South African Journal for Research in Sport, Physical Education and Recreation, 2016, 38(2): 49 - 62.
Suid-Afrikaanse Tydskrif vir Navorsing in Sport, Liggaamlike Opvoedkunde en Ontspanning, 2016, 38(2): 49 - 62.
ISBN: 0379-9069

PREVALENCE AND EFFECT OF DEVELOPMENTAL COORDINATION DISORDER ON LEARNING-RELATED SKILLS OF SOUTH AFRICAN GRADE ONE CHILDREN

Monique DE MILANDER[1], Frederik F. COETZEE[1] & Andrè VENTER[2]
[1] *Department of Exercise and Sport Sciences, University of the Free State, Bloemfontein, Republic of South Africa*
[2] *Department of Paediatrics, University of the Free State, Bloemfontein, Republic of South Africa*

ABSTRACT

Physically awkward children face a host of difficulties, which include difficulties in the school environment. Therefore, it is important to identify Developmental Coordination Disorder (DCD) early in a child's life to allow for proper and timely intervention and support. The objective of this study was to determine the prevalence of DCD and examine the relationship of the degree of motor difficulties on learning-related skills. This comparative study made use of quantitative data. Three hundred and forty-seven (N=347) Grade 1 children took part and were between the ages of five and eight years (mean age=6.58±0.4). There were 190 girls and 157 boys. The Movement Assessment Battery for Children-2 (MABC-2 Test) was used to identify DCD. In addition, each participant was evaluated with the Aptitude Test for School Beginners (ASB). Learning-related skills of children with DCD were compared to those without DCD. The prevalence of DCD (severe motor difficulties) was 6% and the at-risk group constituted another 6%. Motor difficulties had a significant effect on five of the eight learning-related subtypes, namely reasoning, numerical skills, gestalt, coordination and memory. Children with DCD experienced more learning-related problems compared to their peers without DCD.

Key words: Developmental Coordination Disorder (DCD); Movement Assessment Battery for Children-2; Learning-related skills; Aptitude Test for School Beginners questionnaire.

INTRODUCTION

Children with Developmental Coordination Disorder (DCD) experience considerable difficulties in motor learning and in the performance of functional motor tasks that are critical for success in the school environment (APA, 2013). These children demonstrate poor motor performance that is not accounted for by their age, intellect or neurological disorders, and the impact can be found in both their daily living activities and academic performance (APA, 2013).

Research indicates that DCD affects 5 to 6% of school-age children (Gaines & Missiuna, 2007; APA, 2013). According to Hamilton (2002), as well as Wilmut *et al*. (2007), the prevalence of DCD might be even higher (5 to 15%), and the research indicates that a large percentage of school-aged children have coordination difficulties serious enough to interfere

with social integration and academic performance. In South Africa (Bloemfontein, Free State Province), the results indicated that 15% of children between the ages of 6 to 8 years have moderate to severe motor difficulties (De Milander *et al*., 2014). This study involved 559 children, 321 girls and 238 boys, however, the majority of the sample consisted of Caucasian children indicating a high socio-economic status (SES). Alarmingly, a study reported a significantly higher (61.2%) prevalence of DCD in the North-West Province of South Africa (SA), according to Pienaar (2004). The study consisted of 688 children (338 boys and 350 girls), between the ages of 10 to 12 years. The majority of the sample consisted of black children (74%) and at least 60% of the sample fell in a low SES.

A study undertaken by Wessels *et al*. (2008) found the prevalence to be 52% of a sample of 99 children, consisting of 47 boys and 52 girls, with a mean age of 83.33 months. This sample was proportional according to the various populations in SA. This clearly indicates that South African children appear to have more motor difficulties than children in other parts of the world. Pienaar (2004) concluded that the norms of the Movement Assessment Battery for Children (first edition), should be adjusted for South African children, although it was not implemented in her study. However, after the completion of the study by Pienaar, the second edition of the MABC was established where some of the items were changed. The norms according to Pienaar (2004), for a South African population was not used in the current study, since it is a standardised test and changing the norms would not provide the researchers with accurate results in addition to using the MABC-2. Besides, the real prevalence of DCD among children might even be higher, as medical and educational systems frequently fail to identify this disorder in young children (Hamilton, 2002; Missiuna, 2003; Miyahara *et al*., 2008).

A gender difference also occurs with regard to DCD. The literature indicates that boys experience more problems than girls with a boy:girl ratio of 2:1 (Wright & Sugden, 1996). According to Rivard *et al*. (2007), it has been estimated that the gender difference could even be as high as 3 to 4:1. These findings are supported by Hoare and Larkin (1991), who stated that more boys than girls are attending remedial programmes (9:1). South African researchers have found boy:girl ratios of 2 to 3:1 in a study conducted with 99 children with an average age of 83.33 months. Furthermore, the study included 47 boys and 52 girls and had a proportional distribution of the various populations in SA (Wessels *et al*., 2008). In addition, De Milander *et al*. (2014) established a 1 to 6:1 ratio on a sample of 559 children between the ages of 6 and 8 years. There were 321 girls and 238 boys in the study. However, the majority of the population consisted of Caucasian children (57.4%).

According to Schoemaker *et al*. (2003) and Sudgen and Wright (1998), cited in Iversen *et al*. (2005), the major concerns relating to DCD are the considerable harmful effects associated with this disorder. DCD influences children's daily activities at home (self-care tasks), normal play (running, riding a bike, swimming and ball games), and school activities (writing and cutting activities). A problem found amongst children with DCD is that they are often not formally diagnosed, but rather described by their teachers as lazy or awkward (Zwicker *et al*., 2012). These children are not diagnosed due to the lack of awareness of the disorder (Wilmut *et al*., 2007; Zwicker *et al*., 2012).

Children with DCD share a common feature, namely having trouble in executing motor skills necessary for progress in formal and informal learning in a school environment (Sugden & Chambers, 2003). The impaired ability to control functional movements often continues throughout the school years, with evidence showing that children do not outgrow this disorder (Henderson & Henderson, 2002; Sugden & Chambers, 2003). Thus, without early identification and intervention, the difficulties experienced in the school environment will persist into later life (Losse *et al*., 1991).

Secondary problems associated with DCD are physical health issues, such as obesity and lower aerobic capacity due to lower activity levels (Cantell *et al*., 2003; Tsiotra *et al*., 2009), social problems along with emotional problems due to withdrawal or exclusion from peers, as well as academic problems related to aspects such as tracing, writing and learning difficulties (Piek & Edwards, 1997; Hamilton, 2002; Cantell *et al*., 2003). Other co-occurring problems linked to DCD are speech and language disorders (Missiuna, 2003; Wilmut, 2007), visual-motor deficits (Hamilton, 2002), and Attention Deficit Hyperactivity Disorder (ADHD) (Watemberg *et al*., 2007; Wessels *et al*., 2008). It is clear from the literature that the DCD child experiences countless problems associated with the learning process.

PURPOSE OF THE STUDY

Limited research findings specifically with regard to the Movement Assessment Battery for Children-2 (MABC-2) and the Aptitude Test for School Beginners (ASB) were available with reference to the effect of DCD on learning-related skills amongst children in SA (Wessels *et al*., 2008). Thus, the purpose of this study was to determine the prevalence of DCD and the effect of DCD on learning-related skills amongst Grade 1 children in the Bloemfontein area, Free State Province, SA.

METHODOLOGY

Participants

The selection of the 7 mainstream schools was part of a larger randomly selected sample of 13 schools who were invited to participate. The participating schools were located within a 30km radius of the University of the Free State. The ASB is not a compulsory test for schools to use due to the financial implications associated with the test. However, the ASB still provides valuable information with reference to children's learning-related skills and for determining the effect of DCD. Due to the financial aspect, only 4 of the 7 schools that took part in this study still made use of the ASB.

Scores on the MABC-2 Test and the ASB were obtained for 347 Grade 1 children (190 girls and 157 boys). The children in this study were between the ages of 5 and 8 years. The minimum age was 5.67 years and the maximum age was 8.0 years (mean age of the children=6.58±0.4 years). All the children in the participating primary schools were considered for inclusion in the study. Exclusion criteria included a child in the age group outside the expected range of 5 to 8 years, parental permission not obtained or the informed consent not completed fully or because the parents indicated that they would be relocating during the study.

Additionally, the Diagnostic and Statistical Manual of Mental Disorders, fifth edition, (DSM-V) (APA, 2013), was used to exclude children who had associated symptoms according to the criteria for DCD as stated in the DSM-V. Children with motor difficulties should meet criterion C (disturbance is not due to a general medical condition, for example, cerebral palsy, hemiplegia, or muscular dystrophy, and does not meet criteria for a pervasive developmental disorder), or criterion D (if mental retardation is present, the motor difficulties are in excess of those usually associated with it). None of the children met the criteria and, therefore, all of them were included for further data analysis.

Ethical consideration

The Free State Department of Education and the principals of each school gave permission for the research to be conducted on the school premises during the Life Orientation periods. Approval was obtained from the Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS57/2012). The participants were treated in accordance with the ethical guidelines outlined by the Ethics Committee of the Faculty of Health Sciences. The parents of the participants completed an informed consent form for each child participating in this study. In addition, the children signed an assent form. Recruitment was targeted at children with and without DCD via the 4 participating schools.

Measuring instruments

Movement Assessment Battery for Children-2 (MABC-2 Test)

The MABC-2 Test requires children to perform a series of motor tasks in a specified manner (Henderson *et al*., 2007). In addition to age-related norms, the test also provides qualitative information on how children should approach and perform the tasks. The MABC-2 Test is used to assess the motor proficiency levels of the subject and to diagnose DCD in children. The first assessment component of this test battery contains 24 items organised into 3 sets of 8 tasks. Each set is designed for use with children of a different age band. For the current study, age band 1 and age band 2 were used.

The 8 tasks are grouped under 3 headings, namely manual dexterity (MD), balance (B) and aiming and catching (AC). Age-adjusted standard scores and percentiles are provided, as well as a total test score for each of the 3 components of the test. The total test score can be interpreted in terms of a "traffic light" system. The green zone indicates performance in a normal range of a score above 67 (>15th percentile), while the amber zone indicates that a child is at risk, between 57 to 67 and needs to be carefully monitored (5th to 15th percentile). The red zone is an indication of definite motor impairment, up to and including 56 (≤5th percentile). Thus, high standard scores on the MABC-2 Test represent good performance. The MABC-2 (performance test) was used instead of the Checklist, since it is only used for screening purposes of bigger groups by means of a teacher or parent. The MABC-2 Test is a valid and reliable tool to use with a reliability coefficient for the total test scores of 0.80 (Henderson *et al*., 2007).

Aptitude Test for School Beginners (ASB)

Qualified teachers administered the ASB to all participating children during the first 2 months of the school year. A requirement of the ASB is that it must be presented and completed in the mother tongue of a child. The ASB is a norm-based instrument and consists of 8 sub-

items, which include perception, spatial skills, reasoning, numerical skills, gestalt, coordination, memory and verbal comprehension (Olivier & Swart, 1996; Van Zyl, 2004). Each sub-item is evaluated by means of a standard score out of 5. An evaluation score of 1 is regarded as below average and an evaluation score of 5 as above average. The aim of the ASB is to obtain a differentiated picture of certain aptitudes of Grade 1 children. The ASB is a valid and reliable tool with a reliability coefficient for the total test of 0.80 (Olivier & Swart, 1996).

Procedure

This comparative study made use of quantitative data. The study involved 1 testing procedure by means of the MABC-2 Test in order to identify DCD among Grade 1 children. Kinderkineticists in training, who had been trained in the use of the measuring instrument, tested the participants at their schools during the Life Orientation periods. Each Kinderkineticist was responsible for 1 subtest in order to have consistency across the study. In addition, each participant was evaluated with the ASB that was conducted and interpreted by qualified teachers. Teachers, psychologists and occupation therapists need to obtain this qualification from Mindmuzik Media [Pty] Ltd Service Provider Accreditation Number: UP/SP/0735 (University of Pretoria) (Mindmuzik Media, 2015), or from Mind Moves. In the current study, 4 teachers were used to gather the information required. Learning-related skills (determined with the ASB) of children with DCD (as identified by the MABC-2 Test), were compared to the learning-related skills of children without DCD.

Analysis of data

The principle researcher using Microsoft Excel captured data from the MABC-2 Test and the ASB electronically. A statistician performed the data analysis using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS version 16.0, SPSS Inc., Chicago, IL). Descriptive statistics, namely frequencies and percentages were calculated for categorical data. Medians and percentiles were calculated for numerical data. Median differences were tested by calculating p-values using the Signed-Rank Test. The chi-squared statistics was used to test for proportional differences. A probability level of 0.05 or less was accepted to indicate statistical significance.

RESULTS

The distribution of the children in terms of the traffic light system (degree of motor difficulty) according to the MABC-2 Test is illustrated in Figure 1.

The green zone indicates no motor difficulties (88%), amber zone indicates moderate motor difficulties (6%) and the red zone indicates severe motor difficulties or DCD (6%) amongst children in Bloemfontein, Free State province, SA.

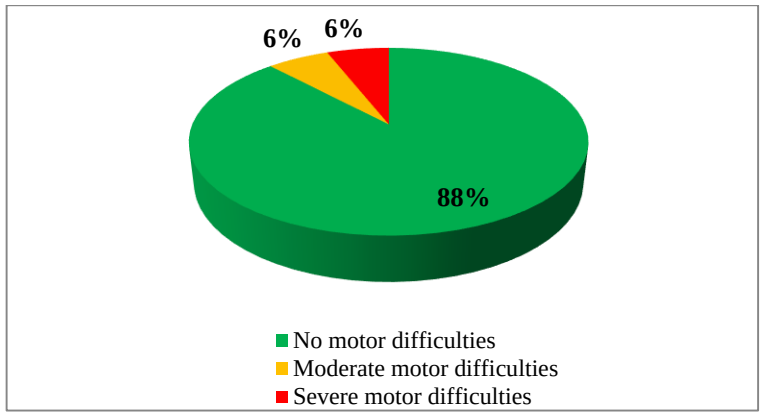


Figure 1. **PREVALENCE OF DCD IN CHILDREN IN GRADE 1**

The distribution of the girls and boys in terms of the traffic light system (degree of motor difficulty) according to the MABC-2 test is shown in Figure 2 and 3.

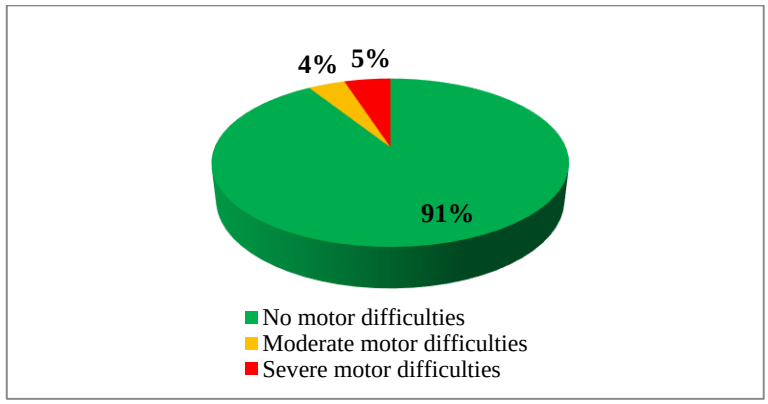


Figure 2. **PREVALENCE OF DCD AMONG THE GIRLS**

As expected, Figure 2 and 3 indicate that 91% of the girls fell in the green zone compared to 84% of the boys. With reference to the amber zone, 4% of the girls had moderate motor difficulties in contrast to 9% of the boys. The red zone indicates that 5% of the girls had severe motor difficulties compared to 7% of the boys. However, there was no significant difference (p=0.115) between the genders.

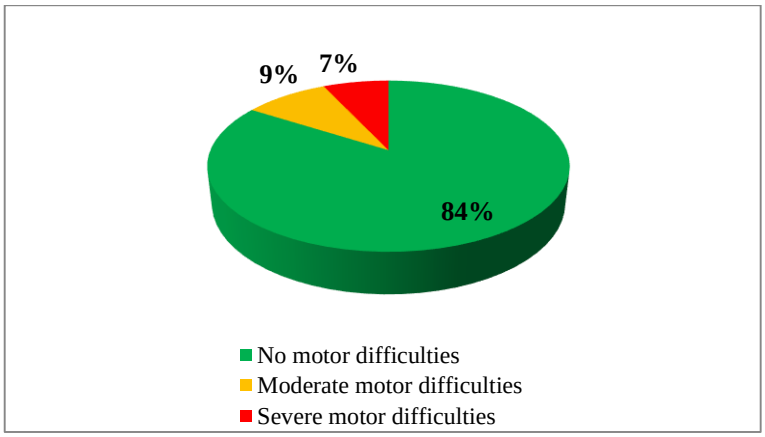


Figure 3. **PREVALENCE OF DCD AMONG THE BOYS**

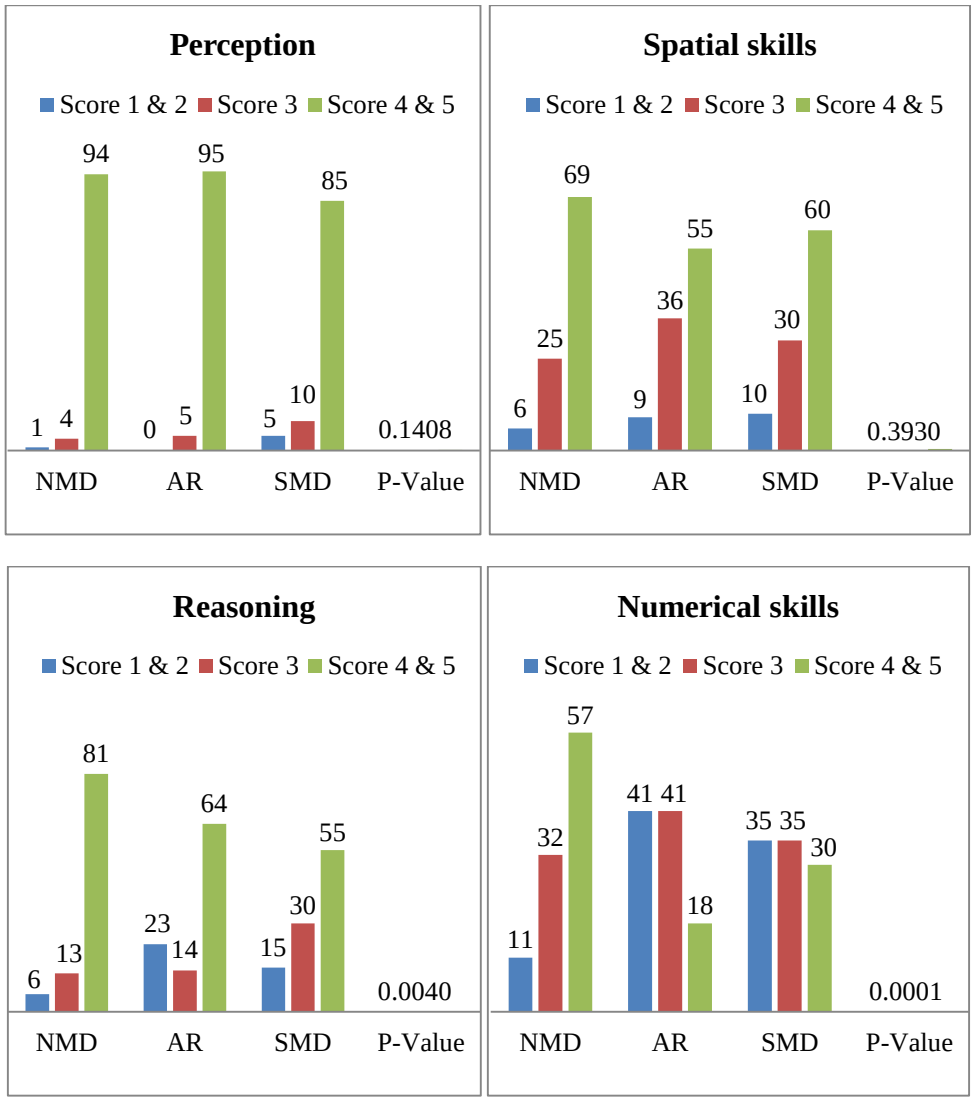
Figure 4, presented on the next page, indicates the results of the various learning-related skills according to the ASB in the different categories of degree of motor difficulty (at risk and severe), and no motor difficulties. It can be observed that for 3 of the 8 learning-related skills, namely perception (p=0.141), spatial skills (p=0.393) and comprehension (p=0.074), there were no significant differences between children with DCD and those without DCD. Furthermore, for the remaining learning-related skills, significant differences were indicated for reasoning (p=0.004) and memory (p=0.024). However, there were highly significant differences between the children with different degrees of motor difficulty and those with no motor difficulties for numerical skills (p=0.0001), gestalt (p=0.0001) and coordination (p=0.0001), where children without DCD significantly outperformed their peers with DCD.

In summary, it would appear that children at risk for motor difficulties and those with severe motor difficulties may struggle more with the domains of reasoning, numerical skills, gestalt, coordination and memory, as illustrated by the sub-tests of the ASB.

DISCUSSION

The research set out to determine the prevalence of DCD in Bloemfontein, Free State Province, SA. In addition, the study aimed to provide possible answers regarding the effect of DCD on specific learning-related skills amongst children aged five to eight years.

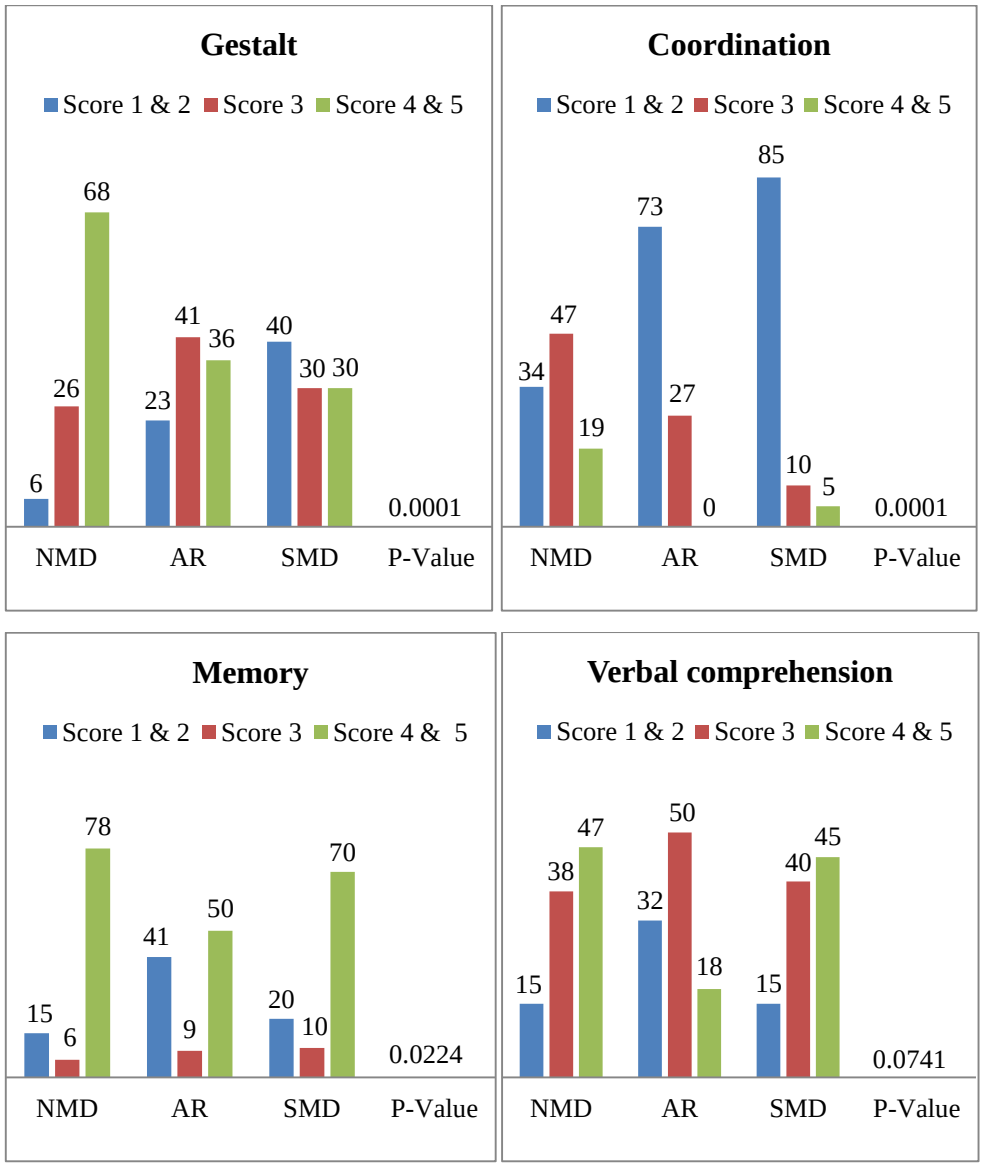
Literature clearly indicates that DCD affects children all over the world, but the prevalence differs considerably between various countries (Lingam *et al*., 2009; Prado *et al*., 2009). The results of the current study indicate that at least 12% of the sample had moderate to severe motor difficulties. These results are in contrast to various findings reported in the literature where the researchers state that DCD affects more or less 5 to 6% of school-age children (Prado *et al*., 2009; APA, 2013).



NMD = no motor difficulties AR = At Risk SMD = Severe Motor Difficulties
Score 1 & 2 = Below average Score 3 = Average Score 4 & 5 = Above average

Figure 4. **LEARNING-RELATED SKILL SCORES OF ASB EXPRESSED AS A PERCENTAGE BY DEGREE OF MOTOR DIFFICULTY IN EACH SUBCOMPONENT**

Continued …



NMD = No Motor Difficulties AR = At Risk SMD = Severe Motor Difficulties
Score 1 & 2 = Below average Score 3 = Average Score 4 & 5 = Above average.

Figure 4. **LEARNING-RELATED SKILL SCORES OF ASB EXPRESSED AS A PERCENTAGE BY DEGREE OF MOTOR DIFFICULTY IN EACH SUBCOMPONENT** *(continued)*

Researchers reporting on the prevalence of DCD in the United Kingdom estimate that 4 to 5% of children struggle with motor difficulties (Lingam *et al*., 2009), which is much lower than the 12% found in the present study. The findings of research conducted on Canadian children correlate the best with the findings of the current study. These researchers found approximately 8 to 15% of Canadian children to have some form of coordination problems (Junaid *et al*., 2000). Studies in America and Europe found an even higher prevalence of DCD, estimated at 5 to 19% (Miller *et al*., 2001). It is interesting to note that more children are experiencing motor difficulties than previously indicated in the literature.

The current study found that boys did not exhibit significantly ($p=0.1150$) more moderate to severe motor difficulties than girls, with a boy:girl ratio of 1 to 6:1. However, this ratio is smaller than the ratio found in other research. The literature indicates that boys experience more problems than girls, with reported boy:girl ratios of 2 to 3 (Wessels *et al*., 2008) and 3 to 4:1 (Wright & Sugden, 1996). Although gender differences do occur, researchers need to take into consideration that gender differences are a normal phenomenon in the attainment of motor skills among children. Literature indicates that girls perform better in fine motor skills, whilst boys are better at gross motor skills (Gallahue & Ozmun, 2006). Furthermore, research reported that girls outperformed boys with regard to the manual dexterity items of the MABC and boys were superior with regard to the ball skills items (Junaid & Fellowes, 2006). No differences were established between boys and girls for balancing skills and the researchers argue that these differences were due to the disparity in the acquisition of motor skills between boys and girls (Junaid & Fellowes, 2006).

Research reported on the effect of DCD on specific learning-related skills such as reasoning, numerical skills, gestalt, coordination, memory perception, spatial skills and comprehension amongst children are limited. The results of the current study indicate that the different degrees of motor difficulty do have a significant differential negative effect on the subtypes of specific learning-related skills such as reasoning, numerical skills, gestalt, coordination and memory. This may be because children who are at risk, as well as children with severe motor difficulties, could have deficits due to their diagnosis that may influence these different domains negatively.

Children with DCD struggle to organise tasks, since the DCD child needs to plan the movement repeatedly. This could influence their gestalt and reasoning abilities. The findings of the current study correlate with a number of other studies indicating that children with DCD struggle with academic skills such as writing and tracing, which forms part of gestalt and numerical and coordination abilities (Hamilton, 2002; Missiuna, 2003; Tsiotra *et al*., 2009). Since children with DCD struggle with coordination activities in general, it is obvious that they will experience significant difficulties with regard to the coordination domain of the ASB. This result correlates with a previous study done in Potchefstroom, North-West Province, SA, where the researchers established that boys with DCD struggled more with the coordination domain of the ASB (Wessels *et al*., 2008). In contrast to the current study, the same researchers did not find any significant correlation between learning-related skills and DCD with regard to the remaining seven domains in 52 children with DCD (Wessels *et al*., 2008).

There were no significant differences between the different categories of motor difficulties for the domains of perception, spatial skills and verbal comprehension. The results of the current study indicate that being at risk for or having severe motor difficulties did have an effect on learning-related skills. Similar to the results of this study, the majority of research reported that there is a strong relationship between DCD and learning-related skills and that many children with DCD experience difficulties with learning and academic performance (Hamilton, 2002; Henderson & Henderson, 2002; Rivard *et al*., 2007; Wilmut *et al*., 2007; Tsiotra *et al*., 2009).

The current research showed that children who are at risk for or who have severe motor difficulties are potentially at risk of struggling more with specific learning-related skills. These findings of this research can be drawn upon to evaluate, manage and possibly improve the specific domains of weakness for the degrees of motor difficulty in order to improve these children's prognosis for their learning-related skills.

LIMITATIONS AND RECOMMENDATIONS

This study had some limitations. It should be recognised that the current study only recruited children from the Bloemfontein metropolitan area, while excluding children from the rural regions. Furthermore, since this was a population-based sample, criterion B of the diagnostic criteria for DCD, which states that the academic performance of the children should also be considered (APA, 2013), was not used. Hence, a replication of this study in the different provinces and regions in SA is recommended so that more generalizable and robust results can be provided. The researchers are of the opinion that an equal distribution of various populations and schools from lower socio-economic backgrounds should be included in future research. Furthermore, the authors concur with Pienaar (2004) who stated that the norms of the MABC-2 should be adapted for the South African population.

CONCLUSIONS

The results of this study are important for teachers who work with young children, as children who start formal school with a motor deficit may also have problems with a variety of learning-related skills necessary for school success. Thus, teachers can take these limitations into consideration and address these problems by means of new preventative strategies. It would also be necessary to present motor programmes by professionals who are familiar with motor development, to attend to the motor difficulties experienced by children with DCD. It is important to view development in a holistic manner (Van Zyl, 2004), thus, motor difficulties and difficulties with learning-related skills should be addressed in order to minimise problems associated with academic performance.

As indicated in the current study, children with DCD in a Bloemfontein, Free State Province, South African sample, struggle more with learning-related skills than children without motor difficulties. The researchers, therefore, conclude that it is critical that early identification of DCD should take place by means of parent and teacher questionnaires, as well as professionals such as Kinderkineticists, since these children do not outgrow their motor difficulties. Appropriate interventions such as a combination of the bottom-up- and top-down approaches, which could improve their motor abilities and scholastic performance by

professionals at an early age, are crucial. Results with regard to the learning-related skills can offer teachers a better understanding of difficulties experienced by children with DCD. Thus, the researchers propose that teachers should consider these difficulties to help children excel in their academic performance.

Acknowledgement

Thank you to the principals, staff members and children at the primary schools where the study was conducted.

REFERENCES

APA (AMERICAN PSYCHIATRIC ASSOCIATION) (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Association.

CANTELL, M.H.; SMYTH, M.M. & AHONEN, T.P. (2003). Two distinct pathways for developmental coordination disorder: Persistence and resolution. *Human Movement Science*, 22(4-5): 413-431.

DE MILANDER, M.; COETZEE, F.F. & VENTER, A. (2014). Developmental coordination disorder in Grade 1-learners. *African Journal for Physical, Health Education, Recreation and Dance*, 20(3): 1075-1085.

GAINES, R. & MISSIUNA, C. (2007). Early identification: Are speech/language-impaired toddlers at increased risk for developmental coordination disorder? *Child Care Health and Development*, 33(3): 325-332.

GALLAHUE, D.L. & OZMUN, J.C. (2006). *Understanding motor development: Infants, children, adolescents, adults* (6th ed.). Boston, MA: McGraw-Hill.

HAMILTON, S.S. (2002). Evaluation of clumsiness in children. *American Family Physician*, 66(8): 1435-1441.

HENDERSON, S.E. & HENDERSON, L. (2002). Toward an understanding of developmental coordination disorder. *Adapt Physical Activity Quarterly*, 19(1): 11-31.

HENDERSON, S.E.; SUGDEN, D.A. & BARNETT, A.L. (2007). *Movement Assessment Battery for Children-2* (2nd ed.). London, UK: Harcourt Assessment.

HOARE, D. & LARKIN, D. (1991). State of the Art Review No. 18: Coordination problems in children. Canberra, Australia: National Sports Research Centre, Australian Sports Commission.

IVERSEN, S.; ELLERTSEN, B.; TYTLANDSVIK, A. & NODLAND, M. (2005). Intervention for 6-year-old children with motor coordination difficulties: Parental perspectives at follow-up in middle childhood. *Advances in Physiotherapy*, 7(2): 67-76.

JUNAID, K.A.; HARRIS, S.R.; FULMER, K.A. & CARSWELL, A. (2000). Teachers' use of the MABC Checklist to identify children with motor coordination difficulties. *Paediatric Physical Therapy*, 12(4): 158-163.

JUNAID, K.A. & FELLOWES, S. (2006). Gender differences in the attainment of motor skills on the Movement Assessment Battery for Children. *Physical Occupation Therapy in Paediatrics*, 26(1-2): 5-11.

LINGAM, R.; HUNT, L.; GOLDING, J.; JONGMANS, M. & EMOND, A. (2009). Prevalence of developmental coordination disorder using the DSM-IV at 7 years of age: A UK population-based study. *Paediatrics*, 123(4): 693-700.

LOSSE, A.; HENDERSON, S.E.; ELLIMAN, D.; HALL, D.; KNIGHT, E. & JONGMANS, M. (1991). Clumsiness in children – do they grow out of it? A 10-year follow-up study. *Development Medicine and Child Neurology*, 33(1): 55-68.

MILLER, L.T.; MISSIUNA, C.A.; MACNAB, J.J.; MALLOY-MILLER, T. & POLATAJKO, H.J. (2001). Clinical description of children with developmental coordination disorder. *Canadian Journal of Occupation Therapy*, 68(1): 5-15.

MINDMUZIK MEDIA (2015). Hyperlink: [http://mindmuzik.com/index.php?option=com_content&view=article&id=62&Itemid=116]. Retrieved on 18 November 2015.

MISSIUNA, C. (2003). Children with Developmental Coordination Disorder: At home and in the classroom [booklet]. Hamilton, ON: Can Child Centre for Childhood Disability Research.

MIYAHARA, M.; YAMAGUCHI, M. & GREEN, C. (2008). A review of 326 children with developmental and physical disabilities, consecutively taught at the Movement Development Clinic: Prevalence and intervention outcomes of children with DCD. *Journal of Developmental and Physical Disability*, 20(4): 353-363.

OLIVIER, N.M. & SWART, D.J. (1996). Handleiding vir aanlegtoetse vir skoolbeginners *(ASB)* (*trans*.: *Manual of aptitude tests for school beginners*). Pretoria, RSA: Raad vir Geesteswetenskaplike Navorsing (*trans*.: Human Science Research Council).

PIEK, J.P. & EDWARDS, K. (1997). The identification of children with developmental coordination disorder by class and physical education teachers. *British Journal of Education Psychology*, 67(1): 55-67.

PIENAAR, A.E. (2004). Developmental co-ordination disorder in an ethno-racially diverse African nation: Should norms of the MABC be adjusted? *Journal of Human Movement Studies*, 47(1): 75-92.

PRADO, M.S.S.; MAGALHÃES, L.C. & WILSON, B.N. (2009). Cross-cultural adaptation of the Developmental Coordination Disorder Questionnaire for Brazilian children. *Brazilian Journal of Physical Therapy*, 13(3): 236-243.

RIVARD, L.M.; MISSIUNA, C.; HANNA, S. & WISHART, L. (2007). Understanding teachers' perceptions of the motor difficulties of children with developmental coordination disorder (DCD). *British Journal of Educational Psychology*, 77(3): 633-648.

SCHOEMAKER, M.M.; SMITS-ENGELSMAN, B.C.M. & JONGMANS, M.J. (2003). Psychometric properties of the Movement Assessment Battery for Children-Checklist as a screening instrument for children with a developmental co-ordination disorder. *British Journal of Educational Psychology*, 73(3): 425-441.

SUGDEN, D.A. & CHAMBERS, M.E. (2003). Intervention in children with developmental coordination disorder: the role of parents and teachers. *British Journal of Educational Psychology*, 73(4): 545-561.

SUGDEN, D.A. & WRIGHT, H.C. (1998). *Motor coordination disorders in children*. Thousand Oaks, CA: Sage Publications.

SUGDEN, D.A. & WRIGHT, H.C. (1998). Motor coordination disorders in children. Thousand Oaks, CA: Sage. In Iversen, S., Ellertsen, B., Tytlandsvik, A. & Nodland, M. (2005). Intervention for 6-year-old children with motor coordination difficulties: Parental perspectives at follow-up in middle childhood. *Advances in Physiotherapy*, 7(2):67-76.

TSIOTRA, G.D.; NEVILL, A.M.; LANE, A.M. & KOUTEDAKIS, Y. (2009). Physical fitness and developmental coordination disorder in Greek children. *Paediatric Exercise Science*, 21(2): 186-195.

VAN ZYL, E. (2004). The relation between perceptual development (as part of school readiness) and school success of Grade 1 learners. *Africa Education Review*, 1(1): 147-159.

WATEMBERG, N.; WAISERBERG, N.; ZUK, L. & LERMAN-SAGIE, T. (2007). Developmental coordination disorder in children with attention-deficit-hyperactivity disorder and physical therapy intervention. *Development and Medicine Child Neurology*, 49(12): 920-925.

WESSELS, Y.; PIENAAR, A.E. & PEENS, A. (2008). Gender and racial differences in 6- and 7-year-old children with developmental coordination disorder (DCD) in learning-related abilities and ADHD. *Journal of Humanities*, 48(4): 493-504.

WILMUT, K.; BROWN, J.H. & WANN, J.P. (2007). Attention disengagement in children with developmental coordination disorder. *Disability and Rehabilitation*, 29(1): 47-55.

WRIGHT, H.C. & SUGDEN, D.A. (1996). A two-step procedure for the identification of children with developmental co-ordination disorder in Singapore. *Development and Medicine Child Neurology*, 38(12): 1099-1105.

ZWICKER, J.G.; MISSIUNA, C.; HARRIS, S.R. & BOYD, L.A. (2012). Developmental coordination disorder: A review and update. *European Journal of Paediatric Neurology*, 16(6): 573-581.

Dr Monique de MILANDER: Department of Exercise and Sport Sciences, University of the Free State, PO Box 339, Bloemfontein, 9300. Republic of South Africa. Tel.: +27 (0)51 401 9342 (w), +27 (0)82 979 1040 (h), Fax.: 051 401 2323, Email: demilanderm@ufs.ac.za

(Subject Editor: Dr Dané Coetzee)