme en kriteria in die literatuur vergelyk is. Die 3-, 4- en 5-jariges het goed vergelyk met hulle portuurgroep met betrekking tot al die toetse behalwe in die staande verspring, balansloop en vang by die 4-jarige groep en gooi by die 5-jarige groep. Die 6 jarige groep se resultate was swakker as die norme en kriteria in al die toetse behalwe die in staande verspring, wat dui op negatiewe implikasies vir skoolgereedheid by die groep.

Hoofstukke 4 en 5 het die voorkoms van oorgewig en obesiteit ondersoek, asook die verskille in die kwantitatiewe en kwalitatiewe uitvoering van vier grootmotoriese take (staande verspring, hop, eenbeenstand en vang) tussen oorgewig en obese (O) groepe en nie-obese (N) groepe seuns, en dogters, onderskeidelik. In die manlike studie is 17 O-proefpersone vergelyk met 49 N-proefpersone, terwyl 13 O-proefpersone met 54 N-proefpersone vergelyk is in die vroulike studie. Verskille van praktiese betekenisvolheid (medium of groot effekte) ten gunste van die N-groepe is gevind in al die kwantitatiewe en kwalitatiewe toetse by die manlike proefpersone, terwyl ooreenstemmende verskille slegs in die kwantitatiewe toetse van die eenbeenstand en al die kwalitatiewe toetse by die vroulike proefpersone gevind is. 'n Voorkoms van oorgewig en obesiteit van 16.35% is by die seuns gevind en 'n voorkoms van 11.81% by die dogters. Die resultate dui daarop dat 3-6 jarige oorgewig en obese kinders oor die algemeen swak vergelyk met nie-obese kinders met betrekking tot grootmotoriese ontwikkeling.

In Hoofstuk 6 is die vermoe van 514 proefpersone om op een been te balanseer, kwantitatief en kwalitatief geëvalueer deur middel van geldige norme en kriteria soos in die literatuur gevind. 'n Statisties betekenisvolle positiewe verband (p≤ 0.05) is gevind tussen die kwantitatiewe en kwalitatiewe resultate in elke ouderdomsgroep. 'n Relatief groot persentasie (44.10%) van die 3-jariges het beter as die gemiddelde vlakke vir hulle ouderdom getoets in albei tipes toetse, wat daarop wys dat norme en kriteria wat vir 3-
jariges gebruik word moontlik nie gepas is vir hierdie ouderdom nie. Relatief groot persentasies (25.27% - 27.47%) van die 6-jariges het swakker getoets as die gemiddelde vlakke vir 5-jariges in die kwalitatiewe toets, wat dui op ontwikkelingsagterstande of -uitvalle met betrekking tot hulle statiese balansvermoë. Hierdie resultate dui daarop dat kwantitatiewe en kwalitatiewe toetse saam gebruik moet word om 'n meer akkurate evaluasie te verseker.

Die resultate van Hoofstuk 7 het statisties betekenisvolle geslagsverskille uitgewys ten opsigte van hop (regs) en die eenbeenstand (regs) ten gunste van die vroulike proefpersone in die 3-jarige groep asook in die staande verspring en gooi ten gunste van die manlike proefpersone in die 5- en 6-jarige groepe. Hierdie bevindinge dui daarop dat aparte norme vir elke geslag gebruik behoort te word wanneer die staande verspring en gooi geëvalueer word in 5- en 6-jariges.

In die lig van die bevindinge van hierdie studies, kan aanbevelings ten opsigte van die evaluasie van en die strukturering van 'n program vir die optimale ontwikkeling van grootmotoriese vaardighede by voorskoolse kinders gemaak word, dit wil sê: 1) aandag moet spesifiek gegee word aan die optimale ontwikkeling van grootmotoriese vaardighede van 6-jariges in 'n gestrukureerde grootmotoriese ontwikkelingprogram, 2) obesiteit behoort selfs in die kleuterjare al aangespreek te word, en aktiwiteite vir die spesifieke vaardighede wat deur obesiteit beïnvloed word, moet bekleemtoon word by obese kinders, 3) beide 'n kwantitatiewe en kwalitatiewe evaluasie moet gebruik word om veral die eenbeenstand sowel as ander fundamentele vaardighede akkuraat te evalueer, en 4) aparte norme moet gebruik word vir die evaluering van die staande verspring en die gooì in 5- en 6-jarige kinders en meer klem moet geplaas word op die ontwikkeling van balvaardighede by dogters en koördinasievaardighede by seuns.

Sleutelwoorde: Grootmotoriese ontwikkeling, kleuters, obesiteit, kwantitatiewe, kwalitatiewe evaluasie, geslagsverskille.
CHAPTER ONE: PROBLEM AND AIM OF THE STUDY

1.1 Introduction ............................................................. 1
1.2 Problem statement .................................................... 1
1.3 Aims of the study ...................................................... 4
1.4 Hypotheses ............................................................... 5
    1.4.1 Hypothesis 1 ....................................................... 5
    1.4.2 Hypothesis 2 ....................................................... 5
    1.4.3 Hypothesis 3 ....................................................... 5
    1.4.4 Hypothesis 4 ....................................................... 5
    1.4.5 Hypothesis 5 ....................................................... 5
1.5 Structure of the dissertation ........................................... 5

CHAPTER TWO: GROSS MOTOR DEVELOPMENT AND RELATED FACTORS IN PRESCHOOL CHILDREN

2.1 Introduction .............................................................. 7
2.2 Gross motor development and physical activity ......................... 8
2.3 The influence of obesity on gross motor development ..................... 10
2.4 Assessment of gross motor development levels ............................. 12
    • Research data used for the development of current tests ............. 13
Quantitative and qualitative assessment methods ............................................. 14
Quantitative and qualitative balance assessment in preschool children .......... 15
2.5 Gender differences in gross motor development ....................................... 16
2.6 Conclusion ............................................................................................. 19

CHAPTER THREE (RESEARCH ARTICLE 1): CURRENT LEVEL OF GROSS MOTOR DEVELOPMENT OF 3-6 YEAR OLD CHILDREN IN POTCHEFSTROOM
3.1 Abstract ............................................................................................... 22
3.2 Introduction ......................................................................................... 22
3.3 Method ................................................................................................. 23
3.3.1 Participants ..................................................................................... 23
3.3.2 Procedure ....................................................................................... 23
3.3.3 Instrumentation .............................................................................. 24
3.3.4 Data analysis ................................................................................ 25
3.4 Results ................................................................................................. 26
3.5 Discussion ........................................................................................... 27
3.6 Conclusion .......................................................................................... 28
3.7 References ........................................................................................ 29

CHAPTER FOUR (RESEARCH ARTICLE 2): OVERWEIGHT AND OBESITY, AND MOTOR PROFICIENCY OF PRESCHOOL BOYS
4.1 Abstract ............................................................................................... 32
4.2 Introduction ......................................................................................... 32
4.3 Procedure ............................................................................................ 34
4.3.1 Subjects .......................................................................................... 34
4.3.2 Assessment procedure .................................................................... 35
4.3.3 Body composition assessment ......................................................... 35
CHAPTER SIX (RESEARCH ARTICLE 4): CURRENT STATUS AND ASSESSMENT OF QUANTITATIVE AND QUALITATIVE ONE LEG BALANCING ABILITY IN 3-6 YEAR OLD CHILDREN

6.1 Abstract ................................................................. 68
6.2 Introduction ............................................................. 68
6.3 Procedures ............................................................. 71
6.3.1 Subjects .............................................................. 71
6.3.2 Assessment procedures ........................................... 71
6.3.3 Quantitative assessment ......................................... 71
6.3.4 Qualitative assessment ........................................... 72
6.3.5 Data analysis ....................................................... 74
6.4 Results ................................................................. 74
6.5 Discussion ............................................................. 78
6.6 Conclusion ............................................................. 80
6.7 References ............................................................ 82

CHAPTER SEVEN (RESEARCH ARTICLE 5): GENDER DIFFERENCES IN GROSS MOTOR SKILLS IN 3-6 YEAR OLD CHILDREN IN POTCHEFSTROOM

7.1 Abstract ................................................................. 85
7.2 Introduction ............................................................. 85
7.3 Method ................................................................. 86
7.3.1 Participants ........................................................ 86
7.3.2 Procedure .......................................................... 87
7.3.3 Instrumentation ................................................... 87
7.3.4 Data analysis ....................................................... 89
CHAPTER EIGHT: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction ................................................................................... 96
8.2 Summary ...................................................................................... 96
8.3 Conclusions .................................................................................. 103
  8.3.1 Hypothesis 1 .............................................................................. 103
  8.3.2 Hypothesis 2 .............................................................................. 104
  8.3.3 Hypothesis 3 .............................................................................. 104
  8.3.4 Hypothesis 4 .............................................................................. 105
  8.3.5 Hypothesis 5 ............................................................................. 105

8.4 Recommendations ........................................................................... 106

LIST OF REFERENCES .............................................................................. 110

Addendum 1 ....................................................................................... 118
Addendum 2 ....................................................................................... 119
LIST OF TABLES

CHAPTER 3: CURRENT LEVEL OF GROSS MOTOR DEVELOPMENT OF 3-6 YEAR OLD CHILDREN IN POTCHEFSTROOM

Table 1: Average norms and criteria for gross motor and perceptual motor skills in 3-6 year old children .................................................................26

Table 2: Mean scores and standard deviations of gross motor and perceptual motor tests in 3-6 year old children (N = 444) ........................................27

CHAPTER 4: OVERWEIGHT AND OBESITY, AND MOTOR PROFICIENCY OF PRESCHOOL BOYS

Table 1: Mean age and anthropometric values of overweight and obese (O) (n=17) and nonobese (NO) (n=49) groups used in the study (N=66) .........................38

Table 2: Mean values for the different gross motor tests in obese and overweight (O) groups and nonobese (NO) groups ........................................40

Table 3: Mean values, standard deviations and effect sizes of the differences between the obese and overweight group (O) and the nonobese group (NO) ....41

Table 4: Effect sizes of medium or large effects, favouring the NO-group, found in the gross motor tests in the different age groups .................................41
CHAPTER 5: OVERWEIGHT AND OBESITY, AND MOTOR PROFICIENCY OF 3-6 YEAR OLD GIRLS

Table 1: Mean age and body composition values of overweight and obese (O) 
\( n=13 \) and nonobese (NO) \( n=54 \) groups used in the study \( N=67 \) ............. 57

Table 2: Mean values for the different gross motor tests in obese and overweight (O) 
groups and nonobese (NO) groups................................................................. 58

Table 3: Means, standard deviations and effect sizes of the differences between the 
obese and overweight (O) and the nonobese group (NO)................................. 59

Table 4: Effect sizes of medium or large effects, favouring the NO-groups, found in 
the gross motor tests in the different age groups.......................................... 59

CHAPTER 6: CURRENT STATUS AND ASSESSMENT OF QUANTITATIVE 
AND QUALITATIVE ONE LEG BALANCING ABILITY IN 3-6 YEAR OLD 
CHILDREN

Table 1: Developmental stages of the one leg balance (adapted from Gallahue & 
Ozmun, 1995) used as qualitative criteria....................................................... 72

Table 2: Quantitative norms for the one leg balance............................................. 73

Table 3: Percentages of \emph{below average} and \emph{average or above average} quantitative and 
qualitative scores for the one leg balance of 4-6 year old subjects \( N=353 \)....... 76
Table 4: Percentages of 4-6 year old subjects (N=353) scoring below average and average or above average for their age in different combinations of the quantitative and qualitative scores for the one leg balance.

Table 5: Chi-square and Phi - scores for quantitative and qualitative scores of 4-6 year old subjects.

CHAPTER 7: GENDER DIFFERENCES IN GROSS MOTOR SKILLS IN 3-6 YEAR OLD CHILDREN IN POTCHEFSTROOM

Table 1: Mean scores (M) and standard deviations (SD) of gross motor tests of male and female 3-6 year old children (N=464).

Table 2: Significance of gender differences among 3-6 year old children (N=464).
LIST OF FIGURES

CHAPTER 6: CURRENT STATUS AND ASSESSMENT OF QUANTITATIVE AND QUALITATIVE ONE LEG BALANCING ABILITY IN 3-6 YEAR OLD CHILDREN

Figure 1: Cross-sectional developmental curves of quantitative and qualitative scores for the one leg balance (left and right leg) in 3-6 year old children......78
LIST OF ADDENDA

Guidelines for submitting manuscripts: African Journal for Physical, Health Education, Recreation and Dance (AJPHERD).............................................................118

Information for authors: South African Journal for Research in Sport, Physical Education and Recreation (SAJRSPER).............................................................119
Chapter 1

Problem and aim of the study
1.1 Introduction
Optimal gross motor development at a young age plays an essential role in a child's holistic development, because of its close relationship with the cognitive and affective domains of human behaviour (Merriman & Barnett, 1995:1212; Krombholz, 1997:1168; Reeves, 1997:335). The period between the ages of 2 and 7 years is characterized by the rapid development of various gross and perceptual motor skills, which should exhibit mature patterns at school-going age (between 6 and 7 years of age) (Gustafson-Munro, 1985:1; Haywood, 1986:141; Walkley et al., 1993:11; Gallahue & Ozmun, 1998:356). Running, jumping, balancing and co-ordination skills form an important part of these motor skills, as they are part of play, through which further perceptual, cognitive and affective development takes place (Gallahue & Ozmun, 1995:205; Ayres, 1997:25; Cooley et al., 1997:307). According to Broadhead and Church (1985:208) and Revie and Larkin (1993:4), gross motor skills can indirectly have an influence on the child's scholastic achievement, being the basis for fine motor development including skills like writing and cutting.

Gross motor skill patterns need to be developed at the mature stage to provide the foundation for the development of various sport skills later in life (Larkin & Hoare, 1992:425; Walkley et al., 1993:11; Gallahue & Ozmun, 1998:356). Competence on the sports field plays an essential role in the establishment of a child's peer image as well as his self-concept, especially in the school-going period of a child's life (Hoare & Larkin, 1991:37; Krombholz, 1997:1168). Children with gross motor deficits and problems often tend to avoid physical activities and sports in which these skills are prominent (Ulrich, 1987:57; Larkin & Hoare, 1992:431; Revie & Larkin, 1993:4), and most probably never get to the stage where fundamental motor skills reach the mature stage of development (Gallahue & Ozmun, 1998:356).

1.2 Problem statement
Various authors (Kapp, 1991:126; Gallahue & Ozmun, 1998:356; Krebs & Johnson, 2000:38) emphasize the detrimental effects of certain aspects of modern technology on early gross motor and perceptual motor development. The limited spaces of city life, television, the personal
computer and even high crime rates limit a child's opportunities to develop through movement, and create a more sedentary lifestyle. Marshall and Bouffard (1994:217) as well as Krebs and Johnson (2000:38) emphasize that physical inactivity is considered to be one of the major causes of obesity among children, which, according to Gallahue and Ozmun (1995:219) can again have a detrimental effect on gross motor as well as perceptual motor development. According to Marshall and Bouffard (1994:297) modern-day circumstances often lead to the development of a vicious cycle of physical inactivity leading to increasing overweight or obesity, and accompanying gross motor development problems. According to Gustafson-Munro (1985:9), Walkley et al. (1993:12), Cooley et al. (1997:307) and Taggart and Keegan (1997:16), structured motor development programmes play an important role in the present-day society in achieving a child's optimal development and preventing gross motor and health-related problems, especially with reference to children living in urban areas.

In order to compile an effective motor development programme, it is necessary to use valid and reliable procedures to assess a child's current level of motor development for his / her age (Gustafson-Munro, 1985:12; Gallahue & Ozmun, 1998:489). Furthermore, the accurate assessment of gross motor development levels is necessary for the correct identification of and intervention of deficits or problems (Walkley et al., 1995:2; Cowden & Torrey, 1995:2; Reeves, 1997:342). Reeves (1997:342) emphasizes that the use of inaccurate testing norms during the preschool years can have a detrimental effect on a child's motor development later on, as problems which are not identified correctly, cannot be addressed effectively. Therefore, it is considered important to accurately assess these motor skills before the child reaches school-going age, using valid and reliable norms and criteria (Revie & Larkin, 1993:4; Walkley et al., 1993:12).

Several norms and criteria for the assessment of gross motor skills in preschool children are published in the literature (Bruininks, 1978; Henderson & Sugden, 1992; Gallahue & Ozmun, 1998) and are used by movement developmentalists in movement development programmes, as well as therapists and teachers in South Africa. However, the validity, reliability and accuracy of these norms and criteria for children living in an urban area in South Africa become questionable when certain criteria are applied to its usability.
Firstly, these norms and criteria have been developed by means of studies that were conducted mainly on European and American children almost a decade ago. In the review of Burton and Miller (1998:335) on standardized test batteries for the assessment of gross and perceptual motor skills since 1927, it is clear that the research data used for the composition of the most recent test batteries derive from 1992 and earlier. Secondly, many test batteries use only quantitative norms (the measurable time, distance or number) to assess motor skills, but authors like Ulrich (1985:2) and Gallahue and Ozmun (1998:490) emphasize the importance of qualitative (the quality of the execution of the skill) criteria for accurate assessment of gross motor skills in preschool children.

Thirdly, considerable controversy exists in the literature concerning the occurrence and importance of gender differences in gross motor skills in preschool children (Morris et al., 1982:218; Ulrich & Ulrich, 1985:93; Butcher & Eaton, 1989:33; Butterfield & Loovis, 1993:462; Loovis & Butterfield, 1993:1270; Hands & Larkin, 1997:13; Thomas, 2000:3). According to Hands and Larkin (1997:12), the accuracy and validity of assessment norms are compromised if such norms do not address significant differences between subgroups in a population, such as gender differences.

No recent studies on the levels of gross motor development of South African preschool children, and/or the influence of factors like obesity, quantitative or qualitative assessment and gender differences on the gross motor development of these children could be found in the literature. Therefore, an apparent lack of recent research in reference to present-day gross motor development levels and related factors of preschool children is evident, especially regarding children living in an urban area like Potchefstroom.

The research questions arising from the above are:

1.2.1 What are the current levels of gross motor development of Potchefstroom preschool children and how do these levels compare to norms and criteria as found in the literature?

1.2.2 What is the prevalence of, and is there a relationship between obesity and overweight, and gross motor development in urban preschool children in Potchefstroom?

1.2.3 Is the relationship of overweight and obesity with gross motor development similar among the genders?
1.2.4 What is the relationship between quantitative and qualitative scores in the assessment of gross motor skills in urban preschool children in Potchefstroom, and is the use of both types of assessment recommendable?

1.2.5 Do gender differences in gross motor skills occur among preschool children living in Potchefstroom?

With these questions answered, knowledge will be available which will enable movement developmentalists and Kinderkineticists to make recommendations with reference to the accuracy and suitability of norms and criteria found in the literature for the assessment of preschool children in a movement development programme. Furthermore, these answers are essential for the composition and planning of effective movement development programmes for preschool children living in urban areas like Potchefstroom. The findings of this research can also benefit professionals working with children with special needs, like those displaying movement delays and obesity.

1.3 Aims of the study

The aims of the study are:

1.3.1 To assess the current levels of gross motor development of Potchefstroom preschool children, and to compare the results with norms and criteria as found in the literature.

1.3.2 To determine the prevalence of and possible relationship between overweight and obesity, and gross motor competency among preschool children in Potchefstroom.

1.3.3 To determine the possible relationships between gross motor development, overweight and obesity, and gender among preschool children in Potchefstroom.

1.3.4 To establish the quantitative and qualitative levels of the one leg balance of preschool children in Potchefstroom, and to determine the relationship between the quantitative and qualitative scores obtained in assessing this skill.

1.3.5 To investigate the occurrence of gender differences in gross motor skills among preschool children in Potchefstroom.
1.4 Hypotheses

The following hypothesis are stated for this study:

1.4.1 Hypothesis 1:
The current levels of gross motor development of preschool children in Potchefstroom compare favourably to norms and criteria as found in the literature.

1.4.2 Hypothesis 2:
The prevalence of overweight and obesity among preschool children in Potchefstroom is higher than the prevalence found in the literature, and is such that it negatively influences gross motor competency in the group.

1.4.3 Hypothesis 3:
There is a higher prevalence of overweight and obesity and a stronger inverted relationship between gross motor development and overweight and obesity, among preschool boys than among preschool girls in Potchefstroom.

1.4.4 Hypothesis 4:
There is a positive relationship between the quantitative and qualitative scores obtained in the assessment of the one leg balance in preschool children in Potchefstroom.

1.4.5 Hypothesis 5:
Significant gender differences in gross motor skills exist among preschool children in Potchefstroom.

1.5 Structure of the dissertation

This dissertation is presented in the form of five research articles. Each article is submitted for publication in an accredited scientific journal with interests in the topic. This type of dissertation differs from the standard dissertation in the following ways:

1.5.1 Chapter 2 does not comprise a complete literature study, but is a literature review of the most important literature that will form the basis for the research articles.
1.5.2 The research articles incorporate the method and the results of the study, therefore no separate method and results chapters are included.

1.5.3 The relevant references are presented at the end of Chapters 3-7; thus each of these chapters has its own list of references.

1.5.4 The references and list of references of each chapter are presented according to the guidelines of each scientific journal.

1.5.5 The guidelines of each journal are included in the Appendix. Although some journals request that the abstract, tables and figures be placed on separate pages after the list of references, the abstracts, tables and figures were placed in the appropriate places in the text in this dissertation, for technical reasons.

1.5.6 The list of references of the remaining chapters (introduction, literature review and conclusion) is presented at the end of the dissertation, after Chapter 8.

1.5.7 The references and list of references of the remaining chapters (introduction, literature review and conclusion) are presented according to the guidelines of the P.U. for C.H.E.

Results of the literature review will now follow in Chapter 2.
Chapter 2

Gross motor development and related factors in preschool children
CHAPTER TWO: GROSS MOTOR DEVELOPMENT AND RELATED FACTORS IN PRESCHOOL CHILDREN

2.1 Introduction

Gross motor development is considered to provide the foundation for a child's physical, perceptual, cognitive, language, affective-social and normative (behavioral) development (Kapp, 1991:193; Haywood, 1992:5; Gallahue & Ozmun, 1995:322; Auxter et al., 1997:179). In this regard, Haywood (1992:5), Thomas et al. (1993:88) and Auxter et al. (1997:180) state that poor gross motor skills could be detrimental to development in other developmental areas. Poor gross motor skills can therefore have a major influence on the development of school-readiness, which implies sufficient development in all the above-mentioned areas by the age of 6 or 7 years (Kapp, 1991:193). Therefore, the sufficient development of gross motor aspects like fundamental locomotor skills, balance and eye-hand co-ordination, is considered to be extremely important during the preschool years for the child to be developmentally ready for formal schooling at the age of 6 (Auxter et al., 1997:193; Gabbard, 1998:55; Gallahue & Ozmun, 1998:356). Poor gross motor skills can later have a detrimental effect on the school-going child as well. According to Broadhead and Church (1985:208) and Revie and Larkin (1993:4), gross motor skills can indirectly have an influence on the child's scholastic achievement, being the basis for fine motor development including skills like writing and cutting.

Furthermore, gross motor and perceptual motor skills form the basis for the development of specific sport skills (Larkin & Hoare, 1992:415; Walkley et al., 1993:11; Gallahue & Ozmun, 1998:356), and insufficient skills in this regard can influence a child's competence in sports in school, and consequently his self-concept (Revie & Larkin, 1993:4). Even in the preschool years, the insufficient development of gross motor skills could lead to the movement patterns of children being perceived as awkward and the children being exposed to peer ridicule, often leading to the tendency to avoid physical activity (Larkin & Hoare, 1992:425). Physical inactivity can subsequently lead to the development of health risks like obesity and cardiovascular risk factors (Ganley & Sherman, 2000:86). The optimal development of gross motor skills at a young age in order to develop a good self-image and a love for physical activity, could therefore play an important role in health behaviour and prevent the vicious cycle of a
sedentary lifestyle, obesity and the concurrent health risks (Auxter et al., 1997:198; Ganley & Sherman, 2000:89).

Worldwide, there is increasing concern as to the tendency of children's gross motor skills not developing as naturally as in the past, due to several reasons such as modern-day entertainment, lack of space and lack of safety factors. In South Africa, the profession of the movement scientist whose aims include prevention, enhancement and therapy in the optimization of gross motor skills of specifically preschool children becomes increasingly important. The difficulty these people are facing in the evaluation of children's levels of motor development is that there is very little research data available on the gross motor development of the typical South African preschool child. Worldwide tendencies of children to lead more sedentary lifestyles and the concurrent increase in childhood obesity, lead to the question whether the current tests used in this country can accurately assess the gross motor development levels of South African children. To answer this question, literature regarding the motor development and influential factors of children all over the world was studied and will be discussed in this chapter. As physical activity and obesity both have a considerable influence on the development of gross motor skills in preschool children, literature with regard to these factors will be discussed first. Gross motor development cannot be properly addressed without the accurate assessment of the development level of a child; therefore a literature review on the assessment of gross motor development will follow, enhanced by a literature survey on the assessment of a specific motor skill in preschool children, namely the one leg balance. Lastly, gender differences will be discussed in light of their influence on the assessment results and gross motor development in preschool children.

2.2 Gross motor development and physical activity

The development of gross and perceptual motor skills does not occur automatically, but is dependent on both biological and environmental influences (Thomas et al., 1993:73; Walkley et al., 1993:11; Gallahue & Ozmun, 1998:68). Biological influences include factors such as genetics, rate of growth, body composition and neuromotor maturation, while environmental influences include factors such as opportunity to practise and encouragement. As a child gets older and progresses from the development of rudimentary motor patterns to fundamental motor skills, the environment begins to play a greater role in motor skill development (Walkley et al., 1993:11). In fact, the age period of 2-7 years of age is considered to be the most crucial years of
Chapter 2: Gross motor development and related factors

a child's motor development (Gustafson-Munro, 1985:1; Gallahue & Ozmun, 1995:224; Gabbard, 1998:55), as fundamental gross and perceptual motor skills develop mainly during this period. Gabbard (1998:55) calls this one of various "windows of opportunity", referring to a critical age period during which the brain is most susceptible to gross and perceptual motor stimulation. During this period optimal gross and perceptual motor development should take place to provide the foundation for normal further development in life. According to Larkin and Hoare (1992:415) and Gallahue and Ozmun (1995:54), normal development in later periods may be hindered if a child fails to receive the proper stimulation during a critical period.

Motor skills develop mainly through play and physical activities (Taggart & Keegan, 1997:11; Thomas, 2000:1), therefore a child should get sufficient opportunity to play and practise (Walkley et al., 1993:11; Taggart & Keegan, 1997:11; Thomas et al., 2000:73) during this critical period. Gallahue (1996:15) describes this process as "learning to move and moving to learn", emphasizing the cycle of sufficient gross motor movement necessary to develop gross motor skills to again move efficiently in the preschool years. However, recent literature findings indicate that preschool children are physically not as active as in the past (Van Mill et al., 1999:S42; Pienaar & Badenhorst, 2001:122). Reasons for this tendency are modern technological developments such as television, home computers and other environmental factors, such as safety and a lack of space.

Anderson et al. (1998:938) found that 26% of American children engaged in watching more than 4 hours of television per day, while 67% watched at least 2 hours per day. According to Pienaar and Badenhorst (2001:107), more or less the same figures will apply in South Africa. Other studies (Raithel, 1988:146; Tucker & Hager, 1996:1316; Armstrong et al., 1998:363) report similar results, also with reference to time spent in front of home computers (Wolf, 1993:90; Christoffel, 1998:103). According to these authors, the tendency occurs that the more time a child spends watching television, the less time is spent being physically active. Furthermore, in a study on the activity levels of preschool children in Potchefstroom, Pienaar and Badenhorst (2001:113) found that these children's activity levels during free play was mostly sedentary and therefore did not contribute much to optimal motor development or cardiovascular health. Regarding gross motor development, several studies (Marshall & Bouffard, 1994:300; Raudsepp & Jürimäe, 1996:261; Sääkslathi et al., 1999:338) report a relationship between levels of physical activity and motor competency in children. The activity deficit hypothesis postulated by
Bouffard *et al.* (1996:63) indicates that a child’s level of physical activity has a strong influence on the development of gross motor skills. Sääkslathi *et al.* (1999:332) found a significant association between skills requiring good co-ordination (i.e. clapping in rhythm, galloping, somersaulting and kicking a ball) and physical activity in 3 and 4 year old children.

Safety and space also play a role in children’s levels of physical activity, as according to Christoffel (1998:103) and Van Mill *et al.* (1999:S44), parents in many countries today are terrified to let their children play out of doors. In this regard, Butcher and Eaton (1989:7) found differences in proficiency in several motor skills between children who tended to play indoors more and children who tended to play out-of-doors, due to differences in the type of activities engaged in indoors and outdoors. These authors noted that indoor playing presented little space and few opportunities to practise and develop upper-limb coordination skills like catching and throwing (Butcher & Eaton, 1989:34). Outdoor play settings, however, seem to offer comparatively few opportunities for the development of manipulative skills, throwing, catching, hitting and kicking according to Taggart and Keegan (1997: 16) in a study on the opportunities that preschool children have to engage in fundamental movement skills in outdoor play settings.

### 2.3 The influence of obesity on gross motor development

A factor considered to be closely related to physical inactivity, physical fitness and motor skill development in children, is childhood obesity (Christoffel, 1998:103), and will therefore be discussed in more detail. The prevalence of obesity has increased among American children over the last twenty years (Cheung, 1995:310) and an increase has also been reported among English and Scottish children aged 4 to 11 years (Chinn & Rona, 1994:102). An increase from 18.6% to 21.6% in the prevalence of overweight among 1-5 year old children in Latin America has been reported by Christoffel (1998:103). This trend was most marked for boys, 4-5 year olds and children living in cities. Relatively little research has been done on the prevalence of childhood overweight and obesity in South Africa (Richardson, 1978; Monyeki et al., 1999; NFCS, 2000). Richardson (1978:248) found a prevalence of overweight and obesity of 12-18% among white children, and 13-18% among black children aged 1-6 years, in his study on growth patterns in South Africa. In their study on the prevalence of obesity among preschool black children in Ellisras, a rural area in South Africa, Monyeki et al. (1999:290) found that boys of the ages 3-4 years showed the highest prevalence of obesity (15%). According to the National Food
Consumption Survey of 1999 (NFCS, 2000:10), the average prevalence of overweight in South African children aged 1-9 years is currently 7.6%. However, the figure is much higher for children living in urban areas (12.5%), including 4-6 year old children (12%) (NFCS, 2000). The latter percentages are consistent with the prevalence of overweight among children in the United States of 11% to 24% (Flegal, 1999:S510; Ganley & Sherman, 2000:86 Strand & Roesler, 1999:46) and in Canada (between 7 and 43%) (Marshall & Bouffard, 1997:232). Hernandez et al. (1998:71) found a prevalence of 32% in preschool children, and these obese children showed significantly higher levels of blood pressure than their nonobese counterparts.

Other studies have also showed cardiovascular risk factors in obese children as young as three years (Williams et al., 1998:216; Freedman et al., 1999:1179). Figueroa-Colon et al. (1997:808) found significantly higher systolic and diastolic blood pressure values in obese compared to nonobese children in a study on 5953 American children aged 5-11 years, and Dietz (1995:162) reported similar findings with regard to hypertension and hyperlipidemia. In another extensive study on 9167 American children aged 5-17 years, Freedman et al. (1999:1175) identified 50% of overweight children who had two or more cardiovascular risk factors. Other health risks associated with obesity in children including diabetes, posture-related disorders and respiratory diseases, are emphasized in several studies (Raudsepp & Pääsuke, 1995: 294; Auxter et al., 1997:209; Neumark-Sztainer, 1999:S31; Ganley & Sherman, 2000:85) and can also influence a child's gross motor development (Auxter et al., 1997:209).

Insufficient gross motor development is considered to be another risk factor of childhood obesity. Slaughter et al. (1980:192) found moderate correlations in body fat and horizontal jump, vertical jump and the 50 meter dash in a study involving 7-12 year old girls, whereas Raudsepp and Jürimäe (1996:261) reported a relationship between the percentage body fat, and standing long jump and shuttle run in a study involving 10-11 year old girls. Raudsepp and Jürimäe (1996:261) concluded that adiposity is related to motor skills in which the body has to be moved from one place to another, corresponding to the conclusions of Hensley et al. (1982:137) in a study on the relationship between body fatness and motor performance of preadolescent boys and girls. In two studies involving 6 year and 9 year old boys and girls, Marshall and Bouffard (1994:1997) found significant relationships between obesity and gross motor competency. Compared to the nonobese groups, the obese groups in this study showed significantly lower scores in the locomotor subscale of the Test of Gross Motor Development (Ulrich, 1985).
consisting of tests for running, galloping, hopping, leaping, horizontal jumping, skipping and sliding. No significant difference was found in the Object Control Skills subscale, consisting of tests for two-hand striking, stationary bouncing, catching, kicking and overhand throwing. With regard to a series of studies, Larkin and Hoare (1992:432) report that poorly co-ordinated groups of children involved in these studies were consistently more endomorphic than their well co-ordinated peers.

Relatively few studies which take into account the influence of obesity on the gross motor skill development of the different genders, could be found (Hensley et al., 1982:139; Marshall & Bouffard, 1997:233). Hensley et al. (1982:138) found that the inverted relationships between body fatness and performance in the standing long jump, vertical jump, 400 m. run, 40 m. dash and the modified pull-up, were larger among preadolescent boys than girls. These authors concluded that the detrimental effects of excessive fatness are less among young girls than boys, in agreement with the findings of Marshall and Bouffard (1997:234) that obese girls were significantly more movement-competent than obese boys with regard to locomotor skills.

No data could be found in the literature with regard to the relationship between overweight or obesity and gross motor skill development among preschool South African children.

Obesity is closely related to physical inactivity in leading to insufficient gross motor development. According to Auxter et al. (1997:209), obese children, especially girls (Hoare & Larkin, 1991:38), tend to avoid physical activity which in turn could lead to insufficient development of gross motor skills (Marshall & Bouffard, 1994:298; Auxter et al., 1997:209). Obesity, social seclusion and the resulting poor gross motor skills could again influence the total well-being as the child’s self confidence and self-esteem, thus emotional development is affected (Fox, 1992:34; Dietz, 1995:161).

2.4 Assessment of gross motor development levels

The treatment of obesity mainly constitutes the increase of physical activity and dietary changes (Dietz, 1995:163; Christoffel, 1998:104; Epstein & Goldfield, 1999:S557). In encouraging physical activity, and also in providing sufficient opportunity for practice in the development of gross motor skills, several authors (Gustafson-Munro, 1985:9; Walkley et al., 1993:12; Cooley et
al., 1997:307; Marshall and Bouffard, 1997: 235; Taggart & Keegan, 1997:16) state that structured gross motor development programmes play an important role in the present-day society, especially with reference to children living in urban areas. Pienaar and Badenhorst (2001:107) found that a structured movement development programme for preschool children in Pothefsrroom provided more optimal motor stimulation and contributed more to health by elevating heart rate levels to more appropriate levels than was the case during free play. However, to be able to present an efficient gross motor development programme, accurate assessment of the gross motor development of participants in the programme is necessary, for three reasons: 1) to determine the developmental level of the child and subsequently choose gross motor activities suitable for that developmental level, 2) to monitor progress, and 3) to identify gross motor deficits or disorders. Reeves (1997:342) points out that inaccurate test norms in the preschool years can have a detrimental effect on a child's further motor development, as problems which are not identified correctly, cannot be addressed effectively. If a child with gross motor deficits or disorders can be accurately identified during the critical period of gross motor development, such a child could benefit from intervention (Pienaar, 1994:200). Larkin and Hoare (1992:415) maintains that identification, remediation and support during this period are important to prevent the development of inappropriate patterns in the fundamental skills acquired during this time. Therefore, it is considered important to accurately assess these motor skills before the child reaches school-going age, using valid and reliable norms and criteria (Revie & Larkin, 1993:4; Walkley et al., 1993:12).

Several assessment batteries and many norms and criteria exist in the literature for use of gross and perceptual motor assessment of preschool children (Bruininks, 1978; Folio & Fewell, 1983; Gustafson-Munro, 1985; Ulrich, 1985; Frankenburg, 1990; Henderson & Sugden, 1992; Gallahue & Ozmun, 1998; Van Gelder & Sweitszer, 1999), and are being used by teachers, occupational therapists and movement scientists in South Africa. However, the validity, reliability and accuracy of these norms and criteria for children living in an urban area in South Africa become questionable when certain factors are considered. They are:

- **Research data used for the development of current tests**

The norms and criteria of commonly used test batteries (Bruininks, 1978; Folio, & Fewell, 1983; Gustafson-Munro, 1985; Ulrich, 1985; Frankenburg, 1990; Henderson & Sugden, 1992;
Gallahue & Ozmun, 1998; Van Gelder & Sweitszer, 1999) have been developed by means of studies that had been conducted mainly on European and American children almost a decade earlier. In the review of Burton and Miller (1998:335) on standardized test batteries for the assessment of gross and perceptual motor skills since 1927, it is clear that the research data used for the composition of the most recent test batteries derive from 1992 and earlier. Although assessment batteries for South African children exist in the form of school-readiness tests (Nel & Sonneckus, 1963; Herbst, s.a.;; Kruger, 1983; Park, 1986) which include selected test items for the evaluation of gross motor skills, no recent gross motor test batteries with regard to evaluating South African preschool children and no research on the current levels of gross motor development of South African preschool children could be found in the literature.

- **Quantitative and qualitative assessment methods**

Many commonly-used test batteries (Bruininks, 1978; Folio, & Fewell, 1983; Gustafson-Munro, 1985; Frankenburg, 1990) use only quantitative norms (the measurable time, distance or number) to assess motor skills. However, authors like Werder and Bruininks (1988:17); Henderson and Sugden (1992:10), Gallahue and Ozmun (1998:490) and Van Gelder and Sweitszer (1999:15) emphasize the importance of qualitative (the quality of the execution of the skill) criteria together with the quantitative norms for accurate motor assessment in preschool children. Gallahue (1996:184) maintains that using quantitative norms alone does not provide information about the qualitative characteristics and changes that occur as the child progresses toward more mature form in a skill. This information is important in the identification of deficits or disorders, as a child could sometimes comply with the quantitative norm for a skill, but not with the qualitative criteria (Gallahue, 1996:183). For example, if a child balances on one leg for the required time period but shows extensive arm movements, using qualitative criteria along with quantitative norms could lead to the identification of a balance problem that would not have been recognized in a quantitative test only. According to Haywood (1992:101) it is also possible that at certain ages and on certain tasks, especially balance tasks, children attempt a more mature qualitative performance pattern with a resulting, presumably temporary, decline in quantitative score. The qualitative assessment of the proper mechanics, or the process of movement, is especially relevant at the ages of 3-6, as children are learning and developing new motor skills (Larkin & Hoare, 1992:415; Walkley et al., 1993:12; Gallahue, 1996:183), and it serves as a guideline for the design of movement development programs for children of these ages. The learning of
incorrect methods and techniques in the execution of a motor skill can be detrimental to further development and refining into related or more advanced skills (e.g. balancing on one leg being refined into the hopping skill and later the skipping skill) (Walkley et al., 1993:13). As many movement problems are marked by qualitatively different movement patterns rather than quantitative differences, according to Larkin and Hoare (1992:415), qualitative assessment may prevent this from happening.

Qualitative assessment of fundamental gross motor skills in children constitutes labelling the qualitative changes and characteristics in motor skills as developmental stages (Werder & Bruininks, 1988:17; Walkley & Kelly, 1989:280; Thomas et al., 1993:78; Gallahue & Ozmun, 1995:226). The three popular methods of charting the stage classification of children are the segmental analysis approach, where the separate components of movement within a given pattern are analyzed (Roberton, 1982:294); the total body configuration approach, where an overall stage classification score is assigned (Seefeldt & Haubenstricker, 1982:309); and a combination of the above two methods to qualitatively classify an individual at a developmental stage (Werder & Bruininks, 1988:17; Gallahue & Ozmun, 1998:505). With regard to the latter type of classification system, Gallahue (1996:186) recently expanded and revised the McClenaghan-Gallahue (1978) method of identifying developmental stages of a gross motor skill. This revised and expanded version of the Fundamental Movement Pattern Assessment Instrument (FMPAI) (Gallahue, 1996:186) is a practical and reliable system for classifying individuals at the initial, elementary and mature stage in a given fundamental movement skill. According to Gallahue (1996:185), the latter system offers a quick and easy method of qualitative testing. If this qualitative classifying system of developmental stages could be used as a means of evaluating a gross motor skill qualitatively together with the results of the quantitative assessment, this might contribute to a more accurate assessment process.

**Quantitative and qualitative balance assessment in preschool children**

In order to compare the qualitative and quantitative scores of 3-6 year old children in a gross motor skill assessment, it was decided to choose a specific motor skill for the purpose of this dissertation. As balance is considered to be fundamental to gross motor development (Butterfield & Loovis, 1994: 692; Auxter et al., 1997: 190; Habib et al., 1999:73), a balance skill, namely the one leg balance was chosen. All gross motor skills require some element of balance (Clark &
Proper development of static and dynamic balance skills is therefore considered to be essential in the development of gross motor skills in children. In this regard, Ulrich and Ulrich (1985:94) observed that balance is most effective as a predictor of motor skill development among very young children (ages 3–5). According to Habib et al. (1999:78), balance development can be influenced by modern-day environmental factors, as demonstrated by the significant relationship between sociocultural factors and several balance tests in their study on 5 - 13 year old children. Williams et al. (1983:12), Larkin and Hoare (1992:423) and Habib et al. (1999:80) maintain that a lack of balance and posture-control is a characteristic common to developmentally-delayed and motorically-awkward children. Balance problems are therefore of concern to professionals working with the motor development of children in South Africa, as the prevalence of developmental delays and motorical awkwardness among children in South Africa is estimated to be between 5 and 15% (Pienaar, 1994:125).

Balance assessment items form part of most established motor or movement skill assessment batteries (Bruininks, 1978; Arnheim & Sinclair, 1979; Ulrich, 1985; Gustafson-Munro, 1985; Frankenburg, 1990; Sugden & Henderson, 1992; Van Gelder & Sweitszer, 1999), as well as batteries developed for neurological screening purposes (Haley et al., 1992; Mutti et al., 1998). Static balance is commonly assessed in these test batteries by recording the time in seconds that the child is able to balance on one leg, thus measuring only the quantitative execution of the specific skill. Quantitative norms for this skill in every age group from 3-6 years have been studied and defined in several studies (Arnheim & Sinclair, 1979:136; Cratty, 1979:50; Sugden & Henderson, 1992:52; Reeves, 1997:340; Goshi et al., 1999:172). Qualitative assessment, however, is less commonly used when evaluating the one leg balance in 3 – 6 year old children. The reasons for this could be a lack of knowledge and time to do this type of evaluation, as it requires a knowledgeable person and more time, than needed for a quantitative evaluation (Gallahue, 1996:183). The fact that qualitative assessment is usually subjective can also contribute to it being used less often.

2.5 Gender differences in gross motor development

Considerable controversy exists in the literature concerning the occurrence and importance of gender differences in gross motor skills in preschool children (Morris et al., 1982: 218; Ulrich &
Chapter 2: Gross motor development and related factors

Ulrich, 1985:93; Butcher & Eaton, 1989:33; Butterfield & Loovis, 1993:462; Loovis & Butterfield, 1993:1270; Hands & Larkin, 1997:13; Thomas, 2000:3). Several well-known tests provide separate norms for males and females in this age group (Arnheim & Sinclair, 1979; Seaman & De Pauw, 1989; Van Gelder & Schweitzer, 1999), while many do not differentiate between genders (Folio & Fewell, 1983; Johnston et al., 1987; Frankenburg, 1990; Henderson & Sugden, 1992). According to Hands and Larkin (1997:12), the accuracy and validity of assessment norms are compromised if such norms do not address significant differences between subgroups in a population, such as gender differences.

The results of several studies show differences between genders in gross motor skills of children (Morris et al., 1982: 218; Butcher & Eaton, 1989; Butterfield & Loovis, 1993:462; Loovis & Butterfield, 1993:1270; Revie & Larkin, 1993; Walkley et al., 1993; Hands & Larkin, 1997). In a study on 3 - 6 year old children, Morris et al. (1982: 218) found that the boys at all ages had significantly higher scores in the throw-for-distance tests and at 6 years of age, girls were superior to boys in the balance tests. Differences of a lesser magnitude were found in the speed run and standing long jump, in favour of the boys at all ages. Significant gender differences were also found in two studies by Butterfield and Loovis (1993:462) and Loovis and Butterfield (1993:1270) on the catching and throwing patterns of children in grades K - 8 (3 to 13 years). The results of these studies show that boys showed more mature throwing patterns in Grades K, 1, 2, 4 and 7; and more mature catching patterns in Grades K, 1 and 3. These authors found similar results when testing side-arm striking of the same population (Loovis & Butterfield, 1995:297). Plimpton and Regimbal (1992:401) found significant differences in favour of boys in all the strength and hand-eye coordination items tested, but no differences in balance items. Boys were significantly superior to girls in ball skills (throwing, catching, striking and kicking) in the study of Walkley et al. (1993:13) involving a total of 1182 6 - 13 year old children and Hands and Larkin (1997:13) on 332 preschool and primary school children in Australia. In the latter study, significant differences were also found in two tests for balance, which correlates with the findings of Krombholz (1997:1169) on 5 -11 year olds, and Raudsepp and Pääsuke (1995:297). Standing long jump also produced significantly higher scores for boys in the study of Raudsepp and Pääsuke (1995:297). Ulrich and Ulrich (1985:93) found that girls were more proficient in skipping than boys, but that boys were more advanced in ball skills. Although Thomas and French (1985:285) found in a meta-analysis of gender differences, that gender is related to 12 gross motor tasks, among others: balance, catching, distance-throw and long jump, they believe

Literature review
these differences to be due to environmental effects prior to puberty. These authors conclude that boys generally prove to be superior in skills requiring strength and speed, while girls are often superior in balance and certain co-ordination skills. In contrast, according to Eaton (1989:69) and Thomas (2000:3), motor performance of boys and girls is more similar than different, prior to puberty.

Reasons for gender differences are mainly considered to be related to biological make-up and environmental factors (Eaton, 1989:75; McGuire, 1990:183; Thomas et al., 1993:83; Garcia, 1994:213). Biologically, boys are generally physically stronger than girls from the age of approximately 5 years, while the nervous systems of girls mature more rapidly than that of boys (McGuire, 1990:182; Thomas, 2000:3). Environmental factors include stereotyped play, reinforced by cultural influences (McGuire, 1990:188; Garcia, 1994:213; Habib et al., 1999:78). According to Hands and Larkin (1997:14) and Eaton (1989:68), boys tend to be more physically active than girls, and this correlates with their motor skill development. Furthermore, the type of play and the social style that boys and girls tend to engage in tends to be stereotyped. According to McGuire (1990:188), boys prefer to play outside in competitive games or sports, while girls more often play inside in more quiet games requiring fine rather than gross motor skills. Garcia (1994:223) investigated the social styles of preschool children during gross motor activities, and concluded that the different social styles, boys tending to be more aggressive and competitive, and girls to be more caring and sharing, could contribute to gender differences in favour of boys. These findings support the statement of Thomas et al. (1993:83) and Hands and Larkin (1997:14) that sociocultural factors can play a large role in the development of gross motor skills of the young child. In a study on the influence of sociocultural factors on the balance skills of 5-13 year old children, Habib et al. (1999:78) found that socio-economic status had a significant influence on gender differences in several balance skills. In the high socio-economic sample, boys out-performed girls in all the balance tests used, while girls were superior in some tests in the low socio-economic sample.

Hands and Larkin (1997:14) also maintains that males and females are socialized differently into sport. As the primary sports in South Africa are ball sports played mostly by males (rugby, soccer and cricket), this could influence gender differences in the gross motor skills of young children in this country.
No studies could be found in the literature with regard to gender differences in gross motor skills among 3-6 year old children in South Africa.

2.6 Conclusion

The aim of this literature survey was to describe gross motor development in preschool children, as well as influential and related factors, namely physical activity, obesity, assessment norms and criteria, and gender differences in the preschool years.

From the literature it is clear that optimal levels of physical activity is necessary for sufficient development of gross motor skills in the preschool years. However, modern-day technology such as television and the home computer, and factors such as space and safety, lead to the tendency of children being less active than in the past and running the risk of insufficient gross motor development and the development of obesity.

The prevalence of obesity among South African children in urban areas is consistent with the prevailing figures in several countries, giving reason for concern as to the health risks involved in childhood obesity. The literature also shows that there is a relationship between overweight and obesity, and gross motor development in children, especially in gross motor skills where the body weight has to be moved from one place to another. Furthermore, indications are that obesity influences girls and boys differently. No literature could be found on the relationship between overweight and obesity, and gross motor development of South African preschool children.

Structured gross motor development programmes are valued in the literature for their positive influence on levels of physical activity, treatment of obesity and stimulation of proper development of gross motor skills in preschool children. However, factors influencing the accuracy of the assessment of gross motor development for the use in such programmes, lead to the question of the validity, reliability and accuracy of norms and criteria commonly used for the assessment of South African children. These factors include the lack of recent research data used for the composition of commonly used test norms and criteria, the assessment method
Chapter 2: Gross motor development and related factors

(qualitative or quantitative) and gender differences in gross motor development of preschool children.

Research data used for the composition of commonly used test batteries in South Africa derive from almost a decade ago and mostly involve children from American and European countries. There is a lack of research data on the current levels of gross motor development of preschool children in South Africa. Although many test batteries only use quantitative norms to evaluate gross motor skills, the literature indicates that the use of qualitative criteria provides more information on the qualitative changes that a child undergoes in gross motor development, and can therefore lead to more accurate determination of current levels of development and identification of gross motor problems. In an attempt to illustrate this, the one leg balance will be quantitatively and qualitatively assessed in preschool children, as balance is fundamental to gross motor development and the one leg balance is commonly used in established test batteries. Although many test batteries provide quantitative norms for the assessment of the one leg balance, little literature could be found providing qualitative criteria.

Considerable controversy exists in the literature concerning the occurrence and importance of gender differences in gross motor skills in preschool children. Several authors consider gender differences too small to be significant in the preschool years, while a number of studies indicate that gender differences do occur. Studies show that boys generally prove to be superior in skills requiring strength and speed, while girls are often superior in balance and certain co-ordination skills. No literature could be found on gender differences in gross motor development of preschool children in South Africa.

Through intervention, gross motor deficits and related problems can be remediated or even prevented if deficits can be accurately identified early in a child's life. The accuracy norms and criteria used in the assessment of motor skills, are therefore essential for correct intervention as well as the effective constructing of gross motor development programmes.

Considering all the factors related to gross motor assessment in preschool children, as well as the fact that very little publicized research has been done in this area on South African children of these ages, further research in these areas will be extremely valuable for movement scientists,
teachers and therapists involved with children in gross motor programmes and activities. By means of this information, professionals working with children will be provided with a more accurate profile of the gross motor development levels and characteristics of South African preschool children, and will be able to construct more effective intervention and stimulation programmes.
Chapter 3

Research article 1

Current level of gross motor development of 3-6 year old children in Potchefstroom
CURRENT LEVEL OF GROSS MOTOR DEVELOPMENT OF 3-6 YEAR OLD CHILDREN IN POTCHEFSTROOM

Research shows that preschool children are physically not as active as in the past, leading to the question of the current level of gross motor development of preschool children in urban areas in South Africa. The purpose of this study was to establish and describe specific gross motor components in a group of 3-6 year old urban South African children and compare the results to standardized norms and developmental criteria. A total of 462 3-6 year old children (215 males and 247 females) was tested on 8 gross motor tasks, and compared to norms and criteria as found in the literature. The 3, 4 and 5 year olds compared favourably to their counterparts in the tests for hopping, one leg balance and "jumping jacks". The 5 year olds compared favourably in standing long jump and skipping, while the 3 and 4 year olds compared favourably in the throwing test. Balance walk and catching ability of the 3, 4 and 5 year olds, standing long jump in the 4 year olds and throwing in the 5 year old group were lower than the norms used. The 6 year old group scored lower than the norms and criteria in all the tests except for standing long jump, where they scored higher than the norms. The implications for school readiness of the below-average level of gross motor development of the 6 year olds in this study are discussed.

Key words: Gross motor development level, preschool children, norms, criteria

INTRODUCTION

Criteria for school-readiness usually refer to six major areas, namely physical, perceptual, cognitive, language, affective-social and normative (behavioural) development (Kapp, 1991). Gross motor competency is a fundamental part of the physical component, and is also considered to provide the foundation for development in the other 5 areas (Gallahue & Ozmun, 1998). In this regard, Kapp (1991) and Haywood (1992) stated that poor gross motor skills can be detrimental to development in other developmental areas. Therefore, the sufficient development of gross motor skills and perceptual motor aspects like fundamental locomotor skills, balance and eye-hand co-ordination, is considered to be extremely important during the preschool years for the child to be developmentally ready for formal schooling at the age of 6 (Auxter, Pyfer & Huettig, 1997; Gallahue & Ozmun, 1998; Gabbard, 1998). In fact, the age period of 2-7 years of age is considered to be the most crucial years of a child’s motor development (Gallahue & Ozmun, 1998; Gabbard, 1998). During this age period all fundamental gross motor skills develop mainly through play and physical activities. The activity deficit hypothesis postulated by Bouffard, Watkinson, Thompson et al. (1996) indicates that a child’s level of physical activity

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has a strong influence on the development of gross motor skills. Recent literature findings indicate that preschool children are physically not as active as in the past (Pienaar & Badenhorst, 2001; Van Mill, Goris & Westerterp, 1999). Reasons for this tendency are developments of modern technology such as television, home computers and environmental factors, such as a lack of space and safety. The latter also plays an important role in the level of physical activity of the preschool child, especially the urban child (Van Mill, Goris & Westerterp, 1999; Pienaar & Badenhorst, 2001).

The question arises as to how the gross motor development level of preschool children in an urban environment in South Africa compares to available established norms. Limited data exists on the status of gross motor development in preschool children in South Africa (Nel & Sonnekus, 1963; Herbst, s.a.). The purpose of this study was therefore to establish and describe specific gross motor development components of a group of 3-6 year old urban South African children, and to compare the results to standardized norms or developmental criteria.

METHOD

Participants

The sample consisted of 462 predominantly white 3-6 year old preschool children, made up of 116 3-year-olds (52 male and 64 female), 132 4-year-olds (63 male and 69 female), 112 5-year-olds (50 male and 62 female) and 102 6-year-olds (50 male and 52 female). All participants lived in Potchefstroom, came from a middle class background and had been enrolled in the movement development programme (MOP) presented by movement developmentalists of the Potchefstroom University for Christian Higher Education (P.U. for C.H.E.). This programme is being presented on the premises of 10 preprimary schools in Potchefstroom, as well as at the movement development centre at the university.

Procedure

A one-time cross-sectional design applied on an available sample was used as a research method in the study. All the participants were enrolled in the MDP for their first time. They were all tested for the purpose of this research study before the implementation of the programme. All parents were briefed on the procedures before the testing started, after which informed consent was obtained from them for each participant. The testing was conducted on the premises of the schools and in the movement development centre at the university. The execution of the tests
were videotaped and analyzed afterwards by the researcher. The results were then compared to norms and criteria found in the literature.

Instrumentation

Standing long jump, hopping, skipping, one leg balance, balance walk, throwing-for-distance, catching and "jumping jacks" were selected as the gross motor skills to be tested. These skills were selected for three reasons:
1) They represent the three categories of movement, namely basic locomotion (standing long jump, hopping and skipping), balance (one leg balance and balance walk), and manipulation (throwing and catching) (Gallahue & Ozmun, 1998);
2) they are used extensively in established motor test batteries for children of these age groups (Bruininks, 1978; Charlop & Attwell, 1980; Folio & Fewell, 1983; Frankenburg, 1990; Henderson & Sugden, 1992; Gustafson-Munro, 1985; Pyfer, 1990; Ulrich, 1985); and
3) they are suitable to use in the form of a screening test in a MDP because of their simplicity and compatibility with the type of activities used in the MDP.

The skills were evaluated based on the following procedures:

Standing long jump (Arnheim & Sinclair, 1979; Bruininks, 1978; Ulrich, 1985). The test measured how far the child could jump horizontally, using a two-foot takeoff and landing. The score was the highest of three trials. This skill was not tested in the 3 year old group, as a child is usually not capable of jumping for distance at this age (Haywood, 1992; Thomas, Thomas & Gallagher, 1993).

Hopping (Frankenburg, 1990; Johnston, Crawford, Short, Raymond Smyth, & Moller, 1987; Mutti, Martin, Sterling & Spalding, 1998; Werder & Bruininks, 1988). The test entailed two trials of hopping forward on each leg as many times as possible, up to a maximum of 12 hops. The higher score was taken.

Skipping (Mutti et al., 1998; Pyfer, 1990). The skipping pattern (step, hop, step, hop) was demonstrated by the researcher and then the participant was asked to skip across the room. According to Gallahue and Ozmun (1998), 20% of 5 year olds and nearly all 6 year olds can skip proficiently, therefore skipping was only evaluated among the 5 and 6 year olds. The number of skipping steps done correctly, to a maximum of 4, was taken as the score.

One leg balance (Bruininks, 1978; Frankenburg, 1990; Henderson & Sugden, 1992; Johnston et al., 1987; Mutti et al., 1998). The test entailed two trials of balancing on one foot, with the arms hanging at the sides, for as long as possible up to a maximum of 12 seconds. The participant was instructed to stand with the free leg bent backwards at the knee and kept off the floor. Swaying...
was allowed, and the arms were allowed to move from the sides. Balancing was tested on both legs, and the better of the two trials taken as the score.

**Balance walk** (Bruininks, 1978; Gustafson-Munro, 1985; Johnston et al., 1987; Mutti et al., 1998; Werder & Bruininks, 1988). The 3 and 4 year olds were asked to walk forward a line (50 mm. wide and 2.5 m. long), while the 5 year olds were asked to walk heel-to-toe (placing the heel of one foot against the toes of the other foot in each step) on the same line on the floor. The 6 year olds were asked to walk heel-to-toe on a low balance beam (2.5 m. long, 100 mm. wide and 300 mm. high), and then walk heel-to-toe backward on the beam. The score was the distance completed with the feet placed on the line (3 and 4 year olds) or correctly placed heel-to-toe (5 and 6 year olds) up to a maximum of 1.5 m. Two trials were allowed.

**Throwing** (Folio & Fewell, 1983; Haubenstricker & Seefeldt, 1986). The test entailed throwing a tennisball as far as possible, using the overhand technique. The researcher demonstrated the throw first. The longer distance off two throws was scored.

**Catching** (Bruininks, 1978; Folio & Fewell, 1983; Gustafson-Munro, 1985; Pyfer, 1990). The test measured the ability to catch an aerial, underhand thrown 20-cm. ball with two hands. The thrower was positioned 1.5 meters from 3 year old participants, and 2 meters from 4-6 year old participants. The score was the number of successful catches off 4 throws.

"**Jumping jacks**" (Charlop & Atwell, 1980). The "jumping jack" movement was demonstrated to the 6 year old participant by the researcher, who at the same time explained that the feet had to jump apart and the hands had to clap above the head, before returning to the starting position. For the 5 year olds, this test was modified so that the arms were required only to lift sideways up to shoulder level before returning to the starting position. The score was the number of correct executions (i.e. if the feet and hands moved simultaneously and co-ordinatedly up and down and the jumping action was done rhythmically) up to a maximum of 10. Two trials were given.

Each test was conducted by the researcher, and each child was videotaped individually from the side by a trained assistant. With the exception of throwing distance, which was measured during the test, the researcher scored each participant’s performance after analyzing the recording.

**Data analysis**

All calculations of means ($M$) and standard deviations ($SD$) were done using the Statistica for Windows (6.0) computer program (Statsoft, 1995). Analysis was only of a descriptive nature, as it was not possible to compare norms from the literature directly with the sample. Furthermore, the aim of this study was limited to establishing and describing the status of these skills in relation to international norms.
RESULTS

The results obtained from different studies regarding the tests used in this study are summarized in Table 1. Some of these are norms, while other studies provide criteria describing the average characteristics of the skill at a specific age displayed by a "normal" child.

Table 1: Average norms and criteria for gross motor and perceptual motor skills in 3-6 year old children

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Long Jump (cm.)</th>
<th>Hop</th>
<th>Skip</th>
<th>One leg balance (sec.)</th>
<th>Balance walk (cm.)</th>
<th>Catch</th>
<th>Throw (m.)</th>
<th>Jumping Jacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2,7,12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>89.00</td>
<td>4-6</td>
<td>2-7</td>
<td></td>
<td>150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2,7,12)</td>
<td></td>
<td>(2,7,10)</td>
<td></td>
<td>(8,12,16)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Male 100.58</td>
<td>Female 92.96</td>
<td></td>
<td></td>
<td>150 (F, B)</td>
<td></td>
<td></td>
<td>Male Female</td>
</tr>
<tr>
<td></td>
<td>(9)</td>
<td>(9)</td>
<td></td>
<td></td>
<td>(6,11,12)</td>
<td></td>
<td></td>
<td>7.6</td>
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<td></td>
<td>8-10</td>
<td></td>
<td>20% can</td>
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<td>(1,3,6,11)</td>
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<td>4.5</td>
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<td></td>
<td>(2,12,13)</td>
<td></td>
<td>(2,7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(15)</td>
</tr>
<tr>
<td>6</td>
<td>Male 113.03</td>
<td>Female 106.93</td>
<td>10-12</td>
<td></td>
<td>150 beam (F, B)</td>
<td></td>
<td></td>
<td>Male Female</td>
</tr>
<tr>
<td></td>
<td>(9)</td>
<td>(9)</td>
<td>(13,12)</td>
<td></td>
<td>(3,8,14)</td>
<td></td>
<td></td>
<td>11.7</td>
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<tr>
<td></td>
<td>10-12</td>
<td></td>
<td>4 / more</td>
<td></td>
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<td></td>
<td>6.6</td>
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<td></td>
<td>(2,7,13,)</td>
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<td>(3,6,7,14)</td>
<td></td>
<td></td>
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<td></td>
<td>(9)</td>
</tr>
</tbody>
</table>


Norms or criteria were used when they corresponded with several different studies, or when a norm was derived from a single standardized test battery. When norms from different studies differed slightly, the average of these norms were calculated by dividing the sum by the number of norms used (i.e. the number of successful catches required in the test for catching). The results obtained from the gross motor tests in this study are presented in Table 2. In comparing these results (Table 2) with the norms and criteria presented in Table 1, the participants in this study compared favourably with their counterparts in most of the tests. The 3, 4 and 5 year old participants in this study compared well with their counterparts as found in the literature with reference to hopping, one leg balance and jumping jacks.
Table 2: Mean scores and standard deviations of gross motor and perceptual motor tests in 3-6 year old children (N = 444)

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Long Jump (m.)</th>
<th>Hopping</th>
<th>Skip</th>
<th>One leg balance (sec)</th>
<th>Balance walk (cm.)</th>
<th>Catch</th>
<th>Throw (m.)</th>
<th>Jumping Jacks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L R</td>
<td>L R</td>
<td>L R</td>
<td>F B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 M SD</td>
<td>-</td>
<td>2.48 2.47</td>
<td>-</td>
<td>3.19 2.88</td>
<td>145.70 -</td>
<td>3.70</td>
<td>2.86</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.43 2.59</td>
<td></td>
<td>1.93 1.89</td>
<td>20.79</td>
<td>0.75</td>
<td>1.16</td>
<td>-</td>
</tr>
<tr>
<td>4 M SD</td>
<td>84.92</td>
<td>2.65 2.81</td>
<td>5.21</td>
<td>5.66 5.52</td>
<td>150.0 -</td>
<td>3.86</td>
<td>4.78</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>19.40</td>
<td>5.31</td>
<td></td>
<td>2.29 2.15</td>
<td>0.00</td>
<td>0.49</td>
<td>2.86</td>
<td>-</td>
</tr>
<tr>
<td>5 M SD</td>
<td>Male 108.71</td>
<td>Female 96.56</td>
<td>7.98</td>
<td>7.97 3.62</td>
<td>7.69 7.76</td>
<td>147.41 -</td>
<td>3.85</td>
<td>Male 6.13 Female 3.86</td>
</tr>
<tr>
<td></td>
<td>17.45</td>
<td>18.91</td>
<td>2.61</td>
<td>2.66 0.94</td>
<td>2.84 2.85</td>
<td>19.70</td>
<td>0.44</td>
<td>1.77 1.23</td>
</tr>
<tr>
<td>6 M SD</td>
<td>Male 116.50</td>
<td>Female 107.44</td>
<td>9.26</td>
<td>9.15 3.80</td>
<td>9.09 9.18</td>
<td>149.48 148.53</td>
<td>3.94</td>
<td>Male 10.06 Female 6.29</td>
</tr>
<tr>
<td></td>
<td>17.39</td>
<td>17.31</td>
<td>2.09</td>
<td>2.10 0.71</td>
<td>2.23 2.12</td>
<td>0.51</td>
<td>4.26</td>
<td>0.33 1.98</td>
</tr>
</tbody>
</table>

Note: L = left; R = right; F = forward; B = backward.

The 5 year olds also compared favourably with their counterparts in the standing long jump and skipping, while the 3 and 4 year olds compared well with their counterparts in the test for throwing. Balance walk and catching ability of the 3, 4 and 5 year olds, standing long jump in the 4 year olds and throwing in the 5 year old group were however slightly lower than the average norms indicated in Table 1. The 6 year olds scored lower than the norm in all the tests except the standing long jump, where they scored higher than the norms.

DISCUSSION

It is widely acknowledged by researchers (Frankenburg, 1990; Gallahue & Ozmun, 1998; Thomas et al., 1993) that children vary considerably in their rate of motor development, especially at a young age. This is reflected in the range in which a child’s performance is still acceptable in several of the tests (Table 1). This phenomenon should be kept in mind when using gross motor tests to evaluate preschool children. The scores of the 3, 4, 5 and 6 year olds which were lower than the average norms and criteria displayed in Table 1, might therefore be a reflection of individual variety in this non-randomized group. However, the scores of the 6 year olds being lower than the norms in 7 of the 8 tests, might be an indication for concern. At 6 years of age, under-developed gross motor skills, as part of the child’s physical development, can have a detrimental influence on the other areas considered to be important for school-readiness,
namely perceptual, cognitive, language, affective-social and normative (behavioural) development (Kapp, 1991). Furthermore, the specific skills testing below average in the 6 year old group can be reflections of the developmental status of underlying neurological aspects which play an important role in fine motor development. Hopping, skipping and jumping jacks, for example, all reflect a level of integration of the two sides of the body, which have to be well developed in order to use both hands proficiently to write (Mutti et al., 1998). Catching skills, testing below average in all the groups, and throwing skills, testing below average in the 5 and 6 year old groups, reflect eye-hand coordination which is also an important aspect in the mastering of handwriting ability. Also, as most school sports in South Africa are ball sports, scores below average in catching and throwing ability could influence a child’s participation in these sports, ultimately playing a negative role in the development of socializing skills. As catching and throwing are outdoor activities, it is possible that insufficient development of these skills in the preschool years could be due to a lack of play time spent out of doors. Butcher and Eaton (1989) found differences in proficiency in several motor skills between children who tended to play indoors more and children who tended to play outdoors, due to differences in the type of activities engaged in indoors and outdoors. These authors noted that indoor playing presented few opportunities to practice and develop upper limb coordination skills like catching and throwing. According to Van Mill et al. (1999), South African children often do not play outside as much as they should because of safety reasons.

The performances of the 5 and 6 year olds were better than the norms in the test for standing long jump. The results of two studies by Du Toit and Pienaar (in press) on the relationship between obesity and motor proficiency of preschool children in Potchefstroom, showed that the average height and weight of these children were above the 50th percentile of growth charts commonly used in South Africa, thus a possible tendency in urban South African children to be taller and heavier than their counterparts as found in the literature. As increased height and weight can influence the performance of strength-related skills (Thomas et al., 1993), it is possible that this tendency could contribute to better performance in the standing long jump, a strength-related skill.

CONCLUSION

The results of this study should be considered in the light of the limitation of a non-randomized group, as the performance of the group could be influenced by unmeasured factors.
such as reasons for enrollment into the programme and activity levels of the children. Culturally, Potchefstroom is a city in which education is emphasized because of the high number of schools, colleges and a university in the city. It is, therefore, possible that the poor results of the 6 year olds compared to the other age groups could have been influenced by more parents entering children with gross motor delays into the MDP at this age, due to their realising the importance of sufficient development in the year before going to school. Nevertheless, the results of this study give a good indication of the level of motor proficiency of preschoolers entering movement development programmes.

Although the gross motor skills of this group of 3, 4 and 5 year old, and strength-related skills of the 6 year old children in Potchefstroom generally compare favourably with norms and criteria in the literature, the results seem to indicate that catching ability at all ages and some other important gross motor skills could be delayed, especially in the 6 year old group. It is estimated that 8.3% of 6-9 year old South African school children have developmental delays influencing their scholastic progress (Pienaar, 1994). It is important to investigate further into gross motor development delays in the preschool years as a possible cause. It is therefore suggested that further research be conducted on gross motor development levels of South African preschool children, using randomly selected populations, and taking into account factors like socio-economic background, nutritional status and activity levels.

REFERENCES


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Chapter 4

Research article 2

Overweight and obesity, and gross motor proficiency of preschool boys
OVERWEIGHT AND OBESITY, AND MOTOR PROFICIENCY OF PRESCHOOL BOYS

Abstract
Increasing childhood obesity has led to concern due to the health and developmental risks involved. The purpose of this study was to examine the prevalence of and the differences in the quantitative and qualitative execution of four gross motor tasks (standing long jump, hopping, one leg balance and catching) between groups of overweight and obese (O) preschool boys (3, 4, 5 and 6 year olds) and their nonobese (NO) counterparts in Potchefstroom. From a total of 104 subjects, enrolled in a movement development program at the University of Potchefstroom, 17 O-subjects and 49 NO-subjects were identified and grouped according to age, 3 year olds (n = 14); 4 year olds (n = 24); 5 year olds (n = 21) and 6 year olds (n = 7). By making use of practical significance based on effect sizes (ES) as recommended by Cohen (1988) and Steyn (1999) for a non-randomized and selected, but complete population, differences between 3-6 year old O- and NO- subjects were seperately determined. Every O-subject was paired and compared with a group of 2-5 age-matched NO-subjects (differing no more than 3 months). Differences of practical significance (ES ≥ 0.5 or ES ≥ 0.8) were found in favour of the NO-subjects in all the age groups with regard to most of the qualitative and quantitative scores for hopping and / or balancing on one leg. Practical significance was also found favouring the 4, 5 and 6 year old NO-group in the qualitative evaluation of the standing long jump and catching, and the quantitative score of the standing long jump. No effect sizes of practical significance were found with regard to the qualitative scores of catching (4, 5 and 6 year olds). The results revealed that 9.61% of the boys are overweight and 6.73% obese and that O-boys of the ages 3-6 years generally compare poorly to NO-boys in relation to balance and locomotor skills, but not to manipulation skills.

Key words: Overweight, obesity, motor proficiency, preschool, boys, children, fundamental movement skills.

Introduction
The health risks associated with obesity in children are reported in several studies (Figueroa-Colon et al., 1997; Hernandez et al., 1998; Williams et al., 1998; Freedman et al., 1999). These health risks include, among others, hypertension, elevated cholesterol levels, diabetes and respiratory diseases. Elevated levels of systolic and diastolic blood pressure have been reported
in 5-11 year old (Figueroa-Colon et al., 1997) and 3-5 year old (Hernandez et al., 1998) obese children, and overweight children aged 5-6 years showed elevated cholesterol levels in the Bogalusa Heart Study (Freedman et al., 1999). Williams et al. (1998) found cardiovascular risk factors in obese children as young as three years. Furthermore, obesity often leads to bad posture and related disorders, placing greater stress on joints and ligaments (Dietz, 1995; Auxter et al., 1997). Because of these health risks, the periods of risk for developing and the causes of childhood obesity have received considerable attention in recent literature (Anderson et al., 1998; Hernandez et al., 1998; Dietz, 2000; Ganley & Sherman, 2000). The age period of around 5-6 years is considered to be one of the periods of growth during which the risk for obesity is markedly increased (Goran et al., 1999). However, Bar-Or et al. (1988) and Goran et al. (1999) suggests that an even earlier age period might increasingly be a period of high risk for the development of overweight or obesity, due to the increasing tendency of younger children to lead a sedentary lifestyle. The primary causes of childhood obesity are considered to be an unhealthy diet and a lack of physical activity (Sääkslahti et al., 1999; Strand & Roesler, 1999).

A lack of physical activity could influence motor development, as participation in frequent physical activities is also important for the development of motor skills and co-ordination in the preschool years (Sääkslahti et al., 1999; Thomas, 1999). The period of 2 to 7 years of age is indeed considered to be the critical years of a child’s motor development, as the fundamental gross motor skills develop during this period (Gabbard, 1998; Gallahue & Ozmun, 1998). The development of these fundamental skills could play an important role in the overall development of school readiness, as a child’s gross motor skills are closely related to his or her fine motor, cognitive, affective, and perceptual development (Pienaar, 1994; Gallahue & Ozmun, 1998). According to Marshall and Bouffard (1994) and Auxter et al. (1997), obese children tend to avoid physical activity, often leading to insufficient development of gross motor skills. Inadequate motor skills could in turn increase the tendency to withdraw from physical activity, thus contributing to the development of a vicious cycle in obese children. The sufficient exposure to and development of gross motor skills early in life could therefore be a contributing factor in the prevention of obesity (Auxter et al., 1997).

The prevalence of underweight, wasting and stunting in South African children has received considerable attention in recent literature (Cameron et al., 1998; Monyeki et al., 1999; NFCS, 2000), but little research has been done on the prevalence of childhood overweight and obesity.
Chapter 4: Overweight and obesity, and gross motor proficiency of boys

According to the National Food Consumption Survey of 1999 (NFCS, 2000), the average prevalence of overweight in South African children aged 1-9 years is currently 7.6%. However, according to the NFCS (2000), the figure is much higher for children living in urban areas (12.5%), including 4-6 year old children (12%). The latter percentages are consistent with international childhood overweight prevalence rates of 11% - 24% in the United States (Strand & Roesler, 1999; Ganley & Sherman, 2000), 7% - 43% in Canada (Marshall & Bouffard, 1997), 10% -13% in Britain (Armstrong et al., 1990) and 8.2% - 9.0% in Kuwait (Al-Isa & Moussa, 1998). Concerning preschool children living in cities like Potchefstroom, the high percentages of childhood obesity in urban areas in South Africa are troubling, as obesity in children is associated with several health risks (Ganley & Sherman, 2000). Furthermore, obese children tend to become obese adults (Anderson et al., 1998; Dietz, 2000).

Correlations between obesity and gross motor skills among children has been found in several studies (Slaughter et al., 1980; Marshall & Bouffard, 1994; Raudsepp & Jürimäe, 1996; Marshall & Bouffard, 1997).

The question arises whether a relationship between overweight and obesity, and gross motor competency exists in the preschool years, where increasing obesity among predominantly urban children is also a major concern of health administrators in South Africa. No evidence exists of such a relationship in the age group of 3-6 years in South Africa. The purpose of this study, therefore, was to (1) determine the prevalence of overweight and obesity in a selected group of 3-6 year old boys in Potchefstroom, and (2) to investigate the possible relationship between overweight and obesity, and motor proficiency represented by four gross motor tasks, in this group.

Procedure

Subjects

The original sample consisted of 104 white male subjects, of the ages of 3 (n=24), 4 (n=31), 5 (n=37), and 6 (n=12) years respectively. All subjects lived in Potchefstroom, came from a middle-class background and had been enrolled in the movement development program presented by movement developmentalists of the Potchefstroom University for Christian Higher Education (P.U. for C.H.E.). This available sample is considered to be a complete population as it constituted all the male participants in this programme. This program is being presented on the

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premises of 10 preprimary schools in different areas of Potchefstroom, as well as at the movement development center at the university.

Seventeen obese and overweight (O) subjects were identified from this group of 104 subjects. Every subject in the obese (n=7) or overweight (n=10) group was matched with a nonobese (NO) age-matched group (2-5 in a group, randomly chosen from the original group). The ages of the subjects in each matched group were no more than 3 months from the chronological age of the obese subject. These groupings resulted in a final total group of 66 subjects used in the study.

**Assessment procedure**

All the subjects were enrolled in the program for their first time, and all assessments were completed before the implementation of the program. Informed consent was obtained for each subject, and all subjects were briefed on the procedures before the evaluation started. The evaluations were conducted on the premises of the schools and in the movement development center at the university. Anthropometric measurements were taken first, followed by specific gross motor tests. These motor skills were videotaped and analyzed afterwards by the researcher.

**Body composition assessment**

Skinfolds (triceps and subscapular) and body height and mass were measured according to the procedures outlined by Lohman (1992). Each skinfold was measured twice, and the average of the two measures taken. The sum of the two skinfold-scores was then used to determine the percentage body fat of each subject using the tables of Lohman (1992). The body mass index (BMI) of each subject was determined according to the formula of $\text{BMI} = \frac{\text{body mass in kg}}{\text{(body height in m)}^2}$. As no national growth charts are available for the South African population, the growth charts of the Centers for Disease Control and Prevention (National Centre for Health Statistics, 2000) which is recommended for international use by the World Health Organization (Must et al., 1991) was used to classify a subject's BMI. To further confirm the diagnoses of obesity or overweight, each subject was visually evaluated using the Marshall Visual Rating Scale, MVRS (Marshall et al., 1990). According to this simple rating test, 1 implies *slim* (thin, anorexic-like), 2 implies *ideal* (optimal weight to height), 3 *overweight* (plump but not indicative to a health risk), and 4 *obese* (grossly overweight, at perceived health risk). To classify a subject in the overweight or obese group, a percentage body fat of 20% or higher and 25% or higher respectively (Lohman, 1992), a corresponding BMI on the 85th percentile or higher and the 95th percentile respectively, according to the growth charts of the Centers for Disease Control and Prevention (National
Centre for Health Statistics, 2000) and a 3 or 4-rating on the Marshall Visual Rating Scale (Marshall et al., 1990) were used.

**Assessment of fundamental gross motor skills**

Standing long jump, hopping, one leg balance, and catching were selected as the four gross motor skills to be tested, as these skills are used extensively in established, validated and reliability-proven motor test batteries for children of these age groups (Bruininks, 1978; Ulrich, 1985; Henderson & Sugden, 1992) and because they represent the three categories of movement, namely basic locomotion (standing long jump and hopping), static balance (one leg balance), and manipulation (catching) (Gallahue & Ozmun, 1998).

These four gross motor skills were qualitatively (the quality of the execution of the skill) and quantitatively (the measurable score given to the skill, e.g. distance in mm.) evaluated.

To obtain a qualitative score, the developmental characteristics of the performed skill were analyzed and compared to the developmental stage criteria of the expanded version of the Fundamental Movement Pattern Assessment Instrument (FMPAI) (Gallahue, 1996) for fundamental motor skills in children of the ages 2-7 years. This system is based on the research of McClenaghan (1976), De Oreo (1980), Halverson and Williams (1985) and Cratty (1986) on the developmental sequences of fundamental movement skills in children. According to Gallahue (1996), the FMPAI has proven to be highly reliable among trained observers and content validity has been established for the fundamental movements. According to the criteria of this system (Gallahue, 1996), the performed skill can qualitatively be classified into one of the three stages of fundamental motor development, namely the initial stage, the elementary stage, and the mature stage. A score of (1) was awarded if the skill was classified as being in the initial stage of development, (2) if it was in the elementary stage, and (3) if it was classified as being in the mature stage. If the performed skill showed characteristics of both the initial and the elementary stages, a score of (1.5) was awarded, signifying the transitional stage between the initial and the elementary stage. The same applied to the transitional stage between the elementary and the mature stage, which was awarded a (2.5). The skills were quantitatively evaluated adhering to the following procedures:

**Standing long jump** (Bruininks, 1978; Ulrich, 1985). The test measured how far the child could jump horizontally, using a two-foot takeoff and landing. The score was the highest of three trials. Standing long jump was not evaluated in the 3 year old group, as children of this age usually are not capable of jumping for distance (Cratty, 1986; Haywood, 1992).
**Hopping** (Ulrich, 1985). The test entailed two trials of hopping forward on one leg as many times as possible, up to a maximum of 12 jumps. The higher score (highest number of hops) was taken. Hopping was tested on both legs.

**One leg balance** (Henderson & Sugden, 1992). The test entailed two trials of balancing on one foot, with the arms hanging at the sides, for as long as possible up to a maximum of 12 seconds. The subject was instructed to stand with the free leg bent backwards at the knee so that the foot was positioned behind the standing leg. The bent leg had to be kept off the floor and away from the supporting leg. Swaying was allowed, and the arms were allowed to move from the sides. Balancing was tested on both legs.

**Catching** (Bruininks, 1978; Ulrich, 1985; Henderson & Sugden, 1992). The test measured the ability to catch an aerial, underhand thrown, 20-cm in diameter, ball with two hands. The thrower was positioned 2 meters from the subject and aimed the ball at the subject's chest. The score was the number of successful catches out of 4 throws.

Every test was conducted by the researcher, and every child was videotaped individually, from the side, by a trained assistant. The researcher then scored each subject’s performance after analyzing the video recording.

**Data analysis**

All calculations were done for descriptive purposes using the Statistica for Windows (6.0) computer program (Statsoft, 1995). As this study was done on a non-randomized, selected group of subjects, statistical significance of differences between groups is not recommended by statisticians (Cohen, 1988; Steyn, 1999) and was therefore not established. However, because this is a complete population, practical significance of the differences between the O subjects and the NO-groups of subjects were established, as recommended by Cohen (1988) and Steyn (1999) for this type of population. According to the formula of Cohen (1988) the following steps were followed to establish practical significance (effect sizes [ES]). Firstly, the difference between the score of each paired group of nonobese subjects and that of the age-matched obese or overweight subject in every gross motor test was determined by subtracting the second (O-subject's) score from the first (NO-subject's) score. Secondly, the average of the differences and the standard deviation of the differences in every test were determined for each age group separately (subjects were classified as 3, 4, 5, and 6 year olds according to their last birthday). Practical significance was then established for each age group by calculating the effect sizes of differences established between the O-groups and the NO-groups. This was done by dividing the average difference in every test by the standard deviation of the differences in every test. Guideline values for the
interpretation of practical significance, as recommended by Cohen (1988) and Steyn (1999) are: ES = 0.2 (small effect), which is considered of little practical significance and therefore not considered to be significant in this study; ES = 0.5 which is considered of practical significance of a medium effect, and ES = 0.8 which is considered of a large effect.

Results

Prevalence of overweight and obesity

The average anthropometric values of the O groups and the NO groups are presented in Table 1.

Table 1: Mean age and anthropometric values of overweight and obese (O) (n=17) and nonobese (NO) (n=49) groups used in the study (N=66)

<table>
<thead>
<tr>
<th>Measurements</th>
<th>3 years</th>
<th>4 years</th>
<th>5 years</th>
<th>6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O (n=3)</td>
<td>NO (n=11)</td>
<td>O (n=7)</td>
<td>NO (n=17)</td>
</tr>
<tr>
<td>Age (year.month)</td>
<td>M 3.07</td>
<td>M 3.07</td>
<td>M 4.04</td>
<td>M 4.04</td>
</tr>
<tr>
<td></td>
<td>SD 0.03</td>
<td>SD 0.03</td>
<td>SD 0.02</td>
<td>SD 0.05</td>
</tr>
<tr>
<td>Triceps (mm)</td>
<td>M 16.33</td>
<td>M 8.91</td>
<td>M 14.00</td>
<td>M 7.85</td>
</tr>
<tr>
<td></td>
<td>SD 4.16</td>
<td>SD 2.51</td>
<td>SD 4.83</td>
<td>SD 2.26</td>
</tr>
<tr>
<td>Subscapular (mm)</td>
<td>M 12.00</td>
<td>M 6.00</td>
<td>M 12.57</td>
<td>M 7.15</td>
</tr>
<tr>
<td></td>
<td>SD 2.65</td>
<td>SD 2.05</td>
<td>SD 5.71</td>
<td>SD 2.83</td>
</tr>
<tr>
<td>% Body fat</td>
<td>M 27.00</td>
<td>M 14.51</td>
<td>M 23.85</td>
<td>M 13.63</td>
</tr>
<tr>
<td></td>
<td>SD 5.28</td>
<td>SD 1.77</td>
<td>SD 4.50</td>
<td>SD 2.40</td>
</tr>
<tr>
<td>Body height (m)</td>
<td>M 0.97</td>
<td>M 0.98</td>
<td>M 1.10</td>
<td>M 1.03</td>
</tr>
<tr>
<td></td>
<td>SD 0.21</td>
<td>SD 0.43</td>
<td>SD 0.06</td>
<td>SD 0.06</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>M 18.33</td>
<td>M 15.27</td>
<td>M 23.14</td>
<td>M 17.49</td>
</tr>
<tr>
<td></td>
<td>SD 2.31</td>
<td>SD 1.49</td>
<td>SD 1.98</td>
<td>SD 4.53</td>
</tr>
<tr>
<td>BMI</td>
<td>M 19.25</td>
<td>M 15.74</td>
<td>M 18.98</td>
<td>M 16.84</td>
</tr>
<tr>
<td></td>
<td>SD 0.98</td>
<td>SD 2.75</td>
<td>SD 1.29</td>
<td>SD 1.84</td>
</tr>
<tr>
<td>MVRS rating</td>
<td>M 4.00</td>
<td>M 1.27</td>
<td>M 3.57</td>
<td>M 1.41</td>
</tr>
<tr>
<td></td>
<td>SD 0.00</td>
<td>SD 0.36</td>
<td>SD 0.14</td>
<td>SD 0.48</td>
</tr>
</tbody>
</table>

Note. BMI = Body mass index; MVRS = Marshall Visual Rating Scale score

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Seventeen overweight and obese subjects were identified, representing 16.35% of the total group \((n=104)\). From this group of seventeen, 10 subjects (9.61%) were overweight and 7 (6.73%) obese. Furthermore, the 3 year-old O-group represented 12.50% (4.17% overweight and 8.33% obese), the 4 year old group 22.58% (12.90% overweight and 9.68% obese), the 5 year old O-group 13.51% (10.81% overweight and 2.70% obese) and the 6 year old O-group 16.67% (16.67% obese) of their respective total age groups.

**Results of the gross motor testing**

The average scores achieved in each gross motor test in the different age groups, are presented in Table 2. From these results it is clear that most scores from the NO-group were higher than those of the O-group in every age group except for among the 5 year olds, where the O-group scored slightly higher in the standing long jump (qualitatively), hopping left and right (quantitatively) and the balance stand on the right leg (qualitatively). The 6 year old O-group also achieved better scores in the hopping on the left leg (quantitatively) than the NO-group. However, none of these differences were of practical significance.

When ES were calculated for the differences found for the four tests in the different age groups (Table 3), several medium and large effects of practical significance favouring the NO-groups were established.
Table 2: Mean values for the different gross motor tests in obese and overweight (O) groups and nonobese (NO) groups

<table>
<thead>
<tr>
<th>Motor tasks</th>
<th>3 years</th>
<th>4 years</th>
<th>5 years</th>
<th>6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O (n=3)</td>
<td>NO (n=11)</td>
<td>O (n=7)</td>
<td>NO (n=17)</td>
</tr>
<tr>
<td>Long jump quant. (cm.)</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>SD</td>
<td>74.00</td>
<td>89.47</td>
<td>107.8</td>
<td>109.6</td>
</tr>
<tr>
<td>Long jump qual.</td>
<td>16.00</td>
<td>17.16</td>
<td>15.34</td>
<td>15.71</td>
</tr>
<tr>
<td>SD</td>
<td>0.49</td>
<td>0.39</td>
<td>0.55</td>
<td>0.51</td>
</tr>
<tr>
<td>Hopping L quant.</td>
<td>1.33</td>
<td>2.55</td>
<td>5.00</td>
<td>6.06</td>
</tr>
<tr>
<td>SD</td>
<td>1.53</td>
<td>2.25</td>
<td>3.12</td>
<td>2.10</td>
</tr>
<tr>
<td>Hopping L qual.</td>
<td>1.00</td>
<td>1.18</td>
<td>1.57</td>
<td>1.76</td>
</tr>
<tr>
<td>SD</td>
<td>0.01</td>
<td>0.40</td>
<td>0.53</td>
<td>0.44</td>
</tr>
<tr>
<td>Hopping R quant.</td>
<td>0.50</td>
<td>2.80</td>
<td>3.57</td>
<td>5.82</td>
</tr>
<tr>
<td>SD</td>
<td>0.71</td>
<td>2.44</td>
<td>3.21</td>
<td>2.48</td>
</tr>
<tr>
<td>Hopping R qual.</td>
<td>1.00</td>
<td>1.20</td>
<td>1.29</td>
<td>1.76</td>
</tr>
<tr>
<td>SD</td>
<td>0.01</td>
<td>0.42</td>
<td>0.49</td>
<td>0.44</td>
</tr>
<tr>
<td>Balance L quant. (sec)</td>
<td>2.33</td>
<td>3.18</td>
<td>4.14</td>
<td>6.06</td>
</tr>
<tr>
<td>SD</td>
<td>1.15</td>
<td>1.72</td>
<td>1.57</td>
<td>2.46</td>
</tr>
<tr>
<td>Balance L qual.</td>
<td>1.33</td>
<td>1.55</td>
<td>1.71</td>
<td>1.94</td>
</tr>
<tr>
<td>SD</td>
<td>0.58</td>
<td>0.52</td>
<td>0.49</td>
<td>0.43</td>
</tr>
<tr>
<td>Balance R quant.</td>
<td>2.00</td>
<td>2.40</td>
<td>4.17</td>
<td>6.00</td>
</tr>
<tr>
<td>SD</td>
<td>0.01</td>
<td>1.27</td>
<td>1.94</td>
<td>1.90</td>
</tr>
<tr>
<td>Balance R qual.</td>
<td>1.00</td>
<td>1.40</td>
<td>1.83</td>
<td>2.00</td>
</tr>
<tr>
<td>SD</td>
<td>0.01</td>
<td>0.52</td>
<td>0.41</td>
<td>0.35</td>
</tr>
<tr>
<td>Catching quant.</td>
<td>3.33</td>
<td>3.55</td>
<td>3.00</td>
<td>3.88</td>
</tr>
<tr>
<td>SD</td>
<td>1.15</td>
<td>1.04</td>
<td>1.41</td>
<td>0.33</td>
</tr>
<tr>
<td>Catching qual.</td>
<td>1.00</td>
<td>1.55</td>
<td>1.57</td>
<td>1.94</td>
</tr>
<tr>
<td>SD</td>
<td>0.01</td>
<td>0.52</td>
<td>0.53</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Note. M = Mean Quant = quantitative score, Qual. = qualitative score: 1 = initial stage; 2 = elementary stage; 3 = mature stage.
Table 3: Mean values, standard deviations and effect sizes of the differences between the obese and overweight group (O), and the nonobese group (NO)

<table>
<thead>
<tr>
<th>Measurements</th>
<th>3 years (N=11)</th>
<th></th>
<th>4 years (N=17)</th>
<th></th>
<th>5 years (N=16)</th>
<th></th>
<th>6 years (N=5)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>ES</td>
<td>M</td>
<td>SD</td>
<td>ES</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>BMI</td>
<td>-3.41</td>
<td>2.57</td>
<td>-1.33**</td>
<td>-2.93</td>
<td>2.68</td>
<td>-1.09**</td>
<td>-1.26</td>
<td>1.79</td>
</tr>
<tr>
<td>Long jump quant. (cm)</td>
<td>13.94</td>
<td>18.91</td>
<td>0.74*</td>
<td>0.29</td>
<td>0.47</td>
<td>0.63*</td>
<td>0.29</td>
<td>0.47</td>
</tr>
<tr>
<td>Hopping L quant.</td>
<td>1.27</td>
<td>2.05</td>
<td>0.62*</td>
<td>0.82</td>
<td>3.94</td>
<td>0.21</td>
<td>0.82</td>
<td>3.94</td>
</tr>
<tr>
<td>Hopping L qual.</td>
<td>0.09</td>
<td>0.30</td>
<td>0.30</td>
<td>0.24</td>
<td>0.66</td>
<td>0.35</td>
<td>0.24</td>
<td>0.66</td>
</tr>
<tr>
<td>Hopping R quant.</td>
<td>1.29</td>
<td>2.36</td>
<td>0.54*</td>
<td>1.29</td>
<td>3.80</td>
<td>0.34</td>
<td>1.29</td>
<td>3.80</td>
</tr>
<tr>
<td>Hopping R qual.</td>
<td>0.29</td>
<td>0.49</td>
<td>0.59*</td>
<td>0.47</td>
<td>0.62</td>
<td>0.75*</td>
<td>0.47</td>
<td>0.62</td>
</tr>
<tr>
<td>Balancing L quant. (sec)</td>
<td>1.27</td>
<td>2.45</td>
<td>0.52*</td>
<td>2.24</td>
<td>2.63</td>
<td>0.85*</td>
<td>2.24</td>
<td>2.63</td>
</tr>
<tr>
<td>Balancing L qual.</td>
<td>0.18</td>
<td>0.40</td>
<td>0.45</td>
<td>0.41</td>
<td>0.62</td>
<td>0.67*</td>
<td>0.41</td>
<td>0.62</td>
</tr>
<tr>
<td>Balancing R quant.</td>
<td>2.14</td>
<td>2.79</td>
<td>0.77*</td>
<td>0.38</td>
<td>2.28</td>
<td>1.04**</td>
<td>0.38</td>
<td>2.28</td>
</tr>
<tr>
<td>Balancing R qual.</td>
<td>0.14</td>
<td>0.69</td>
<td>0.21</td>
<td>0.13</td>
<td>0.34</td>
<td>0.37</td>
<td>0.13</td>
<td>0.34</td>
</tr>
<tr>
<td>Catching quant.</td>
<td>0.00</td>
<td>1.10</td>
<td>0.00</td>
<td>0.59</td>
<td>0.87</td>
<td>0.68*</td>
<td>0.59</td>
<td>0.87</td>
</tr>
<tr>
<td>Catching qual.</td>
<td>0.45</td>
<td>0.69</td>
<td>0.66*</td>
<td>0.06</td>
<td>0.43</td>
<td>0.14</td>
<td>0.06</td>
<td>0.43</td>
</tr>
</tbody>
</table>

Note: * = medium effect; ** = large effect; M = mean difference between O and NO group; ES = effect size

ES indicating medium or large effects are summarized in Table 4.

Table 4: Effect sizes of medium or large effects, favouring the NO-group, found in the gross motor tests in the different age groups

<table>
<thead>
<tr>
<th>Motor tasks</th>
<th>QUANTITATIVE TESTS</th>
<th>QUALITATIVE TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium effect (ES ≥ 0.5)</td>
<td>Large effect (ES ≥ 0.8)</td>
</tr>
<tr>
<td>Long jump</td>
<td>4, 5 years</td>
<td>6 years</td>
</tr>
<tr>
<td>Hopping L</td>
<td>3 years</td>
<td>-</td>
</tr>
<tr>
<td>Hopping R</td>
<td>3 years</td>
<td>-</td>
</tr>
<tr>
<td>Balancing L</td>
<td>3, 5 years</td>
<td>4 years</td>
</tr>
<tr>
<td>Balancing R</td>
<td>-</td>
<td>4 years</td>
</tr>
<tr>
<td>Catching</td>
<td>4 years</td>
<td>5, 6 years</td>
</tr>
</tbody>
</table>
Discussion

Prevalence of overweight and obesity

The figures of 10 overweight (9.61%) and 7 obese (6.73%) children found in this study, totaling 16.35% of the total group, is higher than the prevalence of overweight among South African urban children (12.5%) and 4-6 year old urban children (12%) (NFCS, 2000), as are the representing percentages of overweight and obese boys of every age group. A possible reason for this could be that the subjects in this study were all white, while the NFCS included children of all races. According to Richardson (1978), overweight and obesity were more prevalent among white children than other races in 1978. Of concern is the findings of such high percentages of overweight and obese children in the very young age groups (3 year olds – 12.5%; 4 year olds – 22.58%). The age period of around 5-6 years is considered to be one of the periods of growth during which the risk for obesity is markedly increased (Goran et al., 1999). The results of this study seem to support the suggestion of Bar-Or et al. (1988) and Goran et al. (1999) that an even earlier age period might be a period of high risk for the development of overweight or obesity.

Differences between the O- and the NO-group regarding the four motor tasks

Practical significance with medium or large effects was found in every age group favouring the NO-group, regarding hopping and / or balancing on one leg (Tables 3 and 4). These results correspond with the studies of Marshall and Bouffard (1994; 1997), involving 6 year and 9 year old boys, which showed a negative relationship between obesity and gross motor competency. Compared to the nonobese groups, the obese groups in this study showed significantly lower scores in the locomotor subscale of the Test of Gross Motor Development (TGMD), consisting of tests for running, galloping, hopping, leaping, horizontal jumping, skipping, and sliding.

Both the skills of hopping and one leg balancing are dependent on good balancing ability. Two possible reasons for the poorer performance of the O-group in these skills, could be, 1) The point of gravity shifts and the base of support (the feet) becomes smaller when a person’s body size increases (Haywood, 1992). The child would then be forced to use compensating movements with the arms and upper body to maintain equilibrium, resulting in poorer qualitative control, as was indeed the case. 2) The lower strength-to-weight ratio of obese children could effect performance in these skills (Raudsepp and Jürimäe, 1996). Poor balancing skills, which were evident among all the age groups (Table 4), can have a negative influence on the development of all other gross motor skills, as balance and posture control are the cornerstones for the
development of all gross motor skills according to Auxter et al. (1997) and Gallahue and Ozmun (1998).

Medium or large effects were found in favour of the NO-group regarding the quantitative scores of the standing long jump in the 4, 5, and 6 year old groups, and in the 4 and 6 year old groups with regard to the qualitative scores (Table 4). Although this study involved much younger boys, this corresponds to the findings of Hensley and Whitfield (1982) and Raudsepp and Jürimäe (1996), that adiposity is related to motor skills in which the body has to be moved from one place to another. Raudsepp and Jürimäe (1996) reported a negative relationship between the percentage body fat, standing long jump, and shuttle run in a study involving 10-11 year old children (higher percentages of body fat were related to lower scores in these tests). Slaughter et al. (1980) reported significant correlations between overweight and horizontal jump, vertical jump, and the 50 meter dash in a study involving 7-12 year old children. According to Raudsepp and Jürimäe (1996), overweight and obese children seem to lack the leg power in relation to their body mass to jump distances comparable to those of their nonobese age group.

A possible explanation for the negative (practically insignificant) differences between the 5 year old O- and NO-group (skills where the O-group performed better than the NO-group), could be that this age group showed smaller differences in their BMI and percentage body fat measures, between the O-group and the NO-group than the other age groups. Had the subjects in the O-group showed larger degrees of overweight or obesity, the results of the gross motor tests might have been more in favour of the NO-group.

In Table 3 it can be seen that a larger effect size was found in tests of age groups showing greater effect sizes concerning percentage body fat and BMI (3, 4, and 6 year olds). This seems to suggest that an increase in levels of obesity would be related to larger differences in motor proficiency between obese and nonobese children.

No difference was found between the O-group and the NO-group with regard to the qualitative performance of catching in the 4, 5, and 6 year old groups. This corresponds to the findings of Hensley and Whitfield (1982) and Raudsepp and Jürimäe (1996), that adiposity is related to motor items in which the body is projected or moved, but not to static items such as catching. In the studies of Marshall and Bouffard (1994; 1997), no significant difference was found between
obese and nonobese boys in the Object Control Skills subscale of the TGMD, consisting of tests for two-hand striking, stationary bouncing, catching, kicking, and overhand throwing. Possibly, because their body weight probably does not have an effect on the qualitative performance of the catching skill, these overweight and obese children have acquired the qualitative skill of catching. Also, because the most popular sport disciplines in South Africa are ball sports (rugby, cricket and soccer) which enjoy extensive coverage in the media, it is possible that boys tend to practice ball skills from an early age.

**Limitations of the study**

The results obtained with this study should be evaluated in the light of the following limitations, lessening the measure of generalizability. Firstly, although a complete population, a comparatively small and selected, group of subjects was used. Secondly, relatively few overweight and obese subjects were compared to groups of nonobese subjects, and thirdly, the number of subjects used in the 6 year-old group were less than the other groups. Bearing these limitations in mind, it is suggested that future studies researching the same problem should make use of larger, and if possible randomly selected populations. A problem with random selection at very young ages, however, is that some children may not be willing to participate, limiting this more scientific way of doing as well (Hernandez et al., 1998).

It is possible that, although three methods were used to classify a child as overweight or obese, this classification is still problematic due to variability and growth rate differences at such a young age (Cameron et al., 1998), therefore errors may have occurred in classification of borderline subjects at this age. It is therefore recommended that overweight subjects be excluded in future comparisons, as comparisons between obese and nonobese subjects may show larger differences. To account for different growth rates, the controlling of biological age together with chronological age is recommended in such comparisons, as children of the same chronological age grow at different rates.

**Conclusion**

This study's results showed that overweight and obesity is prevalent among children at very young ages, a phenomenon which needs attention from health professionals. The findings also show that overweight and obesity at a very young age can already have a detrimental effect on basic locomotive and balance skills of boys, thereby limiting future development of these motor skills which may contribute to other aspects of the child's holistic development (social,
affective, health). For professionals working with children of preschool ages, an important goal should be to maximally stimulate and develop gross motor skills in this critical period via sufficient and frequent physical activity. Acquisition of fundamental motor skills is essential to promote self-efficacy and to obtain psychological readiness to participate in health-enhancing activities in later life.
References


SAJRSPER: Revised manuscript submitted on 23 November, 2001


[http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/set2/chart%2015.PDF]


SAJRSPER: Revised manuscript submitted on 23 November, 2001
Chapter 4: Overweight and obesity, and gross motor proficiency of boys


SAJRSPER: Revised manuscript submitted on 23 November, 2001
Chapter 5

Research article 3

Overweight and obesity, and gross motor proficiency of 3-6 year old girls
OVERWEIGHT AND OBESITY, AND MOTOR PROFICIENCY OF 3-6 YEAR OLD GIRLS

Abstract
Childhood obesity has increased over the last two decades, with increasing concern regarding health and other developmental risks. The aim of this study was to examine the prevalence of overweight and obesity and the differences in gross motor skills between overweight and obese preschool girls (3, 4, 5 and 6 year olds) and their nonobese counterparts in Potchefstroom. Four fundamental motor tasks were qualitatively (the quality of the execution of the skill) and quantitatively (the measurable score given to the performance of the skill, e.g. distance in mm.) assessed in 13 overweight and obese participants and 54 nonobese participants in age-matched groups. The prevalence of obesity (11.81%) found in this sample, corresponds with worldwide and national trends in this age group. Differences of practical significance established with effect sizes (ES) were established, as recommended by Cohen (1988) and Steyn (1999) for non-randomized and selected, but complete populations. ES of medium or large effects were found in favour of the nonobese participants in all the age groups with regard to most of the qualitative and quantitative scores for hopping and / or balancing on one leg, suggesting that overweight and obese girls perform poor in comparison with nonobese girls in tasks that require good balancing ability. Practical significance was also found favouring the nonobese group in the qualitative evaluation of catching (3, 5 and 6 year olds) as well as the qualitative score of the standing long jump (6 year olds). The results indicate that overweight and obese girls of the ages 3-6 years generally compare poorly to nonobese girls of this age group in relation to gross motor proficiency.

Key words: Overweight, obesity, motor proficiency, preschool, girls, children, movement skills.

Introduction
Childhood obesity has received considerable attention in the literature in recent years (Goran et al., 1999; Owens et al., 1999; Van Mill et al., 1999; Writer, 2000) due to the increase of obesity and overweight among children over the last two decades (Van Mill et al., 1999; Dietz, 2000) and due to the health risks involved.
The prevalence of obesity has increased among American children over the last twenty years (Cheung, 1995) and an increase has also been reported among English and Scottish children aged 4 to 11 years (Chinn & Rona, 1994). Relatively little research has been done on the prevalence of childhood overweight and obesity in South Africa (Monyeki et al., 1999; NFCS, 2000; Richardson, 1978). Richardson (1978) found a prevalence of overweight and obesity of 12-18% among white children, and 13-18% among black children aged 1-6 years, in his study on growth patterns in South Africa. In their study on the prevalence of obesity among preschool black children in Ellisras, a rural area in South Africa, Monyeki et al. (1999) found that boys of the ages 3-4 years showed the highest prevalence of obesity (15%). A prevalence of overweight and obesity of 16.35% was found by Du Toit and Pienaar (2000) for 3-6 year old boys in Potchefstroom, a city in the Northwest Province of South Africa. According to the National Food Consumption Survey of 1999 (NFCS, 2000), the average prevalence of overweight in South African children aged 1-9 years is currently 7.6%. However, the figure is much higher for children living in urban areas (12.5%), including 4-6 year old children (12%) (NFCS, 2000). The latter percentages are consistent with the prevalence of overweight among children in the United States of 11% to 24% (Flegal, 1999; Strand & Roesler, 1999; Ganley & Sherman, 2000) and in Canada (between 7 and 43%) (Marshall & Bouffard, 1997). Hernandez et al. (1998) found a prevalence of 32% in preschool children, and these obese children showed significantly higher levels of blood pressure than their nonobese counterparts.

Other studies have also showed cardiovascular risk factors in obese children as young as three years (Williams et al., 1998; Freedman et al., 1999). Cardiovascular risk factors and other health risks associated with obesity in children including hypertension, diabetes, posture-related disorders and respiratory diseases, are emphasized in several studies (Raudsepp & Pääsu, 1995; Auxter et al., 1997; Marshall & Bouffard, 1997; Neumark-Sztainer, 1999; Ganley & Sherman, 2000). However, relatively little research has been done on a different kind of health risk, possibly influencing the child’s overall development and well being, associated with obesity, namely insufficient fundamental gross motor development of the preschool child.

The period of 2 to 7 years of age is considered to be the critical years of a child’s motor development, as, through play and physical activities, the fundamental gross motor skills develop during this period (Gabbard, 1998; Gallahue & Ozmun, 1998). However, as obese children, especially girls (Hoare & Larkin, 1991), tend to avoid physical activity, this could lead to
insufficient development of gross motor skills (Marshall & Bouffard, 1994; Auxter et al., 1997). Obesity, social seclusion and the resulting poor gross motor skills could again influence total well-being as the child’s self-confidence and self-esteem, thus emotional development is affected (Fox, 1992; Marshall & Bouffard, 1994).

Slaughter et al. (1980) found moderate correlations in body fat and horizontal jump, vertical jump and the 50 meter dash in a study involving 7-12 year old girls, whereas Raudsepp and Jürimäe (1996) reported a relationship between the percentage body fat, and standing long jump and shuttle run in a study involving 10-11 year old girls. In two studies involving 6 year and 9 year old boys and girls, Marshall and Bouffard (1994; 1997) found significant relationships between obesity and gross motor competency. Compared to the nonobese groups, the obese groups in this study showed significantly lower scores in the locomotor subscale of the Test of Gross Motor Development, consisting of tests for running, galloping, hopping, leaping, horizontal jumping, skipping and sliding. No significant difference was found in the Object Control Skills subscale, consisting of tests for two-hand striking, stationary bouncing, catching, kicking and overhand throwing. In the only study of a similar conduct on preschool children (Du Toit & Pienaar, 2000), practically significant differences were found with regard to basic locomotor skills (standing long jump and hopping) and balance between overweight or obese, and nonobese white preschool boys between the ages of 3 – 6 years. Significant differences were found with regard to the quantitative and qualitative execution of standing long jump, hopping, and balancing on one leg. Balancing skills of these young boys seemed to be especially affected. This finding is troublesome, as researchers highlight that balance and posture control are the cornerstones for the development of all gross motor skills, and can therefore influence the development of all other gross motor skills (Auxter et al., 1997; Gallahue & Ozmun, 1998).

The question arising is whether the prevalence of obesity is similar to what was found in the NFCS and in other countries and whether a relationship between overweight and obesity, and gross motor competency exists among girls in the preschool years, as no evidence exists of such a relationship in this age group and gender in South Africa. The purpose of this study is therefore to investigate the prevalence of and possible relationship between overweight and obesity, and movement competency in a group of 3-6 year old girls in Potchefstroom.
Chapter 5: Overweight and obesity, and gross motor proficiency of girls

Procedure

Subjects
The original sample consisted of 110 white female subjects, of the ages of 3 \( (n=33) \), 4 \( (n=34) \), 5 \( (n=32) \) and 6 \( (n=11) \) years respectively. All subjects lived in Potchefstroom, came from a middle class background and had been enrolled in the movement development program (MDP) presented by movement developmentalists of the Potchefstroom University for Christian Higher Education (P.U. for C.H.E.). This available sample is considered to be a complete population as it constitutes all the female participants in the programme. This program is being presented on the premises of 10 preprimary schools in Potchefstroom, as well as at the movement development center at the university.

Thirteen (13) obese and overweight (O) subjects were identified from this group of 110 subjects. To classify a subject in the overweight or obese group, percentage body fat, BMI and the Marshall Visual Rating Scale (MVRS) of Marshall et al. (1990) were used. Every subject in the obese \( (n=5) \) or overweight \( (n=8) \) group was then matched with a nonobese (NO) age-matched group (2-5 in a group, randomly chosen from the original group). The ages of the subjects in each matched group were no more than 3 months from the chronological age of the obese subject. These groupings resulted in a final total group of 67 subjects used in the study.

Evaluation procedure
A one-time cross-sectional design was used as research method in the study. All the subjects were enrolled in the MDP for their first time, and all were evaluated before the implementation of the program. All parents were briefed on the procedures before the evaluation started, after which informed consent was obtained from them for each subject. The evaluations were conducted on the premises of the schools and in the movement development center at the university. Body composition measurements were done first, followed by the assessment of specific fundamental gross motor skills. The execution of these motor skills were videotaped and scored afterwards by the researcher.

Body composition assessment
Skinfolds (triceps and subscapular) and body height and mass were measured according to the procedures outlined by Lohman (1992). Each skinfold was measured twice, and the average of the two measures taken. The sum of the two skinfold-scores was then used to determine the percentage body fat of each subject using the tables of Lohman (1992). The body mass index
(BMI) of each subject was determined according to the formula of $BMI = \frac{\text{body Mass in kg}}{\text{body height in m}^2}$. As no national growth charts are available for the South African population, the growth charts of the Centres for Disease Control and Prevention (National Centre for Health Statistics, 2000) which are recommended for international use by the World Health Organization (Must et al., 1991) were used to classify a subject’s BMI. To further confirm the diagnoses of obesity or overweight, each subject was visually evaluated using the Marshall Visual Rating Scale, MVRS (Marshall et al., 1990). According to this simple rating test, 1 implies slim (thin, anorexic-like), 2 implies ideal (optimal weight to height), 3 overweight (plump but not indicative to a health risk), and 4 obese (grossly overweight, at perceived health risk). To classify a subject in the overweight or obese group, a percentage body fat of 25% or higher and 30% or higher respectively (Lohman, 1992), a corresponding BMI on the 85th percentile or higher and the 95th percentile respectively, according to the growth charts of the Centres for Disease Control and Prevention (National Centre for Health Statistics, 2000) and a 3 or 4-rating on the Marshall Visual Rating Scale (Marshall et al., 1990) were used.

**Assessment of fundamental gross motor skills**

Standing long jump, hopping, one leg balance, and catching were selected as the four gross motor skills to be tested, as these skills are used extensively in established, validated and reliability-proven motor test batteries for children of these age groups (Bruininks, 1978; Ulrich, 1985; Henderson & Sugden, 1992) and because they represent the three categories of movement, namely basic locomotion (standing long jump and hopping), static balance (one leg balance), and manipulation (catching) (Gallahue & Ozmun, 1998).

These four gross motor skills were qualitatively (the quality of the execution of the skill) and quantitatively (the measurable score given to a skill, e.g. distance in mm) evaluated.

To obtain a qualitative score, the developmental characteristics of the performed skill were analyzed and compared to the developmental stage criteria of the expanded version of the Fundamental Movement Pattern Assessment Instrument (FMPAI) (Gallahue, 1996) for fundamental motor skills in children of the ages 2-7 years. This system is based on the research of McClenaghan (1976), De Oreo (1980), Halverson and Williams (1985), and Cratty (1986), on the developmental sequences of fundamental movement skills in children. According to Gallahue (1996), the FMPAI has proven to be highly reliable among trained observers and content validity has been established for the fundamental movements. According to the criteria of this system (Gallahue, 1996), the performed skill can qualitatively be classified into one of the three stages of fundamental motor development, namely the initial stage, the elementary stage, and the
mature stage. A score of (1) was awarded if the skill was classified as being in the initial stage of development, (2) if it was in the elementary stage, and (3) if it was classified as being in the mature stage. If the performed skill showed characteristics of both the initial and the elementary stages, a score of (1.5) was awarded, signifying the transitional stage between the initial and the elementary stage. The same applied to the transitional stage between the elementary and the mature stage, which was awarded a (2.5). The skills were quantitatively evaluated adhering to the following procedures:

**Standing long jump** (Bruininks, 1978; Ulrich, 1985). The test measured how far the child could jump horizontally, using a two-foot takeoff and landing. The score was the highest of three trials. This skill was not evaluated in the 3 year old group, as children of this age usually are not capable of jumping for distance (Cratty, 1986; Haywood, 1992).

**Hopping** (Ulrich, 1985). The test entailed two trials of hopping forward on one leg as many times as possible, up to a maximum of 12 jumps. The higher score was taken. Hopping was tested on both legs.

**One leg balance** (Henderson & Sugden, 1992). The test entailed two trials of balancing on one foot, with the arms hanging at the sides, for as long as possible up to a maximum of 12 seconds. The subject was instructed to stand with the free leg bent backwards at the knee so that the foot was positioned behind the standing leg. The bent leg had to be kept off the floor and away from the supporting leg. Swaying was allowed, and the arms were allowed to move from the sides. Balancing was tested on both legs.

**Catching** (Bruininks, 1978; Ulrich, 1985; Henderson & Sugden, 1992). The test measured the ability to catch an aerial, underhand thrown ball, 20-cm. in diameter, with two hands. The thrower was positioned 2 meters from the subject. The score was the number of successful catches out of 4 throws.

Every test was conducted by the researcher, and every child was videotaped individually, from the side, by a trained assistant. The researcher then scored each subject’s performance after analyzing the video recording.

**Data analysis**

All calculations were done for descriptive purposes using the Statistica for Windows (6.0) computer program (Statsoft, 1995). As this study was done on a non-randomized, selected group of subjects, analyzing groups for statistical significance is not recommended by statisticians (Cohen, 1988; Steyn, 1999) and was therefore not established. However, because this is a
complete population, practical significance of the differences between the O-subjects and the
NO-groups of subjects were established, as recommended as an appropriate method by Cohen
the following steps were followed to establish practical significance (effect sizes, ES). Firstly,
the difference between the score of each paired group of nonobese subjects and that of the age-
matched obese or overweight subject, which did not differ more than 3 months, in every gross
motor test was determined by subtracting the second (O-subject's) score from the first
(NO-subject's) score. Secondly, the average of the differences and the standard deviation of the
differences in every test was determined for each age group separately (subjects were classified
as 3, 4, 5, and 6 year olds according to their last birthday). Practical significance was then
established for each age group by calculating the effect sizes of differences established between
the O-groups and the NO-groups. This was done by dividing the average difference in every test
by the standard deviation of the differences in every test. The guideline values for practical
significance recommended by Cohen (1988) and Steyn (1999) of ES = 0.2, which is considered
of little practical significance (small effect) and therefore not considered to be significant in this
study; ES = 0.5 which is considered of practical significance of a medium effect, and ES = 0.8
which is considered to be of a large effect, were used.

Results

Prevalence of overweight and obesity

Thirteen overweight and obese subjects were identified, representing 11.81% of the total group.
From this group of thirteen, 8 subjects (7.27%) were overweight and 5 (4.55%) obese.
Furthermore, the 3 year-old O-group represented 18.18% (9.09% overweight and 9.09% obese)
of their specific age group, the 4 year old group 5.88% (2.94% overweight and 2.94% obese), the
5 year old O-group 6.25% (3.13% overweight and 3.13% obese) and the 6 year old O-group
27.27% (27.27% overweight) of their respective total age groups. The average body composition
values of the O groups and the NO groups are presented in Table 1.

The results of Table 3 show that differences of large effects were established in percentage body
fat in every age group, while, except for the 6 year old group (medium effect), large effects were
also established for BMI indexes between the two groups.
Table 1: Mean age and body composition values of overweight and obese (O) 
\((n=13)\) and nonobese (NO) \((n=54)\) groups used in the study \((N=67)\).

<table>
<thead>
<tr>
<th>Body composition measurement</th>
<th>3 years</th>
<th>4 years</th>
<th>5 years</th>
<th>6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n=6) (n=13) (n=21) (n=20) (n=2) (n=6) (n=3) (n=7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (year.month)</td>
<td>3.06</td>
<td>3.05</td>
<td>4.03</td>
<td>4.04</td>
</tr>
<tr>
<td>(SD)</td>
<td>0.03</td>
<td>0.03</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Triceps (mm)</td>
<td>16.00</td>
<td>9.83</td>
<td>16.25</td>
<td>9.75</td>
</tr>
<tr>
<td>(SD)</td>
<td>3.74</td>
<td>2.48</td>
<td>1.06</td>
<td>2.65</td>
</tr>
<tr>
<td>Subscapular (mm)</td>
<td>15.17</td>
<td>6.90</td>
<td>16.75</td>
<td>7.23</td>
</tr>
<tr>
<td>(SD)</td>
<td>8.70</td>
<td>2.07</td>
<td>8.13</td>
<td>2.59</td>
</tr>
<tr>
<td>(SD)</td>
<td>12.80</td>
<td>3.03</td>
<td>3.18</td>
<td>2.74</td>
</tr>
<tr>
<td>Body height (m)</td>
<td>1.00</td>
<td>0.97</td>
<td>1.09</td>
<td>1.08</td>
</tr>
<tr>
<td>(SD)</td>
<td>0.05</td>
<td>0.04</td>
<td>0.28</td>
<td>0.06</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>18.83</td>
<td>14.83</td>
<td>24.50</td>
<td>18.55</td>
</tr>
<tr>
<td>(SD)</td>
<td>1.94</td>
<td>2.00</td>
<td>4.95</td>
<td>2.07</td>
</tr>
<tr>
<td>BMI (Body mass index)</td>
<td>18.75</td>
<td>15.76</td>
<td>20.53</td>
<td>15.81</td>
</tr>
<tr>
<td>(SD)</td>
<td>1.85</td>
<td>1.45</td>
<td>3.10</td>
<td>1.15</td>
</tr>
<tr>
<td>MVRS</td>
<td>3.67</td>
<td>1.29</td>
<td>3.50</td>
<td>1.25</td>
</tr>
<tr>
<td>(SD)</td>
<td>0.01</td>
<td>0.66</td>
<td>0.50</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Note. BMI = Body mass index; MVRS = Marshall Visual Rating Scale score.

Results of gross motor tests
The average scores achieved in each gross motor test in the different age groups, are presented in Table 2. From these values it is clear that differences favouring the NO-group were found in either the quantitative or qualitative, and sometimes both, evaluations of all 4 components in all the age groups.
Table 2: Mean values for the different gross motor tests in obese and overweight (O) groups and nonobese (NO) groups

<table>
<thead>
<tr>
<th>Test</th>
<th>3 years</th>
<th>4 years</th>
<th>5 years</th>
<th>6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O (n=6)</td>
<td>NO (n=21)</td>
<td>O (n=2)</td>
<td>NO (n=20)</td>
</tr>
<tr>
<td>Long jump quant. (cm.)</td>
<td>M 77.00</td>
<td>M 86.16</td>
<td>M 109.00</td>
<td>M 112.17</td>
</tr>
<tr>
<td>SD</td>
<td>14.14</td>
<td>22.67</td>
<td>1.34</td>
<td>11.74</td>
</tr>
<tr>
<td>Long jump qual.</td>
<td>M 1.50</td>
<td>M 2.05</td>
<td>M 2.50</td>
<td>M 2.83</td>
</tr>
<tr>
<td>SD</td>
<td>0.71</td>
<td>0.52</td>
<td>0.71</td>
<td>0.41</td>
</tr>
<tr>
<td>Hopping L quant.</td>
<td>M 1.50</td>
<td>M 3.05</td>
<td>M 4.00</td>
<td>M 6.70</td>
</tr>
<tr>
<td>SD</td>
<td>0.55</td>
<td>3.19</td>
<td>2.83</td>
<td>3.04</td>
</tr>
<tr>
<td>Hopping L qual.</td>
<td>M 1.08</td>
<td>M 1.33</td>
<td>M 1.50</td>
<td>M 1.80</td>
</tr>
<tr>
<td>SD</td>
<td>0.24</td>
<td>0.48</td>
<td>0.71</td>
<td>0.41</td>
</tr>
<tr>
<td>SD</td>
<td>1.51</td>
<td>3.58</td>
<td>2.83</td>
<td>3.43</td>
</tr>
<tr>
<td>Hopping R qual.</td>
<td>M 1.08</td>
<td>M 1.48</td>
<td>M 2.08</td>
<td>M 1.85</td>
</tr>
<tr>
<td>SD</td>
<td>0.24</td>
<td>0.51</td>
<td>0.24</td>
<td>0.37</td>
</tr>
<tr>
<td>Balance L quant. (sec)</td>
<td>M 3.17</td>
<td>M 3.05</td>
<td>M 3.08</td>
<td>M 5.90</td>
</tr>
<tr>
<td>SD</td>
<td>2.04</td>
<td>1.66</td>
<td>0.24</td>
<td>2.43</td>
</tr>
<tr>
<td>Balance L qual.</td>
<td>M 1.33</td>
<td>M 1.52</td>
<td>M 1.08</td>
<td>M 1.80</td>
</tr>
<tr>
<td>SD</td>
<td>0.52</td>
<td>0.51</td>
<td>0.24</td>
<td>0.41</td>
</tr>
<tr>
<td>Balance R quant.</td>
<td>M 2.83</td>
<td>M 3.76</td>
<td>M 3.50</td>
<td>M 5.00</td>
</tr>
<tr>
<td>SD</td>
<td>2.14</td>
<td>2.62</td>
<td>0.71</td>
<td>2.66</td>
</tr>
<tr>
<td>Balance R qual.</td>
<td>M 1.33</td>
<td>M 1.52</td>
<td>M 1.50</td>
<td>M 1.90</td>
</tr>
<tr>
<td>SD</td>
<td>0.52</td>
<td>0.51</td>
<td>0.71</td>
<td>0.55</td>
</tr>
<tr>
<td>Catching quant.</td>
<td>M 3.50</td>
<td>M 3.86</td>
<td>M 4.00</td>
<td>M 3.95</td>
</tr>
<tr>
<td>SD</td>
<td>1.22</td>
<td>0.65</td>
<td>0.01</td>
<td>0.22</td>
</tr>
<tr>
<td>Catching qual.</td>
<td>M 1.33</td>
<td>M 1.76</td>
<td>M 1.50</td>
<td>M 2.05</td>
</tr>
<tr>
<td>SD</td>
<td>0.52</td>
<td>0.54</td>
<td>0.71</td>
<td>0.39</td>
</tr>
</tbody>
</table>

M = Mean  Quant. = quantitative score  Qual. = qualitative score: 1 = initial phase; 1.5 = transitional phase between initial and elementary phase; 2 = elementary phase; 2.5 = transitional phase between elementary and mature phase; 3 = mature phase. - = not evaluated.

Differences of practical significance are represented in Table 3 and summarized in Table 4.
Table 3: Means, standard deviations and effect sizes of the differences between the obese and overweight group (O), and the nonobese group (NO)

<table>
<thead>
<tr>
<th></th>
<th>3 years (n=27)</th>
<th>4 years (n=22)</th>
<th>5 years (n=8)</th>
<th>6 years (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>ES</td>
<td>M</td>
</tr>
<tr>
<td>BMI</td>
<td>-4.18</td>
<td>1.45</td>
<td>-2.88**</td>
<td>-3.04</td>
</tr>
<tr>
<td>Long jump quant. (cm)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6.00</td>
</tr>
<tr>
<td>Long jump qual.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.00</td>
</tr>
<tr>
<td>Hopping L quant.</td>
<td>1.38</td>
<td>3.19</td>
<td>0.43</td>
<td>1.69</td>
</tr>
<tr>
<td>Hopping L qual.</td>
<td>0.33</td>
<td>0.48</td>
<td>0.69*</td>
<td>0.23</td>
</tr>
<tr>
<td>Hopping R quant.</td>
<td>1.67</td>
<td>3.55</td>
<td>0.47</td>
<td>-1.00</td>
</tr>
<tr>
<td>Hopping R qual.</td>
<td>0.48</td>
<td>0.51</td>
<td>0.93**</td>
<td>-0.31</td>
</tr>
<tr>
<td>Balancing L quant. (sec)</td>
<td>-0.33</td>
<td>2.83</td>
<td>-0.12</td>
<td>0.38</td>
</tr>
<tr>
<td>Balancing L qual.</td>
<td>0.29</td>
<td>0.78</td>
<td>0.37</td>
<td>0.08</td>
</tr>
<tr>
<td>Balancing R quant.</td>
<td>1.38</td>
<td>3.38</td>
<td>0.36</td>
<td>1.46</td>
</tr>
<tr>
<td>Balancing L qual.</td>
<td>0.29</td>
<td>0.78</td>
<td>0.36</td>
<td>0.15</td>
</tr>
<tr>
<td>Catching quant.</td>
<td>0.14</td>
<td>1.15</td>
<td>0.12</td>
<td>0.00</td>
</tr>
<tr>
<td>Catching qual.</td>
<td>0.57</td>
<td>0.75</td>
<td>0.75*</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Note: $M =$ mean difference between O and NO group; $ES =$ effect size; ** = medium effect; *** = large effect; - = not evaluated

Table 4: Effect sizes of medium or large effects, favouring the NO-group, found in the gross motor tests in the different age groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>QUANTITATIVE TESTS</th>
<th>QUALITATIVE TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium effect (ES≥0.5)</td>
<td>Large effect (ES≥0.8)</td>
</tr>
<tr>
<td>Long jump</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hopping L</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hopping R</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Balancing L</td>
<td>6 years</td>
<td>5 years</td>
</tr>
<tr>
<td>Balancing R</td>
<td>6 years</td>
<td>5 years</td>
</tr>
<tr>
<td>Catching</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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Differences of practical significance were found in the qualitative tests only for hopping and catching in all the age groups except for the 4 year olds, while quantitative and qualitative differences of practical significance were found for balancing in the 5 and 6 year old groups only. No significant differences were found for the standing long jump in any of the age groups, except for the 6 year olds, and only on a qualitative level. No significant differences of a medium or large effect were found between the 4 year old O and NO groups in any of the tests. However, it could be noted that the test scores, which constituted differences with small effects, were the quantitative and qualitative scores for hopping on the left leg and the quantitative score for balancing on the right leg. These small effects might be seen as a tendency toward emerging differences, which can be seen as corresponding with the hopping and balancing differences found.

Balance on the left leg (quantitative score) in the 3 year old O-group and hopping on the right leg (quantitative scores and qualitative scores) and catching (quantitative score) in the 4 year old group were scored higher than NO 3 year olds and 4 year olds respectively (Table 2). Hopping on the left leg (qualitative score) in the 5 year old group and qualitative hopping on the right leg in the 6 year old group scored slightly higher in the O-group. None of these differences was, however, of practical significance.

Discussion

The prevalence of 8 overweight (7.27%) and 5 obese (4.55%) children found in this study, totaling 11.81% of the total group, correspond to the reported prevalence of overweight among preschool urban children in South Africa, of 12% (NFCS, 2000). These percentages are also higher or consistent with the estimated prevalence of obesity among preschool children in the U.K. and Canada of 3% and 6% (Epstein & Higgins, 1992) and overweight among American children of 11-24% (Flegal, 1999; Ganley & Sherman, 2000). The age period of around 5-6 years is considered to be one of the periods of growth during which the risk for obesity is markedly increased (Goran et al., 1999). However, the high percentage of overweight and obese subjects in the 3 year old age group (18.18%) seems to support the suggestion of Bar-Or et al. (1998) and Goran et al. (1999), that an even earlier age period might be a period of high risk for the development of overweight or obesity.
The fact that no medium or large effects were established with regard to any test scores in the 4 year old group, could possibly be attributed to the large standard deviations of the differences in the specific skill tests in this group, indicated in Table 3. Three girls from the NO-group, especially, had extremely low scores in almost every test. However, the small effects found in the hopping and the balancing tests (ES≥0.2), corresponds to the medium and large effects found regarding these skills in the other age groups.

Regarding hopping and / or balancing on one leg, practical significance with medium or large effects favouring the NO-group was found in every age group but the 4 year old group (where small effects were found) (Table 3). Both these skills are dependent on good balancing ability. The point of gravity shifts and the base of support (the feet) becomes smaller when a person’s body size increases (Haywood, 1992). This factor, as well as the lower strength-to-weight ratio of obese children, could effect performance in these skills (Raudsepp and Jüirimäe, 1996). Such a child would then be forced to use compensating movements with the arms and upper body in order to maintain equilibrium, resulting in poorer qualitative control, as was indeed the case. Poor balance skills can be detrimental to the development of all other gross motor skills, as balance and posture control are the basis for the development of all gross motor skills (Auxter et al., 1997; Gallahue & Ozmun, 1998). The negative influence of obesity on these skills seems evident from these findings.

No medium or large effects were found in favour of the NO-group regarding the quantitative scores of the standing long jump in any of the age groups. This is contradictory to the findings of Hensley and Whitfield (1982) and Raudsepp and Jüirimäe (1996), namely that adiposity is related to motor skills in which the body has to be moved from one place to another. However, the differences found in hopping ability (qualitative, left leg, 3 and 6 years; qualitative, right leg, 3 and 5 years) corresponds to these findings. The non-significant differences with regard to the standing long jump in the 3, 4 and 5 year old groups in this study are also in contrast to the results found in the study on the difference in motor skills between obese and nonobese boys (Du Toit & Pienaar, 2000), where the O-group showed poorer scores in the long jump than the NO boys, although only regarding the quantitative scores.

In comparison to the 3 and 4 year olds, larger effect sizes were found in the motor skills tests of the 5 and 6 year old groups, also showing greater effect sizes concerning percentage body fat.
This seems to indicate that an increase in level of obesity would be related to larger differences in motor proficiency between obese and nonobese children.

In the study on differences in motor skills between obese and nonobese boys, no differences were found between the O-group and the NO-group with regard to the qualitative performance of catching in the 4, 5, and 6 year old groups (Du Toit & Pienaar, 2000). In contrast, the girls in this study showed practically significant differences with regard to the qualitative scores of the 3 (ES=0.75), 5 (ES=2.04) and 6 (ES=0.63) year olds, contradicting the findings of Raudsepp and Jüirimäe (1996), that adiposity is related to motor items in which the body is projected or moved, but not to static items such as catching. However, their studies were based on results obtained on older subjects. Possibly, the overweight and obese subjects in this study, by avoiding or not participating regularly in physical activities, have not acquired the age-appropriate stage of qualitative development for which sufficient movement experiences is needed, even though they have developed the perceptual- and spatial abilities to catch accurately. As games with balls tend to be less part of girls’ play than that of boys’ play (Hands & Larkin, 1997), this could also be a contributing factor to this result.

From the results summarized in Table 4, it is evident that the motor skills of the older overweight and obese girls (5 and 6 year olds) were overall affected to a larger degree than the younger girls, especially the qualitative nature of their motor skills, although it had a detrimental effect on both the quantitative and qualitative performance of balancing skills at 5 and 6 years of age. These findings seem to suggest that overweight and obesity may have a larger detrimental effect on the gross motor skills of girls at later ages. According to Hoare and Larkin (1991) and Pratt et al. (1999), levels of physical activity decrease as girls age, and to a greater degree than boys. These decreasing levels of physical activity, in concord with overweight and obesity, could be a possible explanation for the larger differences in the scores of the motor skills seen in the older age groups.

**Conclusion**

To summarize, the results of this study show that there is a relatively high prevalence of overweight and obesity in this selected group of preschool girls in Potchefstroom. They also show a relationship between several gross motor skills and overweight and obesity in the preschool years. These results are in accordance with other studies researching the same topic,
except for differences found in qualitative execution of catching skills where obesity in this study only seemed to be detrimental to the quality of these skills at ages as young as 3 years.

The results obtained with this study should be evaluated in the light of the following limitations, lessening the measure of generalizability. Firstly, a comparatively small, and a selected, group of subjects was used. Secondly, the number of subjects in the 5 and 6 year-old groups was relatively small. Bearing these limitations in mind, but also the significant differences found in this study, it is suggested that future research should be conducted to further examine the problem, but that they should make use of larger, and if possible randomly selected populations. It is possible that clearer differences might be obtained between groups if the classification of obesity (excluding overweight) is applied, thus comparing an obese group to a nonobese group. This may also limit the possibility of classification errors, which can be a problem at this young age due to large variation in the rate of growth. To account for different growth rates, the controlling of biological age together with chronological age is recommended in such comparisons, as children of the same chronological age grow at different rates.

One of the primary goals for people working with preschool children should be to optimize the development of gross motor skills in this critical period via sufficient and frequent physical activity. Acquisition of fundamental motor skills is essential to develop a healthy lifestyle and to participate in health-enhancing activities in later life, thus preventing obesity. Giving children of these young ages the stimulation and opportunities to develop these skills in order to develop a good self-image and a love for physical activity, could have a long-lasting effect on health behaviour and prevent the vicious cycle of a sedentary lifestyle, growing overweight, obesity and the concurrent health risks.
References


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Chapter 6
Research article 4

Current status and assessment of quantitative and qualitative one leg balancing ability in 3 - 6 year old children
CURRENT STATUS AND ASSESSMENT OF QUANTITATIVE AND QUALITATIVE ONE LEG BALANCING ABILITY IN 3-6 YEAR OLD CHILDREN

Abstract

Qualitative assessment (the developmental quality of the movement), of the one leg balance is not as commonly used as quantitative assessment (the measurable time in seconds), possibly prohibiting the accurate identifying of balance problems. The purpose of this study was to determine the current status of the quantitative and qualitative balancing ability in a selected group of South African children, and to examine the interrelationships between the quantitative and qualitative results of 3-6 year old children as to propose a more accurate assessment of the one leg balance. The subjects \( N = 514 \), aged 3-6 years, were quantitatively and qualitatively assessed using valid norms and criteria found in the literature. The effect sizes measuring the relationship between the quantitative and qualitative assessments as determined by the Phi-score, showed a large effect for the 4 year olds \( (ES >0.8) \), and small effects for the 5 and 6 year olds \( (ES >0.2) \). A relatively large percentage \( (44.10\%) \) of 3 year olds scored well above the average level for their age in both the quantitative and qualitative assessment, indicating that the norms and criteria used might not be appropriate for 3 year olds. Relatively large percentages \( (25.27\% - 27.47\%) \) of the 6 year olds scored below the average level for 5 year olds in the qualitative assessment, suggesting developmental balance delays or disorders that might not have been identified by means of only a quantitative assessment. These findings indicate that, when evaluating the one leg balance in children aged 3-6 years, a quantitative and qualitative assessment should be used in combination together to assure a more accurate assessment.

Key words: Qualitative assessment, quantitative assessment, one leg balance, preschool, gross motor development

Introduction

Balance is considered to be fundamental to gross motor development (Butterfield & Loovis, 1994: 692; Auxter et al., 1997: 190), as all gross motor skills require some element of balance (Clark & Watkins, 1984: 854; Ulrich & Ulrich, 1985:87). Proper development of static and dynamic balance skills is therefore considered to be essential in the development of gross motor
skills in children. In this regard, Ulrich and Ulrich (1985:87) observed that balance is most effective as a predictor of motor skill development among very young children (ages 3–5). According to Williams et al. (1983), lack of balance control is a characteristic common to developmentally delayed and motorically awkward children. Balance problems are therefore of concern to professionals working with the motor development of children in South Africa, as the prevalence of developmental delays and motorical awkwardness among children in South Africa is estimated to be between 5% and 15% (Pienaar, 1994: 125).

It is therefore not surprising that balance assessment items form part of established motor or movement skill assessment batteries (Bruininks, 1978; Ulrich, 1985; Henderson & Sugden, 1992), as well as batteries developed for neurological screening purposes (Mutti et al., 1998). Static balance is commonly assessed in these test batteries by recording the time in seconds that the child is able to balance on one leg. This test, however, measures only the quantitative execution (the measurable time in seconds) of the specific skill. Quantitative norms for this skill in every age group from 3-6 years have been studied and defined in several studies (Cratty, 1979: 50; Arnheim & Sinclair, 1979:136; Henderson & Sugden, 1992: 52; Reeves, 1997:340; Goshi et al., 1999: 172).

The qualitative execution and development of a motor skill is also considered of great importance (Mutti et al., 1998: 11; Goshi et al., 1999:170; Knudson, 2000:19) as the learning of incorrect methods and techniques in the execution of a motor skill can be detrimental to further development and refining into related or more advanced skills (e.g. balancing on one leg being refined into the hopping skill and later the skipping skill). The qualitative assessment of the proper mechanics, or the process of movement, is especially relevant at the ages of 3-6, as children are learning and developing new motor skills (Gallahue, 1996), and it serves as a guideline for the design of movement development programs for children of these ages.

Qualitative assessment, however, is less commonly used when evaluating the one leg balance in 3 – 6 year old children. The reasons for this could be a lack of knowledge and time to do this type of evaluation, as it requires a knowledgeable person and more time than needed for a quantitative evaluation (Gallahue, 1996). The fact that qualitative assessment is usually subjective can also contribute to it being used less often. However, according to Gallahue (1996), both the (objective) quantitative assessment and the (subjective) qualitative assessment have an
important place in the developmental curriculum as the use of both makes the assessment process more accurate. The stage concept of motor development during early childhood (2-7 years) involves qualitatively classifying individuals at different stages of development of a fundamental movement skill (Gallahue & Ozmun, 1995: 226). The three popular methods of charting the stage classification of children are the segmental analysis approach, where the separate components of movement within a given pattern are analyzed (Roberton, 1982: 294); the total body configuration approach, where an overall stage classification score is assigned (Seefeldt & Haubenstricker, 1982: 309); and a combination of the above two methods to qualitatively classify an individual at a developmental stage (Gallahue & Ozmun, 1995: 226). According to Gallahue & Ozmun (1995), the latter system offers a practical and reliable system for classifying individuals at the initial, elementary and mature stage in a given fundamental movement skill. If this qualitative classifying system of developmental stages could be used as a means of evaluating the one leg balance qualitatively together with the results of the quantitative assessment, this might contribute to a more accurate assessment process.

Therefore, it is hypothesized that by using both a quantitative assessment and a qualitative stages evaluation when assessing balance, problems in this area can be identified and development evaluated with more clarity. If a child can score well in a quantitative assessment, but poorly in the qualitative assessment of the same skill (e.g. balancing on one leg for the required time but showing extensive arm movements), this could indicate an existing balance problem which would otherwise not have been recognised through a quantitative assessment alone. According to Haywood (1986) it is also possible that at certain ages and on certain tasks, especially balance tasks, children attempt a more mature qualitative performance pattern with a resulting, presumably temporary, decline in quantitative score. The identification of any problems in balance is extremely important in the 3-6 year age period, as this is the primary developmental period for balance and related gross motor skills (Gallahue & Ozmun, 1995: 86). Intervention of such problems is imperative in these early years in order to prohibit further gross motor development delays. If the developmental stages of the one leg balance in 3-6 year old children according to the classification system of Gallahue and Ozmun (1995) correlates with the quantitative norms for this skill as found in the literature (Bruininks, 1978: 53; Gustafson-Munro, 1985: 15; Henderson & Sugden, 1992: 52) it would be an indication that these qualitative developmental criteria could be used as a useful qualitative evaluation for static balance at these ages. The primary purpose of this study is therefore to determine if the use of both the
quantitative and qualitative assessment is a more comprehensive way of assessing static balance in children of these ages. To determine this, the following questions have to be answered: Firstly, what is the current status of quantitative and qualitative one leg balancing ability in a selected group of 3-6 year old children in South Africa, and secondly, what is the relationship between quantitative norms and qualitative developmental criteria for the one leg balance test in these 3-6 year old children?

Procedures

Subjects
The number of subjects included in this study were 514 children (254 male and 260 female), of the ages 3 (n=161, 81 male and 80 female); 4 (n=146, 70 male and 74 female); 5 (n=116, 51 male and 65 female) and 6 (n=91, 52 male and 39 female) years respectively. Age was defined by the subject's last birthday. The mean age in months for the 3, 4, 5 and 6 year olds was (year.month) 3.06 ± 0.03; 4.05 ± 0.03; 5.06 ± 0.03 and 6.04 ± 0.03 respectively. All subjects had been enrolled in the movement development program (which is an optional program) presented by movement developmentalists of the Potchefstroom University for Christian Higher Education (P.U. for C.H.E.). This program is being presented on the premises of 10 preprimary schools in Potchefstroom, as well as at the movement development research center of the university.

Assessment procedures
All the subjects were evaluated before the implementation of the program. The movement development program would be presented in weekly classes, consisting of a variety of movement activities designed to stimulate and develop gross motor development. Informed consent was obtained from the parents for each subject to participate in the research. The evaluations were conducted on the premises of the schools and at the movement development research center at the university. Each child was videotaped from the side by a trained assistant and analyzed afterwards by the researcher.

Quantitative assessment
The test entailed two trials of balancing on each leg with open eyes for as long as possible to a ceiling time of 12 seconds. The free leg had to be bent and the foot held behind the supporting leg and the hands placed on the hips (Henderson & Sugden, 1992: 52; Mutti et al., 1998: 30). A trial was ended if the subject's support foot moved before the duration of 12 seconds. The higher score in each test was recorded in seconds, using a stopwatch. The preferred leg was tested first. In the 4, 5 and 6 year olds, the test was also conducted with closed eyes, as the qualitative criteria
included the ability to balance with closed eyes, although these results were not interpreted for the purpose of this study.

**Qualitative assessment**

To obtain a qualitative score, the developmental characteristics of the performed skill was analyzed and compared to the developmental stage criteria of the expanded version of the Fundamental Movement Pattern Assessment Instrument (FMPAI) (Gallahue, 1996) for the one leg balance in children of the ages 2-7 years (Table 1).

**Table 1: Developmental stages of the one leg balance (adapted from Gallahue & Ozmun, 1995) used as qualitative criteria**

<table>
<thead>
<tr>
<th>INITIAL STAGE</th>
<th>ELEMENTARY STAGE</th>
<th>MATURE STAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Raises nonsupporting leg several inches so that thigh is nearly parallel with contact surface</td>
<td>1. May lift non-supporting leg to a tied-in position on support leg</td>
<td>1. Can balance with closed eyes</td>
</tr>
<tr>
<td>2. Either in or out of balance (no in-between)</td>
<td>2. Cannot balance with closed eyes</td>
<td>2. Uses arms and trunk as needed to maintain balance</td>
</tr>
<tr>
<td>3. Overcompensates (“windmill arms”)</td>
<td>3. Uses arms for balance but may tie one arm to side of body</td>
<td>3. Lifts nonsupporting leg</td>
</tr>
<tr>
<td>4. Inconsistent leg preference</td>
<td>4. Performs better on dominant leg</td>
<td>4. Focuses on external object while balancing</td>
</tr>
<tr>
<td>5. Only momentarily balance without support</td>
<td>5. Can go into controlled balance, although not held for long</td>
<td>5. Changes to nondominant leg without loss of balance</td>
</tr>
<tr>
<td>6. Eyes directed at feet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to Gallahue (1996), the FMPAI has proven to be highly reliable among trained observers and content validity has been established for the fundamental movements. According to this system, the performed skill can qualitatively be classified into one of the three stages of fundamental motor development, namely the initial stage, the elementary stage and the mature stage. A score of (1) was awarded if the skill was classified as being in the initial stage of development, (2) if it was in the elementary stage, and (3) if it was classified as being in the mature stage. If the subject showed developmental characteristics of more than one stage, the skill was classified according to the stage of which the highest number of characteristics were present.
To compare the quantitative and qualitative scores, cut-off points for the quantitative and qualitative scores had to be established in order to give a below average or an average or above average rating to the execution of the skill by the subjects in every age group. As cut-off points in the quantitative assessment, the minimum scores reported in the literature (Gustafson-Munro, 1985: 15; Johnston et al., 1987: 159; Olie, 1990: 13; Henderson & Sugden, 1992: 52; Meaney, 1993: 21; Auxter et al., 1997: 256; Mutti et al., 1998: 68; Goshi et al., 1999: 172) as average values for each age group, were used (Table 2). Thus, if a subject scored lower than the cut-off point in the quantitative assessment, his or her quantitative score would be considered below average and would be recorded as such. If a subject had the same score or higher than the cut-off point, his or her score would be considered average or above average and would be recorded as such.

Table 2: Quantitative norms for the one leg balance

<table>
<thead>
<tr>
<th>3 years</th>
<th>4 years</th>
<th>5 years</th>
<th>6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3 seconds</td>
<td>2-7 seconds</td>
<td>8-10 seconds</td>
<td>10-12 seconds</td>
</tr>
<tr>
<td>(Olie, 1990; Meaney, 1993; Gallahue &amp; Ozmun, 1995)</td>
<td>(Gustafson-Munro, 1985; Auxter et al., 1997; Goshi, 1999)</td>
<td>(Gustafson-Munro, 1985; Johnston et al., 1987; Olie, 1990; Mutti et al., 1998)</td>
<td>(Gustafson-Munro, 1985; Henderson &amp; Sugden, 1992; Meaney, 1993)</td>
</tr>
</tbody>
</table>

In the case of the 3 year olds, no cut-off point was established for the minimum quantitative score as the average ability of balancing on one leg reported for 3 year olds is 1-3 seconds, or “momentarily” to 3 seconds (Olie, 1990: 13; Meaney, 1993: 21; Gallahue & Ozmun, 1995: 241). As the 3 year olds could therefore not score lower than this minimum value, a score higher than 3 seconds was used as a cut-off point in order to determine the percentage of 3 year olds scoring above average for their age.

According to Gallahue (1996), 2-3 year olds are usually in the initial stage, 4-5 year olds in the elementary stage and 6-7 olds in the mature stage of motor development. The developmental stage that a subject should usually be in at his or her age, as above, was used as a cut-off point. For instance, if the one leg balance of a 6 year old was classified as being in the elementary stage, the...
qualitative score for the skill was considered below average and was recorded as such. Again, no cut-off point was established for the qualitative scores of the 3 year olds, as children are usually in the initial stage at this age (Gallahue & Ozmun, 1995: 83) and no lower score than (1) could be awarded. In this case, a score higher than (1) was used as a cut-off point in order to determine the percentage of 3 year olds scoring above average for their age in the qualitative assessment.

**Data analysis**

All calculations were done using the Statistica computer program (Statsoft, 1995). The results of the quantitative and qualitative assessments of every subject were classified as below average or average or above average according to the cut-off points as explained above. A 2-way frequency table (Table 3) was drawn up to show the frequencies of subjects scoring below average or average or above average in four possible combinations of the quantitative and qualitative scores. The Pearson Chi-square as well as the Phi for 2-way tables was also calculated for each age group to determine the significance of the relationship, if any, between the quantitative and qualitative scores. If a p ≤ 0.05 was found, the Chi square (C) was interpreted using the following criteria which is consititated by Cohen (1988) as guideline values: ES = 0.2 constituted a small effect of practical significance; ES = 0.5 constituted a medium effect, and ES = 0.8 constituted a large effect (Steyn, 1999: 3). Data of the 3 year olds were not analyzed in this manner.

A cross-sectional box plot graph was also drawn up to compare the developmental curves of quantitative and qualitative development of the subjects.

**Results**

The frequencies of the subjects' levels of quantitative and qualitative scoring are presented in Table 3 and Table 4. From Table 3 it can be seen that the 5 year old group showed the highest percentage of subjects scoring below average in the quantitative assessment (39.66%, left leg and 31.03%, right leg), followed by the 6 year old group (27.47%, left leg and 25.27%, right leg) and the 4 year old group (5.48%, left leg and 9.59%, right leg). In the qualitative assessment, the 6 year old group showed the highest percentage of subjects scoring below average for their age (17.59%, left leg and 25.28%, right leg), followed by the 5 year old group (7.76%, left leg, 7.77%, right leg) and the 4 year old group (6.85%, left leg; 6.85% right leg).
Table 3: Percentages of below average and average or above average quantitative and qualitative scores for the one leg balance of 4-6 year old subjects (N = 353)

<table>
<thead>
<tr>
<th>Age group</th>
<th>QUANTITATIVE (seconds)</th>
<th>QUALITATIVE (stage)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Below average</td>
<td>Average or above average</td>
</tr>
<tr>
<td>4 years</td>
<td>L</td>
<td>5.48</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>9.59</td>
</tr>
<tr>
<td>5 years</td>
<td>L</td>
<td>39.66</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>31.03</td>
</tr>
<tr>
<td>6 years</td>
<td>L</td>
<td>27.47</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>25.27</td>
</tr>
</tbody>
</table>

L = score for balancing on left leg; R = score for balancing on right leg

From Table 4 it is clear that relatively few subjects (4.11% -13.19%) scored below average in both the quantitative and qualitative assessments, while the percentages of subjects scoring below average in the quantitative but average or above average in the qualitative assessment ranged from 1.37% to 31.90%. Subjects scoring below average in the qualitative assessment but average or above average in the quantitative assessment, ranged from 0.00 - 13.19%, while subjects scoring average or above average in both assessments ranged from 60.43% - 91.78%.

Of the 4 year old subjects, 91.78% (left leg) and 89.04% (right leg) scored average or above average (≥ 2 seconds and in the elementary stage of development) in the quantitative and qualitative assessment of the one leg balance. Only 60.34% (left leg) and 68.96% (right leg) of the 5 year olds obtained average or above average scores (≥ 8 seconds and in the elementary stage) in both types of assessments, while only 68.13% (left leg) and 61.54% (right leg) of the 6 year olds were at or above the cut-off points (≥ 10 seconds and in the mature stage).
Table 4: Percentages of 4-6 year old subjects (N=353) scoring below average and average or above average for their age in different combinations of the quantitative and qualitative scores for the one leg balance.

<table>
<thead>
<tr>
<th></th>
<th>QUANTITATIVE % Below average and QUALITATIVE % Below average</th>
<th>QUANTITATIVE % Below average and QUALITATIVE % Average or above average</th>
<th>QUANTITATIVE % Average or above average and QUALITATIVE % Below average</th>
<th>QUANTITATIVE % Average or above average and QUALITATIVE % Average or above average</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>4.11</td>
<td>1.37</td>
<td>2.74</td>
<td>91.78</td>
</tr>
<tr>
<td>R</td>
<td>5.48</td>
<td>4.11</td>
<td>1.37</td>
<td>89.04</td>
</tr>
<tr>
<td>5 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>7.76</td>
<td>31.90</td>
<td>0.00</td>
<td>60.34</td>
</tr>
<tr>
<td>R</td>
<td>7.77</td>
<td>23.28</td>
<td>0.00</td>
<td>68.96</td>
</tr>
<tr>
<td>6 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>13.19</td>
<td>14.29</td>
<td>4.40</td>
<td>68.13</td>
</tr>
<tr>
<td>R</td>
<td>12.09</td>
<td>13.19</td>
<td>13.19</td>
<td>61.54</td>
</tr>
</tbody>
</table>

L = score for balancing on left leg; R = score for balancing on right leg

The Chi-square and Phi scores for the obtained relationships between the qualitative and quantitative frequencies are shown in Table 5. Statistically significant correlations were found between the quantitative and qualitative scores of the 4 year olds; 5 year olds and 6 year olds, where p ≤ 0.05. The effect sizes measuring the relationship as determined by the Phi-score, showed a large effect for the 4 year olds (ES >0.8), but only small effects in the 5 and 6 year olds (ES >0.2) (Steyn, 1999: 3).

For the 3 year olds, only a 2-way frequency table was drawn up to show the frequencies of subjects scoring average (1-3 seconds and in the initial stage) or above average (above 3 seconds
Table 5: Chi-square and Phi – scores for quantitative and qualitative scores of 4-6 year old subjects.

<table>
<thead>
<tr>
<th></th>
<th>4 years</th>
<th></th>
<th>5 years</th>
<th></th>
<th>6 years</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
<td>R</td>
<td>L</td>
<td>R</td>
<td>L</td>
<td>R</td>
</tr>
<tr>
<td>Pearson Chi-square</td>
<td>132.842</td>
<td>123.275</td>
<td>8.797</td>
<td>12.137</td>
<td>22.008</td>
<td>8.288</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>P-level (p ≤ 0.05)</td>
<td>0.000*</td>
<td>0.000*</td>
<td>0.005*</td>
<td>0.000*</td>
<td>0.000*</td>
<td>0.003*</td>
</tr>
<tr>
<td>Phi for 2x2 tables</td>
<td>0.954</td>
<td>0.918</td>
<td>0.275</td>
<td>0.323</td>
<td>0.491</td>
<td>0.302</td>
</tr>
</tbody>
</table>

and in the elementary stage) in the quantitative and qualitative assessments. This analysis indicated that 44.10% of the 3 year olds scored *above average* in the qualitative assessment and *average* in the quantitative assessment of both the left and the right leg, thus almost half of this age group complied to developmental criteria of the elementary stage. A percentage of 31.29% produced *above average* scores in the quantitative, but *average* scores for the qualitative assessment of balancing on the right leg, and 36.75% had the same scores on the left leg.

Figure 1 shows the developmental curves of mean quantitative and qualitative scores across the ages of the subjects. An upward tendency in quantitative as well as qualitative scores across all the ages is clear, indicating ongoing developmental trends to the age of 7 years.
Discussion

The results show that the qualitative and quantitative development of this selected South African group of 3-6 year old children compares well to the qualitative developmental criteria of the stage classifying system of Gallahue and Ozmun (1995) and to quantitative norms found in the literature (Gustafson-Munro, 1985: 15; Johnston et al., 1987: 159; Olie, 1990: 13; Henderson & Sugden, 1992: 52; Mutti et al., 1998: 68). While the largest percentages of the subjects in each age group produced average or above average scores in both the quantitative and qualitative assessments, though, a noteworthy tendency was established in the percentage of scores across the ages in the qualitative scores. The percentage of subjects scoring average or above average become less as their age increase, while the subjects falling in the category for quantitative scores below average but qualitative scores average or above average, increase from 4 years to 6 years. The percentages of subjects failing to score above the cut-off points in both types of assessments also increased from 4 to 5 and 6 years. This is an alarming tendency, as it would seem to indicate that the static balance skills of this group deteriorate as the subjects age. As balance is considered to play a primary role in the development of all gross motor skills, these results may be indicative of the same kind of tendencies in the development of other gross motor...
skills of this group. However, this is only an observation and further research exploring this phenomenon could therefore be of much significance.

The largest percentages of subjects in all the age groups were found in the category for the average or above average quantitative as well as qualitative scores. These results suggest that there is a correlation between the quantitative norms and the developmental criteria used in this study. This relationship is clearly illustrated in the linear upward curve of both types of assessment scores in Figure 1, while the established Chi-square and Phi values also act as confirmation. The established relationship was especially strong among the 4 year olds. The qualitative and quantitative development of the 3 year old group compares well to the norms and criteria found in the literature (Olie, 1990: 13; Meany, 1993: 21; Gallahue & Ozmun, 1995: 241), as almost half of this group (44.10%) scored higher than the qualitative score accepted as average (1-3 seconds) for this age. As these results suggest that that large percentages of subjects in the other age groups might also have scored above the age-appropriate norms and criteria, a further analysis was done to determine the prevalence of such scores in the 4 and 5 year old age groups. From this it was established that 8.90% (left leg) and 8.22% (right leg) of the 4 year olds (above 7 seconds and in the mature stage of development); 30.17% (left leg) and 29.31% (right leg) of the 5 year olds (above 10 seconds and in the mature stage) scored higher than the upper limits of the average quantitative and qualitative scores for their age. However, further research on the appropriateness of these norms for 3, 4 and 5 year olds in South Africa is advised.

No 5 year old subject fell into the category of qualitatively below average and quantitatively average or above average scores, the reason being that falling into this category would have meant that the subject balanced for 8 seconds but were classified as being in the initial stage. The qualitative criteria for the initial stage excluded any possibility of balancing for that long.

The relatively high percentage of 6 year olds scoring below average in the quantitative assessment (27.47% for the left leg and 25.27% for the right leg) is of concern, as this is the age at which school readiness is tested for in South Africa (Steenhuizen et al., 1994). These figures do not necessarily indicate developmental deficits or disorders, as the developmental stages often overlap and considerable variance is found in the rate of gross motor development of young children (Gallahue & Ozmun, 1995: 226). They do, however, resemble the prevalence for motor deficits or disorders estimated in South African children of 5-15% (Pienaar, 1994: 125).
regard, a further analysis was done to determine the percentage of 6 year old children scoring below the norms and criteria set for 5 year olds in the one leg balance (< 8 seconds and in the elementary stage of development). This analysis showed that between 18.68% (left leg) and 18.74% (right leg) of this group could not attain the norms and criteria appropriate for 5 year old children. As the assessment of the one leg balance forms part of the screening test for school readiness (Steenhuizen et al., 1994: 34), below average balancing ability could influence the scoring of 6 year olds in this test.

**Conclusion**

The results of this study should be interpreted in the light of the following limitations. Although a large group of children participated in this study, a non-randomized group was used, minimizing the generalizability of the results. These children mostly came from a white and middle or higher socio-economic background. Different results might be found if a randomly chosen group, from all socio-economic backgrounds, were used. The enrollment of the children in the movement development program might also be a reflection of the parents’ consciousness of the importance of stimulating their children, and this could also effect the current status of the motor development of these children. Future research, taking this limitation in consideration, is recommended.

Secondly, it was not possible to fit all the children who were assessed, precisely into the three-stage progression of Gallahue and Ozmun (1995). For research and practical purposes, the developmental aspects of the one leg balance may be more completely described in a five-stage sequence, as some children showed characteristics of both the previous and the present stage of the one leg balance that they were finally classified at. Further research is therefore recommended on the defining of developmental criteria for the purpose of classifying children into 5 stages (initial stage, transitional stage between the initial and elementary stage, elementary stage, transitional stage between the elementary and mature stage, and mature stage) of development in the one leg balance. Furthermore, one characteristic observed in this study that might be added to the criteria of the one leg balance, was that overcompensation for balance loss seemed to come in “bursts” that became less prevalent as the children’s ages increased. The 3 year olds (initial stage), for example, seemed to overcompensate with their arms and body movements to adjust to losing their equilibrium, in such a burst that they lost their balance completely to the other side. The six year olds (mature stage) compensated in more subtle, fluent
movements with their arms and trunk. This observation is consistent with the findings of Williams et al. (1983) in their study of static postural control in young children.

A correlation was found between quantitative and qualitative scores in every age group, although the practical significance of the effect was small in the 5 and 6 year old groups. Additionally, as seen in Figure 1, there is an upward tendency in both the quantitative and the qualitative scores across ages, thus as the quantitative scores increase, so do the qualitative scores. These results suggest that the qualitative developmental stages of the one-leg balance can be used as an additional form of assessment together with the quantitative assessment. The results has also shown that a child will not necessarily exhibit good qualitative scores and simultaneously show good quantitative scores in tests for static balance, indicating that balance problems could be identified that might not otherwise have been done through a quantitative or a qualitative assessment alone.

The percentage of subjects failing to adhere to the cut-off points are relatively high to the opinion of the authors. Further research is recommended with regard to the quantitative and qualitative assessments of other fundamental gross motor skills, as these balance assessment scores might be an indication of similar tendencies in other gross motor skills. Further research on the age-appropriateness (for South African children) of the quantitative norms and qualitative criteria used in this study which are commonly used in test batteries and screening tests (Gustafson-Munro, 1985; Henderson & Sugden, 1992; Mutti et al, 1998; Goshi et al., 1999) could also be valuable to professionals working with young children. As differences between male and female children have been reported in the literature (Hands & Larkin, 1997: 13; Van Gelder & Schweitzer, 1999: 31), further research on the differences between the sexes with regard to quantitative and qualitative assessment of the one leg balance could also give a more complete picture with regard to gender differences.

In conclusion, it can be stated that in order to get a complete picture of a child’s static balance skills, especially for screening and diagnostic purposes, it is possible, and even necessary, to do both a quantitative and a qualitative assessment based on age-appropriate norms and developmental stage criteria.
REFERENCES


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Chapter 7

Research article 5

Gender differences in gross motor skills in 3 - 6 year old children in Potchefstroom
GENDER DIFFERENCES IN GROSS MOTOR SKILLS IN 3-6 YEAR OLD CHILDREN IN POTCHEFSTROOM

Controversy exists concerning the occurrence and importance of gender differences in fundamental gross motor skills among preschool children. However, it is accepted that if gender differences do exist, separate norms should be used when assessing gross motor skills. The purpose of this study was to evaluate and compare fundamental gross motor skills in a group of preschool children in Potchefstroom, an urban area in South Africa. A total of 221 3-6 year old male participants was compared to a total of 243 3-6 year old female participants in eight gross motor tasks. The results showed significant gender differences in hopping and balancing on the right leg in favour of the females in the 3 year old group, and in the standing long jump and throwing-for-distance in favour of the males in the 5 and 6 year old groups. Similar differences were found in the tests for standing long jump in the 4 year old group and throwing in the 3 and 4 year old groups, although not statistically significant. These results indicate that separate norms should be used for the different genders when assessing standing long jump and throwing-for-distance in 5 and 6 year olds.

Key words: Gross motor development, preschool children, gender differences

INTRODUCTION

The time span between 2 to 7 years of age is considered to be the critical years of a child's fundamental gross motor development. Therefore it is essential to identify and address any motor development delays or disorders during this period (Gallahue & Ozmun, 1998; Gabbard, 1998). To be able to do this, the use of accurate and valid assessment instruments is essential. However, these requirements are compromised if such a test does not address significant differences between subgroups in a population, such as gender differences (Hands & Larkin, 1997). Such a test runs the risk of bias in favour of the better performing group (Hands & Larkin, 1997). Considerable controversy is found in the literature concerning the occurrence and the importance of gender differences in fundamental gross motor skills in the preschool years, as is reflected in the norms and scoring methods of several established motor assessment batteries. Some well-known tests provide separate norms for males and females in this age group (Arnheim & Sinclair, 1979; Seaman & De Pauw, 1989; Van Gelder & Schweitzer, 1999), while many do not differentiate between genders (Folio & Fewell, 1983; Frankenburg, 1990; Henderson & Sugden, 1992; Johnston, Crawford, Short, Raymond Smyth, & Moller, 1987). In a research review, Thomas (2000) stated that gender differences are insignificant with reference to gross motor skills in the pre-pubertal years, while authors like Sääkslahti et al.(1999) and Ulrich...
and Ulrich (1985) did not find significant differences between genders among preschool children. In contrast, several authors have found significant differences between 3-6 year old boys and girls when assessing fundamental gross motor skills (Butcher & Eaton, 1989; Hands & Larkin, 1997; Morris Williams, Atwater, & Wilmore, 1982; Raudsepp & Pääsuke, 1995; Walkley, Holland, Treloar & Probyn-Smith, 1993). In these studies, common findings were that girls outperformed boys in static balance skills and locomotor skills requiring coordination (among others, skipping and hopping), while boys performed better in skills requiring speed and power (running and long jump) and ball skills. According to Hands and Larkin (1997), one of the reasons for inconsistent research findings regarding gender differences is specific cultural and sociological factors of the tested population. In populations where cultural and sociological expectations differentiate between genders, larger gender differences in motor skill development are often found (Hands & Larkin, 1997; Thomas, Thomas & Gallagher, 1993). It is therefore important that gender differences be examined in the context of a specific population and, if necessary, that specific norms are set (Hands & Larkin, 1997).

As no data could be found on gender differences among preschool children in South Africa, the question arises whether gender differences in gross motor skill development exist among preschool children in South African cities like Potchefstroom, a city with unique cultural and sociological characteristics. If such gender differences do exist, specific norms should be considered for the Potchefstroom preschool population. The aim of this study was therefore to evaluate and compare the performances of 3-6 year old males and females on a variety of gross motor skills, in order to determine the extent of gender differences or similarities in this group of children in Potchefstroom.

METHOD

Participants

The sample consisted of 464 predominantly white 3-6 year old preschool children, of whom 116 3-year-old (52 male and 64 female), 136 4-year-old (67 male and 69 female), 116 5-year-old (54 male and 62 female) and 96 6-year-old (48 male and 48 female). All participants lived in Potchefstroom, came from a middle-class background and had been enrolled in the movement development programme (MDP) presented by movement developmentalists of the Potchefstroom University for Christian Higher Education (P.U. for C.H.E.). This programme is being presented on the premises of 10 pre-primary schools in Potchefstroom, as well as at the movement development centre at the university.
Procedure

A one-time cross-sectional design applied on an available sample was used as the research method in the study. All the participants were enrolled in the MDP for their first time, and all were tested for the purpose of this research study before the implementation of the programme. All parents were briefed on the procedures before the testing started, after which informed consent was obtained from them for each participant. The testing was conducted on the premises of the schools and in the movement development centre at the university. With the exception of the throw-for-distance, which was measured during the test, the tests were videotaped and analyzed afterwards by the researcher.

Instrumentation

Standing long jump, hopping, skipping, one leg balance, beam walk, heel-to-toe walk, throwing for distance, catching and "jumping jacks" were selected as the gross motor skills to be tested. These skills were selected for three reasons:
1) They represent the three categories of movement, namely basic locomotion (standing long jump, hopping and skipping), balance (one leg balance and balance walk), and manipulation (throwing and catching) (Gallahue & Ozmun, 1998);
2) they are used extensively in established motor test batteries for children of these age groups (Bruininks, 1978; Charlop & Attwell, 1980; Folio & Fewell, 1983; Frankenburg, 1990; Henderson & Sugden, 1992; Gustafson-Munro, 1985; Pyfer, 1990; Ulrich, 1985); and
3) they are suitable to use in the form of a screening test in a movement development programme because of their simplicity and compatibility with the type of activities used in the MDP.

The skills were evaluated based on the following procedures:

Standing long jump (Arnheim & Sinclair, 1979; Bruininks, 1978; Ulrich, 1985). The test measured how far the child could jump horizontally, using a two-feet takeoff and landing. The score was the highest of three trials. This skill was not tested in the 3 year old group, as a child is usually not capable of jumping for distance at this age (Thomas et al., 1993; Haywood, 1992).
Hopping (Frankenburg, 1990; Johnston et al., 1987; Mutti, Martin, Sterling & Spalding, 1998). The test entailed two trials of hopping forward on each leg as many times as possible, up to a maximum of 12 hops. The higher score was taken.
Skipping (Mutti et al., 1998; Pyfer, 1990). The skipping pattern (step, hop, step, hop) was demonstrated by the researcher and then the participant was asked to skip across the room. According to Gallahue and Ozmun (1998), 20% of 5 year olds and nearly all 6 year olds can skip...
proficiently. Therefore, skipping was only evaluated among the 5 and 6 year olds. The number of skipping steps done correctly, to a maximum of 4, was taken as the score.

**One leg balance** (Bruininks, 1978; Frankenburg, 1990; Henderson & Sugden, 1992; Johnston *et al.*, 1987; Mutti *et al.*, 1998). The test entailed two trials of balancing on one foot, with the arms hanging at the sides, for as long as possible up to a maximum of 12 seconds. The participant was instructed to stand with the free leg bent backwards at the knee and kept off the floor. Swaying was allowed, and the arms were allowed to move from the sides. Balancing was tested on both legs, and the better of the two trials taken as the score.

**Balance walk** (Bruininks, 1978; Gustafson-Munro, 1985; Johnston *et al.*, 1987; Mutti *et al.*, 1998). The 3 and 4 year olds were asked to walk forward on a line (50 mm. wide and 2.5 m. long), while the 5 year olds were asked to walk heel-to-toe (placing the heel of one foot against the toes of the other foot in each step) on the same line on the floor. The 6 year olds were asked to walk heel-to-toe on a low balance beam (2.5 m. long, 100 mm. wide and 300 mm. high), and then walk heel-to-toe backward on the beam. The score was the distance completed with the feet placed on the line (3 and 4 year olds) or correctly placed heel-to-toe (5 and 6 year olds) up to a maximum of 1.5 m. Two trials were allowed.

**Throwing** (Folio & Fewell, 1983; Haubenstricker & Seefeldt, 1986). The test entailed throwing a tennis ball as far as possible, using the overhand technique. The researcher demonstrated the throw first. The longer distance of two throws was scored.

**Catching** (Bruininks, 1978; Folio & Fewell, 1983; Gustafson-Munro, 1985; Pyfer, 1990). The test measured the ability to catch an aerial, underhand thrown 20-cm. ball with two hands. The thrower was positioned 1.5 meters from 3 year old participants, and 2 meters from 4-6 year old participants. The score was the number of successful catches off 4 throws.

**"Jumping jacks"** (Charlop & Atwell, 1980). The "jumping jack" movement was demonstrated to the 6 year old participant by the researcher, who at the same time explained that the feet had to jump apart and the hands had to clap above the head, before returning to the starting position. For the 5 year olds, this test was modified so that the arms were required only to lift sideways up to shoulder level before returning to the starting position. The score was the number of correct executions (i.e. if the feet and hands moved simultaneously and co-ordinatedly up and down and the jumping action was done rhythmically) up to a maximum of 10. Two trials were given.

Each test was conducted by the researcher, and each child was videotaped individually from the side by a trained assistant. With the exception of throwing for distance, which was measured
during the test, the researcher scored each participant's performance after analyzing the recording.

**Data analysis**

All calculations of means ($M$), standard deviations ($SD$), t-value, degrees of difference ($df$), p-values and effect sizes ($ES$) were done using the Statistica for Windows (6.0) computer program (Statsoft, 1995). Practical significance ($ES$) of the differences between the two groups in every test was established by dividing the difference between the means of the two groups by the highest standard deviation as recommended by Cohen (1988) and Steyn (1999).

Cohen (1988) constituted some guideline-values as an aid to the interpretation of the extent of practical significance, namely $ES = 0.2$ (small effect); $ES = 0.5$ (medium effect) and $ES = 0.8$ (large effect). For the purpose of this study, when an effect size was larger than a medium effect, it was considered to be of practical significance.

**RESULTS**

The mean scores and standard deviations of the gross motor tests of male and female participants are presented in Table 1.

Slight or larger differences between genders can be seen in most of the tests, as presented in Table 1. However, as indicated in Table 2 which shows the statistical analysis of the differences between genders, significant differences were found in the 3 year old group in the tests for hopping (right) and one leg balance (right) in favour of the female participants. The difference between the male and female participants proved to be of practical significance ($ES$ of medium effect) as well. The superior scores of the 5 year old and 6 year old male participants proved to be statistically significant in the tests for throwing and standing long jump. Effect sizes of medium or large effects constituting practical significance, were found in the tests for throwing in all the age groups, and long jump in the 5 and 6 year old groups. Although not statistically significant, the same trends (males scoring better than females) were apparent in the throwing test in the 3 and 4 year old groups, and the standing long jump in the 4 year old group (Table 1). No statistically significant gender differences were found in the 4 year old group.
Table 1: Mean scores (M), standard deviations (SD) of gross motor tests of male and female 3-6 year old children (N = 464)

<table>
<thead>
<tr>
<th>Age</th>
<th>Long jump (cm)</th>
<th>Skip</th>
<th>Hopping L</th>
<th>Hopping R</th>
<th>One leg balance (sec) L</th>
<th>One leg balance (sec) R</th>
<th>Balance walk (m) F</th>
<th>Balance walk (m) B</th>
<th>Catch</th>
<th>Throw (m)</th>
<th>Jumping Jacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>M</td>
<td>(n=52)</td>
<td>2.18</td>
<td>1.85</td>
<td>2.94</td>
<td>2.18</td>
<td>145.70</td>
<td>-</td>
<td>3.60</td>
<td>3.25</td>
<td>-</td>
</tr>
<tr>
<td>Female</td>
<td>M</td>
<td>(n=64)</td>
<td>2.81</td>
<td>2.91</td>
<td>3.38</td>
<td>3.25</td>
<td>145.64</td>
<td>-</td>
<td>3.78</td>
<td>2.61</td>
<td>-</td>
</tr>
<tr>
<td>4 years</td>
<td></td>
<td></td>
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<tr>
<td>Male</td>
<td>M</td>
<td>(n=67)</td>
<td>2.08</td>
<td>2.15</td>
<td>2.94</td>
<td>2.18</td>
<td>145.70</td>
<td>-</td>
<td>3.60</td>
<td>3.25</td>
<td>-</td>
</tr>
<tr>
<td>Female</td>
<td>M</td>
<td>(n=69)</td>
<td>1.74</td>
<td>2.99</td>
<td>1.86</td>
<td>2.09</td>
<td>19.97</td>
<td>-</td>
<td>0.71</td>
<td>1.02</td>
<td>-</td>
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<tr>
<td>5 years</td>
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<tr>
<td>Male</td>
<td>M</td>
<td>(n=54)</td>
<td>5.08</td>
<td>4.88</td>
<td>5.70</td>
<td>5.17</td>
<td>150.00</td>
<td>-</td>
<td>3.77</td>
<td>5.75</td>
<td>-</td>
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<tr>
<td>Female</td>
<td>M</td>
<td>(n=56)</td>
<td>5.34</td>
<td>5.70</td>
<td>5.86</td>
<td>5.84</td>
<td>150.00</td>
<td>-</td>
<td>3.93</td>
<td>4.01</td>
<td>-</td>
</tr>
<tr>
<td>6 years</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Male</td>
<td>M</td>
<td>(n=48)</td>
<td>87.96</td>
<td>-</td>
<td>5.08</td>
<td>4.88</td>
<td>143.48</td>
<td>-</td>
<td>3.86</td>
<td>6.13</td>
<td>7.76</td>
</tr>
<tr>
<td>Female</td>
<td>M</td>
<td>(n=48)</td>
<td>82.26</td>
<td>-</td>
<td>5.34</td>
<td>5.70</td>
<td>143.62</td>
<td>-</td>
<td>3.98</td>
<td>3.87</td>
<td>8.36</td>
</tr>
</tbody>
</table>

Note: M = Mean; SD = Standard deviation; L = left leg; R = right leg; B = Backward; F = Forward.

Table 2: Significance of gender differences among 3-6 year old children (N = 464)

<table>
<thead>
<tr>
<th>Test item</th>
<th>3 Years (n = 116)</th>
<th>4 Years (n = 136)</th>
<th>5 Years (n = 116)</th>
<th>6 Years (n = 96)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t-value df p ES</td>
<td>t-value df p ES</td>
<td>t-value df p ES</td>
<td>t-value df p ES</td>
</tr>
<tr>
<td>Long jump</td>
<td>-</td>
<td>1.73 135 0.0861 0.29</td>
<td>3.56* 116 0.0005 0.64*</td>
<td>2.87* 97 0.0049 0.52*</td>
</tr>
<tr>
<td>Hopping L</td>
<td>-1.20 116 0.2343 -0.35</td>
<td>-0.58 138 0.5609 -0.09</td>
<td>0.92 118 0.3571 0.16</td>
<td>-0.02 97 0.9827 -0.21</td>
</tr>
<tr>
<td>Hopping R</td>
<td>-2.20* 114 0.0301* -0.35</td>
<td>-1.73 136 0.0864 -0.27</td>
<td>-0.96 118 0.3409 0.06</td>
<td>-0.53 97 0.5955 -0.02</td>
</tr>
<tr>
<td>Skipping</td>
<td></td>
<td>-1.14 113 0.2569 -0.19</td>
<td>-1.36 95 0.1757 -0.17</td>
<td></td>
</tr>
<tr>
<td>One leg balance L</td>
<td>-1.22 114 0.2270 -0.22</td>
<td>-1.03 130 0.3048 -0.07</td>
<td>1.01 111 0.3157 0.06</td>
<td>-0.84 79 0.4054 -0.17</td>
</tr>
<tr>
<td>One leg balance R</td>
<td>-2.59* 112 0.0109* -0.51*</td>
<td>-1.79 130 0.0757 -0.30</td>
<td>1.71 111 0.0895 0.19</td>
<td>-1.38 79 0.1715 -0.31</td>
</tr>
<tr>
<td>Balance walk F</td>
<td>-1.23 116 0.2323 0.00</td>
<td>-1.32 130 0.2331 0.00</td>
<td>-1.24 56 0.2203 -0.21</td>
<td>-1.23 79 0.2341 -0.27</td>
</tr>
<tr>
<td>Balance walk B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catch</td>
<td>-1.33 118 0.1867 -0.23</td>
<td>-1.95 138 0.0530 -0.25</td>
<td>0.27 118 0.7874 0.05</td>
<td>-1.68 96 0.0969 -0.21</td>
</tr>
<tr>
<td>Throw</td>
<td>1.51 28 0.1428 0.49</td>
<td>1.61 25 0.1192 0.48</td>
<td>3.72* 22 0.0011* 1.28*</td>
<td>4.92* 19* 0.0009* 1.91*</td>
</tr>
<tr>
<td>Jumping jacks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * = Statistically significant where p ≤ 0.05; • = Practical significance where ES ≥ 0.5; L = left leg; R = right leg; B = Backward; F = Forward.
DISCUSSION

The statistically, although not practically, significant higher scores of the 3 year old female participants compared to the boys in the one leg balance (right leg) test (Table 2), support the research findings of Hands and Larkin (1997), Morris et al. (1982), Raudsepp and Pääsuke (1995) and Butcher and Eaton (1989), that girls performed better than boys in static balance tasks. Although not statistically or practically significant, the higher scores of the female participants in the one leg balance test in the 4 and 6 year old groups also follow this trend. The differences obtained, although not significant, in the scores of the hopping, skipping and jumping jacks tests favouring the female participants correspond with the findings of Broadhead and Church (1985) and Hands and Larkin (1997), where female children performed better than males in locomotor skills requiring coordination.

The differences, although not statistically or practically significant, found in the throwing tests in favour of the male participants among the 3 and 4 year olds, and the statistically and practically significant differences found in favour of the male participants among the 5 year olds and 6 year olds in the tests for standing long jump and throwing (both skills that require speed and power of movement (Raudsepp & Pääsuke, 1995)), correspond to the results found in the studies of Morris et al. (1982), Raudsepp and Pääsuke (1995), Thomas et al. (1993) and Walkley et al. (1993).

Even when Nelson, Thomas, Nelson & Abraham. (1986) corrected for the differences in throwing distance between 5 year old girls and boys by taking into account a series of biological variables (joint diameters, shoulder/hip ratio and sum of skinfolds), the difference was still significant in favour of the boys.

Gender differences in gross motor skills are attributed to several possible reasons. According to Hands and Larkin (1997) and McGuire (1990), boys tend to be more physically active than girls, and this correlates with their motor skill development. Furthermore, the type of play and the social style that boys and girls tend to engage in tend to be stereotyped. According to McGuire (1990), boys prefer to play outside in competitive games or sports, while girls more often play inside in more quiet games requiring fine rather than gross motor skills. Garcia (1994) investigated the social styles of preschool children during gross motor activities. He concluded that their different social styles wherein boys tend to be more aggressive and competitive, and girls more caring and sharing, could contribute to gender differences in favour of boys. These findings support the statement of Hands and Larkin (1997) and Thomas et al. (1993), that sociocultural factors can play a large role in the development of gross motor skills of the young.
Chapter 7: Gender differences in gross motor skills

child. Furthermore, as Potchefstroom is a city that has a strong sports culture where the main school and university sports are gender specific (rugby and cricket practised mainly by males and netball and hockey practised mainly by females), it is possible that the skills required in these sports are developed to a higher degree among children emulating their role models, parents and peers in these sports.

CONCLUSION

The results of this study indicate that any assessment instruments which do not provide separate norms for genders in the specific skills where significant differences were found, should be interpreted very carefully as not to disadvantage children of a specific gender.

For professionals working with children in gross motor development programmes and who have to report to parents on their children's motor development levels, it is suggested that separate gender norms be used for skills like throwing and standing long jump from the age of 5 years.

The results obtained with this study should be evaluated in the light of the limitation of a selected group of participants used. Factors such as socio-economic background, body composition and activity levels of the children which have not been measured for the purposes of this study, could also have had an influence on the performance of the different genders. It is suggested that future research should be conducted to further examine gender differences, but that it should make use of larger, and if possible randomly selected populations.

Follow-up research is recommended on gender differences in gross motor skills of South African preschool children, investigating the possibility of setting separate norms for the two genders in the specific skills showing significant differences in this study.

REFERENCES


Chapter 7: Gender differences in gross motor skills


AJPHERD: Corrections submitted on 20 November, 2001


Chapter 8

Summary, conclusions and recommendations
8.1 Introduction
In the holistic development of the young child, optimal gross motor development closely relates to optimal physical, perceptual, cognitive, language, affective-social and normative (behavioral) development (Kapp, 1991:193; Gallahue & Ozmun, 1998:356), and is therefore considered to be essential in the preschool years. The brain also provides a window of opportunity for optimal development of gross motor skills during the preschool years (Gabbard, 1998:55) which necessitates the attention of professionals to ensure sufficient opportunities and stimulation, and accurate assessment of gross motor developmental levels in the preschool years (Auxter et al., 1997:179; Gallahue & Ozmun, 1998:356; Gabbard, 1998:55). However, the difficulty professionals in South Africa are faced with in constructing gross motor development programmes and assessing the levels of gross motor development of preschool South African children, is that there is a lack of research data on the gross motor development of these children. This dissertation can be seen as a first step in the direction of much-needed research on the gross motor development of the South African preschool child, where the aims were to 1) determine the current levels of gross motor development, 2) assess the prevalence of and the influence of overweight and obesity on gross motor development, 3) establish the relationship between overweight and obesity, gross motor development and gender, 4) determine the relationship between quantitative and qualitative assessment results of the one leg balance, and 5) to investigate the occurrence of gender differences in gross motor development, in a group of 3-6 year old children in Potchefstroom, an urban area in South Africa.

8.2 Summary
In Chapter 2 (p. 7 to p. 21), the literature regarding gross motor development and influential factors on this development of children all over the world, was discussed. As physical activity and obesity both have a considerable influence on the development of gross motor skills in preschool children, literature with regard to these factors was discussed first. The literature indicated an inverted relationship between obesity and gross motor competency in children, and more so among boys than girls. A literature review on the assessment of gross motor development followed, as gross motor development cannot be properly addressed without the accurate assessment of the development level of a child. In this discussion it became clear that
there is a lack of recent research data on the gross motor development of South African preschool children, and that qualitative assessment methods could increase the accuracy of gross motor skill assessment during this age period. This discussion was enlightened by a literature survey on the assessment of a specific motor skill in preschool children, namely the one leg balance. Gender differences were subsequently discussed in view of their influence on the assessment results and gross motor development in preschool children. According to research findings, boys generally perform better than girls in skills requiring strength and speed, whereas girls perform better in balance and co-ordination skills.

Chapters 3-7 are presented in the form of research articles, all of which have been submitted to accredited journals for publication. Of these five articles, three have already been accepted for publication.

Chapter 3 (p. 22 to p. 31) focused on the current levels of gross motor development of preschool children in Potchefstroom, a city in South Africa, compared to norms and criteria as found in the literature. The results obtained from this study, using descriptive statistics, showed that the 3, 4 and 5 year old participants in this study compared well to their counterparts as found in the literature with reference to hopping, one leg balance and jumping jacks. The 5 year olds also compared favourably to their counterparts in the standing long jump and skipping, while the 3 and 4 year olds compared well to their counterparts in the test for throwing. Balance walk and catching ability of the 3, 4 and 5 year olds, standing long jump in the 4 year olds and throwing in the 5 year old group were, however, slightly lower than norms in the literature. The 6 year olds scored lower than the average norms and criteria used in all the tests except the standing long jump, where they scored higher than the norms. The slightly lower scores of the 3, 4 and 5 year old groups in comparison with the norms and criteria found in the literature, could be due to normal individual variety in the rate of gross motor development of preschool children. However, the scores of the 6 year olds being lower than the norms in 7 of the 8 tests, seems to be reason for concern as under-developed gross motor skills can have a detrimental effect on other developmental areas considered to be important for school-readiness at this age. Below-average scores in the tests for hopping, skipping and jumping jacks could be a reflection of below-average levels of bilateral integration of the two sides of the body, which have to be well developed for fine motor skills like writing. The below-average scores in the test for catching in all the age groups, could be a symptom of the limitations that modern-day circumstances in
urban areas in South Africa place on the development of upper limb co-ordination skills, namely a lack of space and safety limiting children to playing indoors. This finding supports the assertion of Buthcer and Eaton (1989:7) that lack of space and indoor playing do not provide sufficient opportunities for the development of upper limb co-ordination skills like throwing and catching. The above-average performances of the 5 and 6 year olds in the standing long jump could be due to the above-average height and weight of these two groups, as seen in the studies on overweight and obesity and gross motor competency among preschool children in Potchefstroom.

The aim of Chapter 4 (p. 32) and Chapter 5 (p. 50) was to determine the prevalence of and possible relationship between overweight and obesity, and gross motor competency among preschool boys and girls in Potchefstroom. Due to the scale of this investigation, this study was presented in two chapters. The prevalence of overweight and obesity among 3-6 year old boys in Potchefstroom of 16.35% as found in Chapter 4, is higher than the prevalence of overweight among preschool urban children in South Africa, of 12% (NFCS, 2000:10). The high percentages of overweight and obesity found in the 3 and 4 year old groups (12.5% and 22.58%, respectively), indicate that this age period may already be a period of risk for the development of obesity. By making use of practical significance based on effect sizes (ES), differences between 3-6 year old O- and NO- subjects were separately determined. With regard to the relationship between overweight and obesity, and gross motor competency of these participants, the results of the quantitative tests showed that the nonobese groups, in comparison with the obese groups, produced superior results of practical significance (medium or large ES) in the standing long jump (4, 5 and 6 year olds), hopping (3 year olds), one leg balance (3, 4 and 5 year olds) and catching (4, 5 and 6 year olds). In the qualitative tests, the nonobese performed better than the obese groups in the standing long jump (4 and 6 year olds), hopping (3, 4 and 6 year olds), one leg balance (4, 5 and 6 year olds) and catching (3 year olds). The results with regard to the standing long jump and hopping correspond to the findings of Hensley et al. (1982:137) and Raudsepp and Jürimäe (1996:261), that adiposity is related to motor items in which the body is projected or moved. However, the differences found in favour of the nonobese group with regard to the one leg balance and catching, contradict this statement.

The results in Chapter 5 showed a prevalence of overweight and obesity of 11.81%, among girls, corresponding to the prevalence of overweight among preschool urban children in South Africa
of 12% (NFCS, 2000:10) and to the estimated prevalences of obesity among preschool children in America of 11-24% (Flegal, 1999:5509; Ganley & Sherman, 2000:85). A relatively high percentage (18.18%) of overweight and obesity was found in the 3 year old group, indicating that this age period could also be a risk period for the development of obesity. When comparing the nonobese groups with the obese groups in this study, differences of practical significance established with effect sizes of medium or large effects were found favouring the nonobese group in the quantitative test for the one leg balance (5 and 6 years). In the qualitative assessment, effect sizes of medium or large effects were found in favour of the nonobese groups in the tests for the standing long jump (6 years), hopping (3, 5 and 6 years), one leg balance (5 and 6 years) and catching (3, 5 and 6 years). No differences of medium or large effects were found in the 4 year old group, possibly due to large standard deviations in the specific skill tests in this group. The results of the quantitative tests in this study contradict the findings of Hensley et al. (1982:137) and Raudsepp and Jürimäe (1996:261), that adiposity is related to motor items in which the body is projected or moved, although the findings with regard to the test for hopping support this statement.

In Chapter 4 a larger effect size was found in tests of age groups showing greater effect sizes concerning percentage body fat among the 3, 4, and 6 year old boys. In Chapter 5, larger effect sizes were found in the motor skills tests of the 5 and 6 year old groups, also showing greater effect sizes concerning percentage body fat, in comparison to the 3 and 4 year old girls. These tendencies seem to indicate that an increase in level of obesity would be related to larger differences in motor proficiency between obese and nonobese children.

In the study on differences in motor skills between obese and nonobese boys, no differences were found between the O-group and the NO-group with regard to the qualitative performance of catching in the 4, 5, and 6 year old groups. In contrast, the girls in this study showed practically significant differences with regard to the qualitative scores of the 3, 5 and 6 year olds. The female subjects in this study have therefore not acquired the age-appropriate stage of qualitative development for which sufficient movement experiences are needed, even though they seem to have developed the perceptual and spatial abilities to catch accurately. Contributing factors to this result could be that overweight and obese girls tend to avoid participating regularly in physical activities more than overweight and obese boys (Hands & Larkin, 1997:14), and balls tend to be less part of girls' play than boys' play (Hands & Larkin, 1997:14).
Differences of practical significance (medium or large effects) in favour of nonobese groups were found in all the quantitative and qualitative tests (standing long jump, hopping, one leg balance and catching) among the male participants, while similar differences were found in only the quantitative tests for the one leg balance and all the qualitative tests among the female participants. This apparent tendency of a larger number of motor skills being affected by overweight and obesity among boys than girls, corresponds with the higher inverted relationship between obesity and motor skills among boys than girls reported by Hensley et al. (1982:138) and Marshall and Bouffard (1997:234).

For the study in Chapter 6 (p. 68 to p. 84), the one leg balance was chosen to establish the quantitative and qualitative levels of a specific gross motor skill and to determine the relationship between these two types of scores obtained when assessing this skill in preschool children in Potchefstroom. The Pearson Chi-square as well as the Phi for 2-way tables were calculated for each age group to determine the significance of the relationship between the quantitative and qualitative scores. The results show a positive relationship of statistical significance ($p \leq 0.05$) between the quantitative and qualitative scores of the one leg balance in every age group. The results further show that the qualitative and quantitative development of this selected South African group of 3-6 year old children compares well with the qualitative developmental criteria of the stage classifying system of Gallahue and Ozmun (1995) and with quantitative norms found in the literature (Gustafson-Munro, 1985: 15; Johnston et al., 1987: 159; Olie, 1990: 13; Henderson & Sugden, 1992: 52; Mutti et al., 1998: 68). The largest percentages of the subjects in each age group produced *average or above average* scores in both the quantitative and qualitative assessments. However, an alarming tendency was established in the percentage of scores across the ages in the qualitative scores. The percentage of subjects scoring *average or above average* decreased as their age increased, while the subjects falling in the category for quantitative scores *below average* but qualitative scores *average or above average*, increased from 4 years to 6 years. The percentages of subjects failing to score above the cut-off points in both types of assessments also increased from 4 to 5 and 6 years. This tendency would seem to indicate that as the subjects age, the static balance skills of this group deteriorate. These results may be indicative of the same kind of tendencies in the development of other gross motor skills of this group, as balance is considered to form the foundation for the development of all gross motor skills.
The finding that the largest percentages of subjects in all the age groups scored \textit{average or above average} in the quantitative as well as the qualitative tests, suggests that there is a correlation between the quantitative norms and the developmental criteria used in this study. This relationship, illustrated in the linear upward curve of both types of assessment scores and confirmed by the established Chi-square and Phi values, was especially strong among the 4 year olds.

Almost half (44.10\%) of the 3 year old group scored higher than the qualitative score accepted as average (1-3 seconds) for this age. As these results suggested that similar tendencies might exist in the other age groups, a further analysis was done to determine the prevalence of such scores in the 4 and 5 year old age groups. This analysis showed that 8.90\% (left leg) and 8.22\% (right leg) of the 4 year olds (above 7 seconds and in the mature stage of development), 30.17\% (left leg) and 29.31\% (right leg) of the 5 year olds (above 10 seconds and in the mature stage) scored higher than the upper limits of the average quantitative and qualitative scores for their age.

As 6 years is the age at which school readiness is tested in South Africa (Kapp, 1991:193), the relatively high percentage of 6 year olds scoring \textit{below average} in the quantitative assessment (27.47\% for the left leg and 25.27\% for the right leg) is an alarming finding. Although they do not necessarily indicate developmental deficits or disorders, these figures resemble the prevalence for motor deficits or disorders estimated in South African children of 5-15\% (Pienaar, 1994: 125). A further analysis which was done to determine the percentage of 6 year old children scoring below the norms and criteria set for 5 year olds in the one leg balance (<8 seconds and in the elementary stage of development), showed that between 18.68\% (left leg) and 18.74\% (right leg) of this group could not attain the norms and criteria appropriate for 5 year old children. As the assessment of the one leg balance forms part of most screening tests for school readiness (Nel & Sonnekus, 1963; Herbst, \textit{s.a.}; Kruger, 1983; Park, 1986), below average balancing ability could influence the scoring of 6 year olds in these tests. Furthermore, balance plays a primary role in the development of all gross motor skills, therefore below average balancing ability could also be an indication of below average levels of development in other gross motor skills at this age.
Chapter 7 (p. 85 to p. 95) comprises an investigation of the occurrence of gender differences in gross motor skills among preschool children in Potchefstroom. These differences were established by t-testing (p ≤ 0.05) using the Statistica for Windows (6.0) computer program (Statsoft, 1984-1998). The results show significantly higher scores in the one leg balance test in the 3 year old female group compared to the boys, corresponding to the research findings of Hands & Larkin (1997), Morris et al. (1982), Raudsepp and Pääsuke (1995) and Buthcer and Eaton (1989), that girls performed better than boys in static balance tasks. The higher scores of the female participants in the one leg balance test in the 4 and 6 year old groups also follow this trend, although they are not statistically significant. The statistically significant differences found in favour of the female participants in the test for hopping on the right leg in the 3 year old group, support the findings of Broadhead and Church (1985) and Hands and Larkin (1997) where female children outperformed males in locomotor skills requiring coordination. These findings are also supported by the differences, although not statistically significant, found in the scores of the hopping, skipping and jumping jacks tests favouring the female participants in the 4, 5 and 6 year old groups.

Among the 5 year olds and 6 year olds, statistically significant differences were found in favour of the male participants in the tests for standing long jump and throwing, both skills that require speed and power of movement (Raudsepp & Pääsuke, 1995:297), and corresponding with the results found in the studies of Morris et al. (1982:219), Raudsepp and Pääsuke (1995:297), Thomas et al. (1993:83) and Walkley et al. (1993:13).

These gender differences in gross motor skills can be attributed to several possible reasons, among others different levels of physical activity, (Hands & Larkin, 1997:14; Eaton, 1989:68), different social types of play (McGuire, 1990:183) and sociocultural factors (Hands & Larkin, 1997:14; Thomas et al., 1993:83). Potchefstroom as a city has a strong sports culture where the main school and university sports are gender specific (rugby and cricket practiced mainly by males and netball and hockey practiced mainly by females). Therefore, it is possible that among
children who emulate their peers, parents and role models in these sports, the skills required in these sports are developed to a higher degree.

The results of this dissertation show reasons for concern with regard to the gross motor development levels of South African preschool children living in an urban area like Potchefstroom. With increasing demands placed on the South African child in the changing school curriculum, the optimal development of gross motor skills in the preschool years as the basis for the development of other developmental areas, is undeniable. The findings in this dissertation therefore emphasize the increasing importance of sufficient opportunities for practice and encouragement in the development of gross motor skills of 3-6 year old children in modern-day society, such as provided in a movement development programme. The value of a movement development programme specifically structured according to the gross motor characteristics and needs of its participants, and the necessity for accurate norms and criteria in the assessment of gross motor development levels in preschool children, are also demonstrated.

8.3 Conclusions

The conclusions of the study are provided in relation to the hypotheses set out in Chapter 1.

8.3.1 Hypothesis 1:

The levels of gross motor development of preschool children in Potchefstroom compare favourably to norms and criteria as found in the literature.

The results show that 3, 4 and 5 year old participants in this study compared well to their counterparts as found in the literature with reference to hopping, one leg balance and jumping jacks. The 5 year olds also compared favourably to their counterparts in the standing long jump and skipping, while the 3 and 4 year olds compared well to their counterparts in the test for throwing. Balance walk and catching ability of the 3, 4 and 5 year olds, standing long jump in the 4 year olds and throwing in the 5 year old group were, however, slightly lower than the average norms found in the literature. The 6 year olds scored lower than the average norm in all the tests except the standing long jump, where they scored higher than the norms.

The first hypothesis could therefore only be partially accepted.
8.3.2 Hypothesis 2:
The prevalence of overweight and obesity among preschool children in Potchefstroom is higher than the prevalence found in the literature, and is such that it negatively influences gross motor competency in the group.

The prevalence (11.81%) of overweight and obesity among the preschool girls in the study was in agreement with the prevalence (12%) among South African children, while the prevalence (16.34%) among the preschool boys proved to be higher than the known South African prevalence. Negative correlations were found between overweight and obesity, and several gross motor skills in the different age groups. The results of the quantitative tests of the boys showed that the nonobese groups, in comparison with the obese groups, produced superior results of practical significance (medium or large effect sizes) in the standing long jump (4, 5 and 6 year olds), hopping (3 year olds), one leg balance (3, 4 and 5 year olds) and catching (4, 5 and 6 year olds). In the qualitative tests, the nonobese performed better than the obese groups in the standing long jump (4 and 6 year olds), hopping (3, 4 and 6 year olds), one leg balance (4, 5 and 6 year olds) and catching (3 year olds).

With regard to preschool girls in Potchefstroom, effect sizes of medium or large effects were found favouring the nonobese group in the quantitative test for the one leg balance (5 and 6 years). In the qualitative assessment, effect sizes of medium or large effects were found in favour of the nonobese groups in the tests for the standing long jump (6 years), hopping (3, 5 and 6 years), one leg balance (5 and 6 years) and catching (3, 5 and 6 years). No differences of medium or large effects were found in the 4 year old group.

The second hypothesis could therefore only be partially accepted.

8.3.3 Hypothesis 3:
There is a stronger inverted relationship between gross motor development and overweight and obesity, among preschool boys than among preschool girls in Potchefstroom.

Differences of practical significance (medium or large effects) in favour of nonobese groups were found in all the quantitative and qualitative tests (standing long jump, hopping, one leg balance and catching) among the male participants, while similar differences were found in only
the quantitative tests for the one leg balance and all the qualitative tests among the female participants.

These results make it possible to accept hypothesis 3.

8.3.4 Hypothesis 4:
There is a positive relationship between the quantitative and qualitative scores obtained in the assessment of the one leg balance in preschool children in Potchefstroom.

A positive relationship of statistical significance \( p \leq 0.05 \) was established between the quantitative and qualitative scores of the one leg balance in every age group.

The fourth hypothesis could therefore be accepted.

8.3.5 Hypothesis 5:
Significant gender differences in gross motor skills exist among preschool children in Potchefstroom.

The results show that 5 and 6 year old boys were significantly superior to 5 and 6 year old girls in the tests for standing long jump and throwing for distance. Statistically significant gender differences were also found in favour of the girls in hopping (right) and the one leg balance (right) in the 3 year old group. Differences of statistical significance was neither found in the tests for hopping (left) and the one leg balance (left) in the 3 year old group, nor in the tests for hopping (left and right), skipping, balance walk, one leg balance (left and right), throwing, catching and jumping jacks in the 3, 4 and 5 year old groups. No differences of statistical significance was found in the tests for hopping (left and right), skipping, balance walk, one-leg balance and jumping jacks in the 6 year old group.

Therefore, the fifth hypothesis could only be partially accepted.
8.4 **Recommendations**

The results of this study provided valuable insight into the gross motor development of preschool children, which can be used very effectively in the optimization of gross motor development. The following recommendations can be made from the results with reference to the accuracy and suitability of norms and criteria found in the literature, for the assessment of and the planning and composition of an effective movement development programme for preschool children living in South African cities, as well as for further research.

8.3.1 For movement developmentalists working with preschool children in movement development programmes, the results of this study indicate that special attention should be given to 6 year olds entering the programmes, especially with regard to the specific gross motor components which were scored below average (hopping, skipping, one leg balance, balance walk, throwing, catching and jumping jacks). This is important in view of the possibility that parents might be more likely to enroll children with motor related problems in such a programme in the year before they go to school, due to the emphasis placed on school-readiness. Even more important is the possible prevention of these seemingly under-developed components at 6 years of age by structuring an effective movement programme for ages younger than 6 years and providing sufficient stimulation in all gross motor areas in the early years, as well as identifying deficits or disorders as early as possible. Furthermore, activities providing sufficient opportunities for the development of upper limb co-ordination skills such as catching and throwing should be included in a movement development programme, as catching ability in all the age groups and throwing in the 5 and 6 year old groups also scored below average.

8.3.2 The high prevalence of overweight and obesity found in this study, emphasizes the need to address this problem even in the preschool years, as obese preschool children tend to become obese adults (Christoffel, 1998:104). After assessing an overweight or obese child, the role of the movement developmentalist in addressing obesity could be to educate the parents of such a participant in the gross motor development programme, as to the related health and development risks and giving advice on the treatment thereof. According to Christoffel (1998:103), the treatment would include promoting healthy dietary patterns and optimal levels of physical activity, including limiting time spent in
front of the television and home computer. Differences of practical significance found in this study between the overweight and obese groups, and the nonobese groups in several gross motor skills, have implications for the structuring of a programme for gross motor development. By improving and enhancing gross motor skills in the preschool years through an effective programme, overweight and obese children can be encouraged to participate in physical activities which they might otherwise have avoided. Activities for the specific skills shown to be related to overweight and obesity, namely balance skills and catching in boys and girls and standing long jump in boys, should also be specifically emphasized in overweight and obese children in motor development programmes.

One of the primary goals for people working with preschool children should be to optimize the development of gross motor skills in this critical period via sufficient and frequent physical activity. Acquisition of fundamental motor skills is essential to develop a healthy lifestyle and to participate in health-enhancing activities in later life, thus preventing obesity.

8.3.3 The high percentages of participants failing to adhere to the quantitative and qualitative cut-off points in the tests for the one leg balance, emphasize the importance of sufficient age-appropriate balance activities in a movement development programme. In the light of the results of this study, it can be stated that in order to get a complete profile of a child's static balance skills, especially for screening and diagnostic purposes in 6 year old children, it is necessary to do both a quantitative and a qualitative assessment based on age-appropriate norms and developmental stage criteria.

8.3.4 Separate norms should be used for the assessment of the standing long jump and throwing for distance in 5 and 6 year olds. In the light of the gender differences found, more emphasis can be placed on the development of ball skills in girls, and the development of co-ordination skills of boys in the structuring of a movement development programme. Such a programme should also include sufficient activities for the development of hopping and balancing skills on both legs, considering the gender differences found in the hopping (right leg) and one leg balance (right leg) tests.

8.3.5 After reviewing the methods and results of this study, the gross motor items used in this study can be recommended for the use in the gross motor skill assessment of children
entering and participating in a movement development programme, as they were easy to use. The instructions are simple enough for preschool children to understand and no special apparatus is needed. The 8 tests used to assess the current levels of gross motor development in Chapter 3 represent the three categories of movement, namely basic locomotion (standing long jump, hopping, skipping and jumping jacks), balance (one leg balance and balance walk), and manipulation (throwing and catching) (Gallahue & Ozmun, 1995:21), and take relatively little time to complete (approximately 15 minutes per child). It is recommended from the findings of Chapter 6 on the quantitative and qualitative one leg balance assessment, that the qualitative assessment system (Gallahue, 1996) be used along with the quantitative assessment in all of these skills. These gross motor tests are also commonly used in school-readiness tests (Nel & Sonnekus, 1963; Herbst, s.a.; Kruger, 1983; Park, 1986). Perceptual-motor items are usually used with gross motor items in these tests. Although perceptual-motor development is also represented by the one leg balance and catching (Charlop & Atwel, 1980:4), the inclusion of perceptual-motor items commonly used in screening tests for school readiness might make the test more complete and aimed at school readiness. Further research aimed at the inclusion of age-appropriate perceptual-motor items like identifying body parts and imitating postures (Pyfer, 1990:8) is recommended. Other standardized batteries for use, however, among preschool children, are also available (Arnheim & Sinclair, 1979; Bruininks, 1978; Charlop & Atwell, 1980; Folio & Fewell, 1983; Frankenburg, 1990; Henderson & Sugden, 1992; Johnston et al., 1987; Mutti et al., 1998; Werder & Bruininks, 1988).

Any study, however well it has been planned, has limitations, therefore the following recommendations for further research, which can strengthen the results of this study, can be made:

8.3.6 The results obtained highlight the need for further investigation into the current levels of gross motor development of South African children. A selected group of participants were used in this study, limiting the generalizability of the results. In future studies investigating current levels of gross motor development of preschool children, a randomly chosen group of participants, from different races and socio-economic
backgrounds, is recommended to be used in order to increase the generalizability of the results.

8.3.7 When studying the relationship between obesity and gross motor skill development in preschool children, the use of larger, randomly chosen groups, and taking into account factors like socio-economic background, nutritional status and physical activity levels, are also recommended. The classification of children as overweight and obese in one group in this study may have clouded the results obtained. Larger or more specific differences might be obtained if only the classification of obesity (excluding overweight) is used, thus comparing an obese group to a non-obese group. This classification might be appropriate among preschool children especially, as individual variation is high during this age period.

8.3.8 The results obtained with the one leg balance scores might be an indication of similar tendencies in other gross motor skills, like dynamic balance (beam walk) and locomotor skills (hopping and skipping). Further research is recommended with regard to the qualitative assessment of other fundamental gross motor skills.

8.3.9 The percentages of 3 year olds scoring above average for their age suggest that further research on the age-appropriateness (for South African children) of the quantitative norms and qualitative criteria used for 3 year olds in this study is essential.

8.3.10 In view of the gender differences found among the 3-6 year old children in this study, namely the throw-for-distance and standing long jump for 5 and 6 year olds and hopping (right leg) and one leg balance (right leg) for 3 year olds, further research should be aimed at the development of separate norms taking these differences into account.
REFERENCES


References


NFSC, see NATIONAL FOOD CONSUMPTION SURVEY.


References


References


Addenda
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