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Prevalence of motor skill impairment among Grade R learners in the West Coast District of South Africa

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A high prevalence of medical conditions affects the typical motor development of learners in the West Coast District of South Africa. Given the strong correlation between motor skill performance and academic achievement, this study aimed to determine the prevalence of motor skill impairment among Grade R learners (5–7-year olds) enrolled in public schools in the area. Multistage cluster sampling was used to identify 6 schools from which all Grade R learners were invited to participate. Following ethical approval, 138 learners' gross and fine motor skills were assessed using the Movement Assessment Battery for Children 2nd edition (M-ABC2). Results indicate that the prevalence of significant motor skill impairment in this region was high at **14.5%**, and that the prevalence of children with manual dexterity difficulties was very high, at **24.6%** (i.e. scores below the 15th percentile of the M-ABC2) when compared to global statistics, yet comparable to countries with a similar socio-economic structure. The prevalence of children with balance difficulties was **18.1%**, while the prevalence of children with difficulties in aiming and catching was low at **4.3%**. Pearson's correlation indicates that gender (male), a lack of playground equipment and low weight/height are factors associated with learners' poor manual dexterity, while poor manual dexterity and balance skills were associated with learners attending no-fee schools. The study confirms that motor skill difficulties are a significant problem in this region and calls for further research to address the problem.

Keywords: academic progress; Grade R learners; manual dexterity; motor impairment; motor skills; prevalence

Introduction

There is a strong correlation between motor skill difficulties and academic achievement (Geertsen, Thomas, Larsen, Dahn, Andersen, Krause-Jensen, Korup, Nielsen, Wienecke, Ritz, Krustup & Lundbye-Jensen, 2016). Studies have shown that fine motor skills together with general knowledge and executive functioning i.e. attention shifting, working memory, and inhibitory control; are strong academic predictors (Grissmer, Grimm, Aiyer, Murrah & Steele, 2010; Pienaar, Barhorst & Twisk, 2014). The level of a pre-school child's fine motor skill competence can also predict the level of progress s/he is likely to achieve over a six-month period (Cameron, Brock, Murrah, Bell, Worzalla, Grissmer & Morrison, 2012; Carlson, Rowe & Curby, 2013).

In South Africa, the prevalence of health conditions associated with motor skill impairment such as Human Immunodeficiency Virus (HIV), Acquired Immune Deficiency Syndrome (AIDS) (Avert, 2012) and Fetal Alcohol Syndrome (FAS) (Olivier, Curfs & Viljoen, 2016) is high. In addition, environmental factors such as high rates of crime and food insecurity may contribute to decreased levels of physical activity and motor proficiency among young children (Ghosh, Ghosh, Dutta Chowdhury, Wrotniak & Chandra, 2016). Low socio-economic status is a consistent predictor of poor motor skills as is evident in studies in countries with a similar, newly advanced economic development status as in South Africa. These include Brazil (Valentini, Clark & Whittall, 2015), China (Jin, Gu, Qin, Bai & Ma, 2015), and India (Girish, Raja & Kamath, 2016). Venter and Bham (2003) propose that this may account, in part, for the low levels of reading and mathematics literacy observed in some parts of South Africa. These factors are all predictors of high prevalence of motor skill impairment, however statistical evidence is lacking.

While motor skill impairments are often evident before children start school, these do not spontaneously improve without therapeutic intervention (Hillier, 2007). Early identification of, and intervention for children with gross and fine motor skill impairment is therefore important to facilitate and maximize academic performance (Erasmus, Janse van Rensburg, Pienaar & Ellis, 2016; Grissmer et al., 2010; Pienaar et al., 2014).

In our experience, teachers, therapists and healthcare professionals working in the West Coast District, a peri-urban/rural setting, face daily obstacles and restraints. Challenges faced by therapists in the region include limited staff, transport, and budgets. These challenges are also found elsewhere in South Africa (Bateman, 2012) and have been reported globally. For instance, in China (Prakash, Hariohm & Balaganapathy, 2014) and British Columbia (Roots, Brown, Bainbridge & Li, 2014) rehabilitation therapists echo accessibility and staff and resource shortages as barriers to service delivery. Limitations in resources are, however, altering therapists' perceptions of health and their roles as therapists, as the importance of community involvement is emphasised (Roots et al., 2014).

We believe that an urgent need exists for the improvement of health and academic outcomes among pre-school children living in the West Coast District of South Africa. However, before a school- or community-based intervention for pre-schoolers living in this region can be developed, it is crucial to know how prevalent the condition is. This knowledge would allow practitioners to target interventions for Grade R (pre-school) learners where they are needed most. At the time of our study no reliable prevalence data for motor skill impairment among pre-school children in this area or similar settings anywhere in South Africa existed. International prevalence data focusses predominantly on Developmental Coordination Disorder (DCD) and vary widely due to the diversity of populations, sampling, and outcome measures used. The aim of this study was, therefore, to describe the prevalence and level of motor impairment among pre-school children aged 5 to 6 years old living in the West Coast District of the Western Cape. Possible influencing factors were investigated as a secondary aim.

Conceptual Framework

Literacy is a significant problem on the West Coast of South Africa, with less than one quarter of adults over 20 years completing high school and one in five adults unemployed (Western Cape Government, 2016). In South Africa children struggle with academic achievement as early as Grade 1 (Venter & Bham, 2003). In fact, 52% of learners repeat a grade before Grade 10 (Grossen, Grobler & Lacante, 2017). One reason for the academic underachievement could be motor skill difficulties resulting from conditions with a high incidence in South Africa such as HIV (Rollins, Dedicoat, Danaviah, Page, Bishop, Kleinschmidt, Coovadia & Cassol, 2002) and FAS (Olivier et al., 2016). Research indicates that poor motor skills influence academic performance and a study from Finland (Haapala, Poikkeus, Tompuri, Kukkonen-Harjula, Leppänen, Lindi & Lakka, 2014) found that the 33% of children with the lowest level of motor performance had dramatically lower mathematics and reading scores across Grades 1 to 3 compared to children in the rest of the sample ($n = 174$, mean age = 7.7 years). Another study conducted among 423 older Danish children (mean age = 9.29 years) found significant relationships between fine and gross motor skills and cognitive abilities such as mathematics and reading (with $p < 0.001$) (Geertsen et al., 2016). A study in North America found that fine motor skills predicted better performance in sound awareness, picture vocabulary, passage comprehension, letter-word identification, and reading (Cameron et al., 2012). A study in Canada similarly found a relationship between fine motor skills and receptive language skills (Pagani, Fitzpatrick, Archambault & Janosz, 2010). This study

also found a relationship between fine motor skills and classroom participation. In the longer term, fine motor skills in kindergarten predicted reading ability in the second grade, mathematics, and general achievement. All the above studies highlight the importance of developing fine motor skills for a wide range of competencies, beyond the ability to draw and write, required for primary school learning.

Improving motor skills can enhance academic skills. Sherry and Draper (2013) advocate the use of gross motor interventions to address school readiness deficits. The authors made these recommendations following their experience in running a community-based programme (Little Champs) to help develop motor and cognitive skills in pre-school children from disadvantaged settings in South Africa (Draper, Achmat, Forbes & Lambert, 2012). Their findings suggest that significant progress occurred even with limited exposure to a low impact programme.

Few studies report on the prevalence of motor skill impairment among pre-school children, and those that do include this cohort, focus on children with specific health conditions. One Iranian study investigated the prevalence of motor development disorders among infants between four and 18 months and reported a normative prevalence of 3% (Soleimani, Vameghi, Biglarian & Rahgozar, 2014). Hillier (2007), in a systematic review that investigated the efficacy of interventions for children with Developmental Coordination Disorder (DCD), states that the prevalence of DCD is between 6 and 13% for school-aged children (Hillier, 2007). A more recent scoping review reported that the prevalence of DCD is consistently reported as 5 to 6% for all children (Camden, Wilson, Kirby, Sugden & Missiuna, 2015). It is also evident that the prevalence of motor impairment in developing countries is much higher than in developed countries/settings. In a study of disadvantaged Brazilian children (4 to 10 years), it was found that 18% of these children presented with DCD, with a further 15% being at risk of having DCD (Valentini et al., 2015). Another study among pre-school children (3 to 6 years) in the Jiangsu province of China, found that 6% of children met the criteria for DCD, with a further 15.6% with probable DCD (Jin et al., 2015). Among pre-term and low birth weight infants who do not develop cerebral palsy, the prevalence of motor impairment is very high and varies between 40.5% (with mild impairment) to 19% (with moderate impairment) (Williams, Lee & Anderson, 2010). Motor impairment among HIV-infected preschool children in the Cape Town area is reported to be even higher and was reported at 66% (Ferguson & Jelsma, 2009).

Other studies do not report motor impairment, but instead focus on the mastery of fundamental movement skills among children in mainstream

schooling. One such study conducted in Australia reported a low level of mastery of fundamental movement skills among Australian children (Hardy, Reinten-Reynolds, Espinel, Zask & Okely, 2012). A study from South Africa (Draper et al., 2012) showed that 15% ($n = 100$) of children from disadvantaged backgrounds scored very low in fine motor skills, while 8% scored very low in gross motor skill performance tests.

Young learners in South Africa, many from disadvantaged backgrounds, are often faced with complex medical and/or developmental conditions that affect their motor skills and ability to learn. Currently no prevalence data is available to identify the areas where the greatest need exists. Such reliable data is the first step required for intervention.

Method

Study Design

A cross-sectional descriptive study design was used to determine the prevalence of significant motor skill difficulties in Grade R learners in mainstream government schools of the West Coast.

Sampling

Multistage cluster sampling was used to identify six schools according to municipal areas, location (urban main places, urban areas and rural areas) as well as free/paying schools. Children with specific neurological conditions such as cerebral palsy, or muscular pathology such as muscular dystrophy, and children with physical disabilities or significant physical injuries were excluded from the study as these children have known motor dysfunction and are cared for in the public health care system. All children with other diagnoses such as DCD, attention deficit hyper-activity disorder (ADHD), attention deficit disorder (ADD), FAS, HIV/AIDS, etc., not commonly associated with a physical disability, were allowed to participate. Children receiving physiotherapy or occupational therapy were included in the study only if they had not been assessed using the M-ABC2 within the six months prior to the study, as this could affect the validity of the test. One hundred and thirty-nine Grade R learners (age 5 to 7), of which 66 girls and 72 boys, were included in the study. Only one child was later excluded from the study due to being absent on the day of testing.

Instruments and Procedure

The M-ABC2 (Henderson, Sugden & Barnett, 2007) was used to assess participants' motor skills. This tool provides objective quantitative data on motor skills performance. The performance test is designed to be administered individually and requires children to perform a series of eight motor tasks according to their specific age groups in a standard way. These tasks are categorised as manu-

al dexterity, balance, and aiming and catching. The test provides clear criteria to indicate significant motor skill delay and has been standardised for children without muscular or neurological pathology (Henderson et al., 2007). Raw scores are converted to standard scores and percentiles for individual items. Total scores can also be calculated. The total test score percentiles indicate levels of motor impairment at intervals of percentile.

As equipment for the test is standard and included, no additional equipment is needed. A qualified occupational therapist administered the assessments at four schools. Five occupational therapy students in their fourth year of study completed assessments at two schools as part of their research project.

Parents were asked to complete a simple questionnaire to supply additional information regarding their children's activities, therapies attended, and number of years in Grade R. All children were weighed and measured, and gender was recorded as additional anthropometric information.

Analysis

A descriptive analysis of the categories of the total percentages and subtests of the M-ABC2 were carried out. The categories of manual dexterity, ball skills and balance were analysed separately as well as for the total score. The guidelines as described in the M-ABC2 were used where a score below the 5th percentile indicates definite significant motor skill difficulty, a score between the 5th and 15th percentile indicates a risk of motor difficulties and a score above the 15th percentile indicates no risk of motor skill difficulties (Henderson et al., 2007). For the purpose of this study, the prevalence figures were measured for all scores below the 15th percentile in accordance with other international prevalence studies (Salie, 2009; Venetsanou, Kambas & Giannakidou, 2015).

Parametric tests (Pearson X^2 tests) were used to determine the effect of the following factors on motor impairment: gender, type of school (no-fee vs paying schools), and extent of playground available. A non-parametric test (Kruskal-Wallis) was used to measure the effect of weight and height on motor skills. Skewness statistics and its standard error indicated that weight was not normally distributed even though height was. A significance level was set at $p < 0.05$.

Results

Seventy-two boys and 66 girls ($n = 138$) participated in this study. The average age, weight and height of the children, with standard deviations, are shown in Table 1 and the data is noted according to gender, type of school (no-fee vs paying), and extent of the playground.

Table 1 Descriptive data for enrolled sample

	<i>N</i>	Age (years)	Height (cm)	Weight (kg)
		<i>M</i> ± <i>SD</i>	<i>M</i> ± <i>SD</i>	<i>Mdn</i> (range)
Male	72	6.6±0.38	115±6.26	20 (13–38)
Female	66	5.9±0.53	112±6.65	19 (10–38)
No-fee	69	5.9±0.51	112±6.17	18 (10–38)
Paying	69	5.11±0.47	115±6.53	22 (15–38)
Extensive playground	41	5.8±0.55	114±6.82	23 (16–38)
No/limited playground	97	5.9±0.41	113±6.31	19 (10–38)
Total	138	5.11±0.47	113±6.66	20 (10–38)

Prevalence of Motor Impairment

The total score and subtest scores for manual dexterity, aiming and catching, and balance, as determined using the M-ABC2, are shown in Table 2. Across all three sub-tests, the proportion of chil-

dren falling below the 5th percentile was higher than the proportion of children at risk (between 5th and 15th percentile). The findings suggest a high prevalence of manual dexterity and balance difficulties.

Table 2 M-ABC2 scores

	< 5th percentile	5th–15th percentile	< 15th percentile
Total score	8.7%	5.8%	14.5%
Manual dexterity	14.5%	10.1%	24.6%
Aiming and catching	2.2%	2.2%	4.3%
Balance	12.3%	5.8%	18.1%

Factors Associated with Motor Impairment**Gender**

Pearson X^2 tests revealed that gender was associated with manual dexterity ($p < 0.05$) (Table 3),

with boys significantly more likely to develop manual dexterity difficulties than girls. Gender was not associated with the total score ($p > 0.05$), aiming and catching, or balance.

Table 3 Influence of gender on the standard scores, manual dexterity, aiming and catching, and balance

		< 5th percentile	5th–15th percentile	> 15th percentile	<i>p</i>
Total score	Male	9.7%	2.8%	87.5%	0.27
	Female	7.6%	9.1%	83.3%	
Manual dexterity	Male	13.9%	16.7%	69.4%	0.029
	Female	15.2%	3.0%	81.8%	
Aiming and catching	Male	2.8%	1.4%	95.8%	0.712
	Female	1.5%	3.0%	95.5%	
Balance	Male	13.9%	6.9%	79.2%	0.677
	Female	10.6%	4.5%	84.8%	

No-fee vs paying schools

No-fee schools were associated with poor manual dexterity ($p < 0.05$) as well as balance difficulties.

As is clear from Table 4, type of school was not associated with the total score or aiming and catching.

Table 4 Influence of the type of school on the total scores, manual dexterity, aiming and catching, and balance

		< 5th percentile	5th–15th percentile	> 15th percentile	<i>p</i>
Total score	No fee	13%	7.2%	79.7%	0.132
	Fee	4.3%	4.3%	91.3%	
Manual dexterity	No fee	21%	13%	65.2%	0.018
	Fee	7.2%	7.2%	85.5%	
Aiming and catching	No fee	1.4%	0%	98.6%	0.178
	Fee	2.9%	4.3%	92.8%	
Balance	No fee	18.8%	2.9%	78.3%	0.03
	Fee	5.8%	8.7%	85.5%	

Playgrounds

For the purpose of this study, schools were described as having an extensive playground (multiple playground equipment) or a very limited/no playground (one piece of equipment, e.g., a swing/climbing frame or just a level play area).

Schools with a limited or no playground were associated with poor manual dexterity ($p < 0.05$). The extent of the playgrounds was not associated with the total score, aiming and catching, or balance skills, as described in Table 5.

Table 5 Influence of playground facilities on the total score, manual dexterity, aiming and catching, and balance

		< 5th percentile	5th–15th percentile	> 15th percentile	<i>p</i>
Total score	Extensive playground	2.4%	4.9%	92.7%	0.216
	Limited playground	11.3%	6.2%	82.5%	
Manual dexterity	Extensive playground	4.9%	2.4%	92.7%	0.009
	Limited playground	18.6%	13.4%	68.0%	
Aiming and catching	Extensive playground	2.4%	4.9%	92.7%	0.362
	Limited playground	2.1%	1.0%	96.9%	
Balance	Extensive playground	7.3%	9.8%	82.9%	0.25
	Limited playground	14.4%	4.1%	81.4%	

Weight and height

Low body mass (weight) as well as shorter posture (height) were significantly associated with poor

manual dexterity. Neither weight nor height was associated with the total score, aiming and catching, or balance (see Table 6).

Table 6 Influence of weight and height on the total score and individual aspects of manual dexterity, aiming and catching, and balance

	Influence of weight (<i>p</i> value)	Influence of height (<i>p</i> value)
Total score	0.118	0.220
Manual dexterity	0.002	0.005
Aiming and catching	0.278	0.372
Balance	0.954	0.971

Discussion

A higher prevalence of motor skill impairment (14.5%) among children aged 5 to 7 years living on the West Coast of South Africa was found when compared to international figures, where the prevalence of DCD is reported to be between 5 and 6% (Camden et al., 2015). These findings are comparable to countries with similar economic development (Jin et al., 2015; Schultz, 1999; Valentini et al., 2015), and contributes to the evidence that suggests that children living in areas of lower socio-economic status are more likely to present with motor skill difficulties than those from higher socio-economic settings. This also suggests that these areas have a greater need for therapeutic interventions. The lack of therapy resources in these poor-resourced settings means that children with motor difficulties may not be identified timeously and may never receive the therapeutic input they need to improve their skills. Consequently, many of these children may be disadvantaged and not fully ready to face the challenges of the mainstream curriculum. This places them at a disadvantage to progress, even before they start school.

Particularly alarming is our finding that approximately one quarter (24.6%) of participants in this study scored below international norms for fine motor skills, also known as manual dexterity difficulties. Fine motor skills difficulties are strongly associated with auditory comprehension and levels of attention (Jacobs, Miller & Tirella, 2010), as well as school readiness (Cameron et al., 2012). This means that at least a quarter of children living on the West Coast are potentially not ready to start formal schooling. The provision of these statistics may help to create awareness of the significance of the problem.

Current literature often focuses on the rela-

tionship between motor skills and obesity. In a large population-based study of the relationship between obesity and motor skills in the United States of America, Castetbon and Andreyeva (2012) found no difference in coordination or fine motor skills among children aged 5 to 6 years ($n = 5,100$). Only jumping and hopping (gross motor skills) appeared to be affected by obesity (Castetbon & Andreyeva, 2012). In contrast, our study highlights the negative effect that low body mass and height can have on the development of motor skills, particularly fine motor skills. Despite no-fee schools all having a feeding programme in place where children receive one to two meals daily, some children were still underweight and shorter than their peers from less poorer settings. The importance of a healthy diet and lifestyle should be regarded as a priority for pre-school children, not only to combat obesity, but also to assist in developing a healthy body-mass index (BMI) for children who are possibly malnourished. Children with a low BMI should be monitored and screened as priority for possible motor skill difficulties.

Schools in the public sector are considered no-fee (free) or not, according to the parents' income, unemployment rate, and levels of education. Results indicate that learners in no-fee schools are more prone to fine motor difficulties. No-fee schools also had no or very limited playground equipment, for example, one small jungle gym or climbing frame, while all the fee-paying schools had more extensive playgrounds. This study supports the notion that access to playgrounds at school contributes significantly to children's development of fine motor skills. It was, however, interesting that learners with no or very limited access to playgrounds had developed good ball skills – in most cases better than those of learners with access

to playgrounds. This may be because ball play is a relatively cheap and easily accessible option of play where not many play facilities are available. The size and quality of playgrounds were also highlighted as a strong influencing factors in children's motivation to take part in physical play (Delidou, Matsouka & Nikolaidis, 2016). This emphasises the importance of considering environmental factors, including the role parents and the community in supporting and promoting play in young children.

One limitation of this study is that it focused on mainstream government schools only. How this will compare to prevalence in private schools and/or special schools is yet to be determined. The results of this prevalence study however confirm the significant challenges that pre-school children face with regard to motor skill development and subsequent school readiness.

Conclusion

A high prevalence of motor skill impairment, fine motor difficulties in particular, among Grade R learners in the West Coast District of South Africa indicates a need for input to address the problem. It appears from this study that children in no-fee schools were more prone to lower body mass and height, and lacked playground opportunities. The results show that both these factors were significant indicators of fine motor difficulties. This study introduces several unanswered questions regarding community involvement, socio-economic issues, nutrition, and the effect of playground equipment on the development of learners' motor skills. The study further highlights the need to develop an affordable therapeutic input method to help improve motor skills in Grade R learners to help prepare them for Grade 1 and a better educational future. Further research in these areas is implied, which should provide valuable information concerning ways or methods for addressing motor skill difficulties in many young children, not only in South Africa, but also in countries with similar socio-economic structures.

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Author's Contributions

Janke van der Walt conceptualised and designed the study, collected data (together with occupational therapy [OT] students) and carried out the initial analyses, drafted the initial manuscript and reviewed and revised the manuscript. Nicola Plastow and Marianne Unger coordinated and supervised the study including data collection, critical review of the manuscript for important intellectual content and the review and revision of the manuscript. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

Notes

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