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BALANCE AND BILATERAL SKILLS OF SELECTED PREVIOUSLY DISADVANTAGED CHILDREN AGED 9 TO 12 YEARS

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ABSTRACT

The main aim of the study was to design an appropriate motor skills development programme that could be implemented in any primary school to improve the fundamental motor skills (FMS) of children between the ages of 9 and 12 years old. One previously disadvantaged (Quintile 2) school in the Stellenbosch region was selected to participate in the study. The children (N=67) were conveniently selected to participate in the study and were divided into an experimental (n=35) and a control group (n=32). Only the experimental group participated in the motor skill development programme for 12 weeks. No significant differences were found for the mean balance score within the experimental and the control group or between the pre- and post-test. However, there were significant differences found for the mean bilateral coordination scores between the pre- and post-test of the experimental group but not with the control group. This could be attributed to the 12-week intervention programme presented to the experimental group. It is suggested that this programme may be beneficial to all primary school children, not only those from previously disadvantaged schools.

Key words: Balance; Bilateral coordination; Children; Fundamental movement skills.

INTRODUCTION

Movement is such a natural part of a human's daily life that the importance thereof is often overlooked. It is, however, vital for the development of a child's physical, cognitive and social characteristics (Cools *et al*., 2009). Many children who appear to be 'normal' at first sight might experience complications with the acquisition and performance of basic motor skills. These children are often described as clumsy and the cause of the impaired motor performance is usually ascribed to an underlying problem that is not always easy to observe (Smyth, 1992; Hands, 2012).

In order to execute motor skills successfully, the child needs well developed balance and bilateral coordination (Gallahue & Donnelly, 2003). Balance is the ability of a human to maintain his or her equilibrium in relation to the force of gravity, whether the body is static or performing a dynamic activity, as well as the ability to make very small alterations in the body when placed in various positions (Gallahue & Donnelly, 2003). To be able to maintain balance, the line of gravity that passes through the centre of gravity must also lie within the base of support. If this line falls outside the base of support, a person cannot maintain balance and will fall unless compensatory movements are made (Gallahue & Donnelly, 2003).

Balance involves motor control skills that are required for the maintenance of posture whilst standing, walking or other common tasks, such as reaching for an object on a shelf (Bruininks & Bruininks, 2005). Both static (stationary) and dynamic (in motion) balance are in play (Gallahue & Donnelly, 2003; Bruininks & Bruininks, 2005). It is evident that all movement involves an element of balance, whether static or dynamic, as balance is a basic aspect of all movement. Due to this, it is critical that children develop their ability to balance from an early age (Gallahue & Donnelly, 2003).

Bilateral coordination is the ability to use both arms and/or legs together in a coordinated manner and is also known as bilateral integration (Le Roux, 2011; Pienaar, 2012). It is vital to develop bilateral coordination as it provides the foundation for the establishment of hand dominance and it is used in various daily tasks in the school and home environment (Le Roux, 2011; Pienaar, 2012). These skills begin to emerge during the early baby years and consist of symmetrical and asymmetrical movements (Le Roux, 2011). Symmetrical movements occur when both arms and legs are moved together. Examples may include jumping, clapping hands, rolling out dough or pastry with a rolling pin or when pushing a large object such as a piece of furniture (Le Roux, 2011; Pienaar, 2012). This type of coordination involves tasks that require body control, as well as simultaneous and sequential coordination of the upper and lower limbs. Bilateral coordination plays an important role in the participation of various sport and recreational games (Bruininks & Bruininks, 2005).

As soon as a child experiences problems, remedial action should follow immediately (Kapp, 1991). Researchers suggest that motor skills proficiency in children can be improved through physical activity intervention programmes (Folio & Fewell, 2000; Morgan *et al.*, 2013). According to Hardy *et al*. (2010), the mastery of motor skills is sub-standard in most primary school children, indicating the importance of the need for early intervention programmes in the school environment. In this study, a motor skill development programme was designed to improve balance and bilateral coordination in children between 9 and 12 years old.

PURPOSE OF THE STUDY

The main purpose of the study was to design an appropriate motor skills development programme that could be implemented in any primary school to improve the balance and bilateral coordination of children aged 9 to 12 years.

METHODOLOGY

Research design

A quasi-experimental design was accordingly chosen for the current study (Gravetter & Forzano, 2003), as the research population already belonged to existing groups [Grade 5 classes] (Baumgartner *et al.*, 2002). A pre- and post-test design was used for both an experimental and a control group.

Subjects

One Quintile 2 school from a previously disadvantaged community in the Stellenbosch region was selected through a sample of convenience due to the proximity of the school. The study sample consisted of children (N=67; 30 girls, 37 boys) between the ages of 9 and 12 years old. From this sample, two classes in the school were recruited and thereafter randomly assigned by means of a numbering system, as either the experimental (n=35) or control (n=32) group. Only the experimental group participated in the 12-week motor skills development programme.

Ethical approval

The Research Ethical Committee of Stellenbosch University approved the research proposal (HS764/2012). Informed consent from the parents and assent from the children were obtained. The research proposal was submitted to the Western Cape Education Department (WCED) who granted permission to conduct this study in the selected school. Permission to conduct this study was also requested from and approved by the principal and teachers at the school.

Testing procedures

During the pre- and post-tests, both groups completed the Short Form, as well as the balance and bilateral coordination subtest activities in the Long Form of the Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2) (Bruininks & Bruininks, 2005). The reason for completing the Long Form for the balance and bilateral coordination subtests was to gain additional information as the study focussed on these skills. This motor proficiency test battery has been used extensively in school environments (Plimpton & Regimbal, 1992; Hay & Missiuna, 1998; Reeves *et al*., 1999; Nourbakhsh, 2006; Wrotniak *et al*., 2006; Venetsanou *et al*., 2007; Faught *et al*., 2008; Venetsanou *et al*., 2009). Its use is recommended where a brief screening of motor proficiency is required (Bruininks & Bruininks, 2005; Deitz *et al*., 2007).

Motor Proficiency test

The BOT-2 is one of the most popular standardised motor skill test batteries used to determine the level of motor abilities or overall motor proficiency in children and young adults (Burton & Miller, 1998). The BOT-2 is a useful tool to a wide variety of practitioners, specialists and researchers in different settings. Some of the important uses of the BOT-2 includes: supporting the diagnoses of motor impairments; serving as a screening device to identify those who might have motor ability deficits and may benefit from further testing; making educational placement decisions (for example, placement into specific and/or adapted physical education [PE] programmes); developing and evaluating motor training programmes; and also assisting clinicians and researchers in assessments (Burton & Miller, 1998; Bruininks & Bruininks, 2005; Deitz *et al*., 2007).

The BOT-2 uses a composite structure that differentiates motor skills according to the limbs and muscles involved during movement, as well as according to the relationship to functional activities in the areas of postural control, locomotion and object manipulation. Both the Long and Short Form of the BOT-2 comprise of 4 motor area composites: fine manual control; manual coordination; body coordination; and strength and agility (Bruininks & Bruininks, 2005). The four BOT-2 motor area composites are further divided into 8 subtests including: fine motor precision; fine motor integration; manual dexterity; upper-limb coordination; bilateral coordination; balance; running speed; and agility and strength (Bruininks & Bruininks, 2005).

The Short Form consists of 14 items in total that are carefully selected to ensure a sufficient representation of all 8 BOT-2 subtests, to cover the widest range of ability and to produce reliable scores (Bruininks & Bruininks, 2005). This test has an internal consistency of ≥0.80, an inter-rater reliability of >0.90 and a test-retest reliability of ≥0.80 (Deitz *et al.*, 2007). Construct validity of this test is also good, r= 0.78 (Cools *et al*., 2009). The Short Form of the BOT-2 is a quick and easy to administer screening tool and provides a single score of motor proficiency, similar to the Total Motor Composite (TMC). The TMC is the most reliable and also the preferred measure when determining and describing overall motor proficiency. It is computed by calculating the sum of the 4 motor-area composite standard scores, when using the Long Form of the BOT-2 (Bruininks & Bruininks, 2005).

Motor skills intervention programme

A motor skills intervention programme was compiled by the researchers for children between the ages of 9 and 12 year old. The focus of this programme was to improve balance and bilateral coordination, which are needed to maintain a healthy and active lifestyle. Bilateral coordination plays an important role in playing various sport and recreational games (Bruininks & Bruininks, 2005). Information from skills development literature (Cheatum & Hammond, 2000; Bruininks & Bruininks, 2005; Dinoffer, 2011; Le Roux, 2011), was taken into account in the selection of suitable content for the programme.

The researchers, of which one researcher is a qualified and experienced Kinderkineticist, implemented the motor skill development programme whilst the Grade 5 Physical Education teacher assisted with discipline when available and where necessary. The nature of this programme may help empower the teachers to individually implement each lesson and further improve the FMS of the children after the conclusion of this study. The programme was presented during the second and third school terms for 12 weeks. The required 90 minutes (DBE, 2011) of PE time was divided into 3 lessons per week of 30 minutes each. Two lessons of 30 minutes each was allowed for the implementation of the motor skills development programme. The skill focus was alternated weekly between balance and bilateral coordination. The two lessons within each week thus had the same skill focus.

During the first lesson of each week, the researchers introduced and taught activities to children and allowed them time to practise each activity as far as the allocated PE time allowed. The second and third lessons of each week used the same activities as taught during the first lesson, but with added progression for each activity to develop the relevant motor skill further. Activities included dynamic balance (for example, perform 10 jumps with heel-to-toe foot placement); static balance (on dominant leg, lift non-dominant leg and place opposite arm under the lifted leg and pinch the nose); dynamic and static balance (walk on tippy toes on rope while balancing bean bag on the head, turn back and throw bean bag in basket while standing on the dominant leg); and bilateral coordination (jump with 2 feet together, inside the ladder and back out [zigzag pattern]).

This motor skills intervention programme also had to be adapted to include the specific elements, such as rhythmic movements and target games. These elements are required to be covered during PE lessons according to the South African Curriculum and Assessment Policy Statement (DBE, 2011).

Statistical analysis

The data was statistically analysed by the Centre for Statistical Consultation at Stellenbosch University. The results are presented as means and standard deviations. A 5% significance level ($p<0.05$) was chosen for significant results, but in some instances trends are reported for results that were not statistically significant. However, no claims are made on the validity of these trends, which typically need to be investigated further in follow-up studies.

A 3-way mixed model analysis of variance was done with time, gender and group as the fixed effects and the participants nested in group*gender as the random effect. The third order interaction effect (time*group*gender) was investigated to determine if gender in any way affected the results and, thereafter, the time*group second order interaction effect was investigated to determine if the intervention for the experimental group showed an effect when compared to the control group. Normal probability plots were investigated to check the normality of the data and were found to be acceptable.

DISCUSSION OF RESULTS

Long form

No significant differences were found for the mean balance score within the experimental ($p=0.09$) or the control group ($p=0.67$) or the pre- ($p=0.93$) and post-tests ($p=0.32$), for between group comparisons (Table 1 and Figure 1). There was no significant balance improvement in the experimental group, however, a strong trend toward improvement was observed in the mean balance score between the pre- and post-test of the experimental group ($p=0.09$). This indicates that a change occurred within the experimental group that did not occur in the control group, possibly due to participation in the motor skills intervention programme.

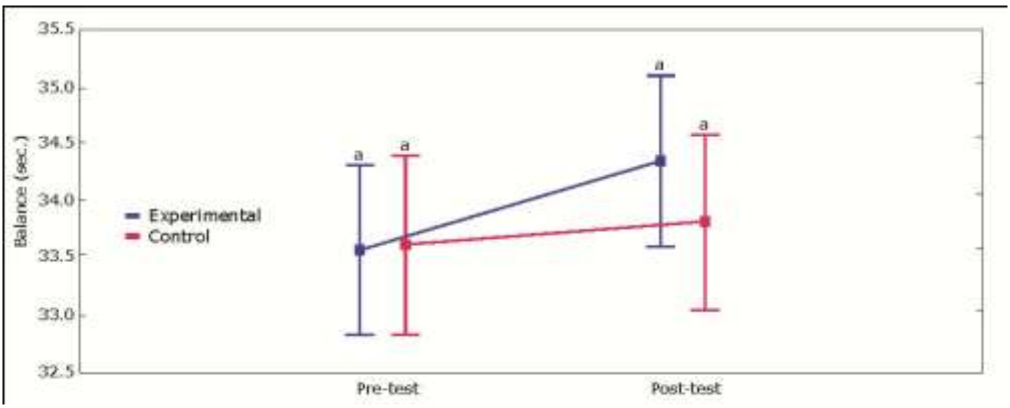
No previous comparable studies, emulating the exact research characteristics of the current study could be found. Similar studies have been conducted but using different populations and different modes or duration of intervention. Gupta *et al*. (2011) also found increased balance performance, within their experimental group, and almost no change in their control group after a 6-week strength and balance training programme for children with Down's syndrome.

Connolly *et al*. (1993) conducted a longitudinal study on the effects of an early intervention programme on Down's syndrome children and found further increased balance performance during the third follow-up test. There was, however, no control group to whom the early intervention group could be compared. Lewis and Fragala-Pinkham (2005) also reported improved balance, in the absence of a control group, after a 6-week aerobic conditioning and strength training intervention programme on a Down's syndrome girl. As a pedagogical model for improving balance/bilateral coordination and eye-hand coordination in school learners, the MUGI model (*Motorisk Utvecklingsom Grund för Inlärning*), for motor skills training was also found to be useful. Furthermore, daily physical activity and motor training showed positive effects in the latter study (Ericsson, 2013).

TABLE 1. **MEAN BALANCE SCORES FOR EXPERIMENTAL AND CONTROL GROUP OVER TIME**

Group	Pre-Test Mean±SD	Post-Test Mean±SD	p#	Mean diff. (Pre - Post)
Experimental	11.11±0.66	11.40±0.66	0.09	-0.78
Control	10.96±0.69	11.24±0.69	0.67	-0.20
p+	0.93	0.32	-	-

SD= Standard deviation
p+ Differences between groups for the pre- and post-test
p# Differences within groups from pre-to post-test
Mean differences within groups from pre- to post-test



(a-a) No significant differences (p>0.05)

FIGURE 1. **BALANCE (Long From): DIFFERENCE BETWEEN EXPERIMENTAL AND CONTROL GROUP FROM PRE- TO POST-TEST**

According to the mean differences between groups, the experimental group improved their balance during the post-test by approximately 0.58 seconds more than the control group. This increase may be due to participation in balance activities addressed in the 12-week motor skills intervention programme. Van Niekerk *et al*. (2007) similarly found significant improvement in the experimental group's balance after a 10-week intervention programme amongst South African shelter-dwelling children. Their control group showed no significant improvements.

Alphabet letters are used in the next figures to indicate a significant difference (p<0.05) between and/or within the experimental and control groups. If there are any overlapping letters (a-a)/(ab-a)/(a-ab)/(ab-b)/(b-ab)/(ab-ac)/(ab-ab)/(c-ac)/(ac-ac)/(cb-ab)/(ac-a)/(c-ac)/(ac-ac), it indicates that there was no statistically significant difference. Where the letters are completely different, (a-b)/(b-a)/(cb-a), it indicates a statistically significant difference between and/or within the experimental and control groups.

Bilateral coordination

Bilateral coordination means, standard deviations and mean differences for the entire duration of the study are summarised in Table 2.

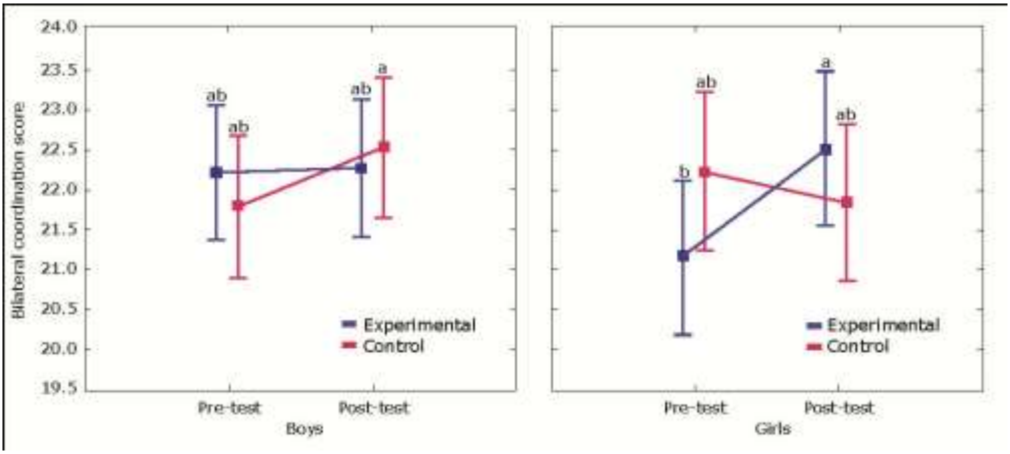
TABLE 2. **BILATERAL COORDINATION (Long Form): MEANS, STANDARD DEVIATIONS AND MEAN DIFFERENCES FOR EXPERIMENTAL AND CONTROL GROUP BETWEEN PRE- AND POST-TESTS**

Group	**Pre-Test Mean±SD**	**Post-Test Mean±SD**	**p#**	**Mean diff. (Pre - Post)**
Experimental	21.47±2.03	22.32±1.57	0.04*	-0.69
Control	21.94±1.72	22.18±1.99	0.61	-0.17
p+	0.49	0.64	-	-

p+ Differences *between* groups for the pre- and post-test
p# Differences *within* groups from pre-to post-test
Mean differences *within* groups from pre- to post-test
* Significant difference (p<0.05) (Pre vs. Post)

A significant difference was found for the mean bilateral coordination score between the pre- and post-test of the experimental group (p=0.04) (Table 2). No significant difference was found for the mean bilateral coordination score between the pre- and post-test of the control group (p=0.61). A significant change was observed only within the experimental group, which may be ascribed to the bilateral coordination activities that were performed during the 12-week motor skills intervention programme. In addition, no significant differences were found for the mean bilateral coordination score between the experimental and control groups at pre- (p=0.49) and post-testing (p=0.64). The significant difference found within the experimental group is not supported, however, by the interaction p-values between groups. Thus, according to the mean differences between the groups, the experimental group improved their bilateral coordination score by 0.52 (touches, jumping jacks, jumps, pivots, and taps combined), more than the control group (Table 2).

Connolly *et al*. (1993) found further improved bilateral coordination performance during their third follow-up test during the longitudinal study on the effects of an early intervention programme on Down syndrome children. There was, however, no control group for comparison. According to Lewis and Fragala-Pinkham (2005), bilateral coordination of a Down's syndrome girl improved after a 6-week aerobic conditioning and strength training intervention programme. Van Niekerk *et al*. (2007) reported a significant improvement in the bilateral coordination of the experimental group after a 10-week intervention programme involving South African shelter-dwelling children. The control group showed no significant improvement. In a study done by Ericsson (2008) with 251 Swedish children, it was found that balance/bilateral coordination of both boys and girls improved with extended physical activity (5 PE lessons per week), and additional motor training (a 45-minute session per week), and the difference between them decreased with the extended training sessions.



(a-b)/(b-a) Significant difference ($p<0.05$) Pre vs. Post
(ab-a)/(a-ab) No significant difference ($p>0.05$) Pre vs. Post and/or Exp vs. Ctrl
(ab-b)/(b-ab) No significant difference ($p>0.05$) Exp vs. Ctrl
(ab-ab) No significant difference ($p>0.05$) Pre vs. Post and/or Exp vs. Ctrl

FIGURE 2. **BILATERAL COORDINATION (Long Form): GENDER DIFFERENCES**

As seen in Figure 2, no significant differences were found in the mean bilateral coordination scores according to gender at the commencement of this study. However, when investigating the third order interaction (time*group*gender), a significant difference was found for gender (p=0.01). Thus, gender appeared to play a significant role in the improvement of bilateral coordination. A trend towards approaching significance was found between the boys and girls of the experimental group at the pre-test (p=0.09). This may be explained by the observation that the girls in the experimental group began this study with a relatively lower mean bilateral coordination score when compared to the boys at pre-test. This trend, however, disappeared after participating in the 12-week motor skills intervention programme (p=0.74). Thus, the girls in the experimental group seem to have improved their bilateral coordination to a similar level as that of the boys after performing the bilateral coordination activities in the motor skills intervention programme.

When investigating the performance of the boys, no significant differences were found for the mean bilateral coordination score within the experimental (p=0.90) and control groups (p=0.11), or between the pre- (p=0.48) and post-tests (p=0.67) (Figure 3). A greater increase in the bilateral coordination of boys was also observed within the control group (p=0.11), whereas the experimental group presented almost no change (p=0.90). The change in the control group may be due to the fact that the control group began the study with a lower mean bilateral coordination score and may have improved as a result of maturation.

It appears that the improvement in bilateral coordination was greater amongst girls when compared to boys (Figure 2). Accordingly, when investigating the mean bilateral coordination scores of girls, a significant difference was observed between the pre- and post-test of the experimental group (p=0.01). A trend towards significance was observed for the mean bilateral coordination score between the girls of the experimental and control groups at the pre-test (p=0.13). However, the score decreased after completion of the post-test. This is supported by the significant increase found within the experimental group (p=0.04) and the mean bilateral coordination scores of the control group remaining relatively similar (p=0.45).

Balance and bilateral coordination

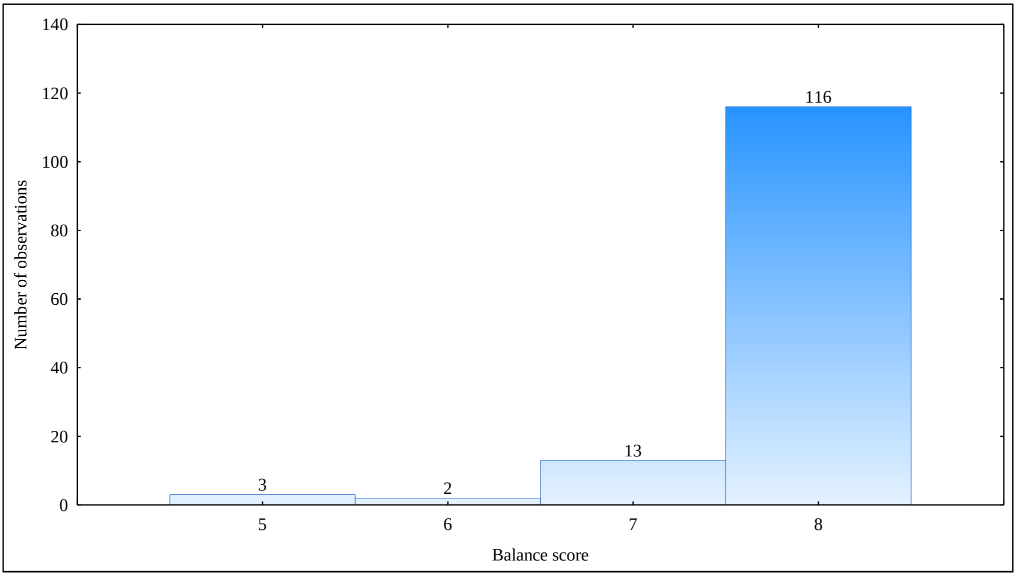


FIGURE 3. **BALANCE ACTIVITIES: NUMBER OF OBSERVATIONS**

The scores for the experimental and control groups as well as the scores achieved on both the Short Form balance and bilateral coordination activities are presented in Figure 3 and Figure 4 respectively. It is evident that there was very little variation in the scores achieved during the 2 balance and 2 bilateral coordination activities used in the Short Form of the BOT-2. Most children (86.57%) achieved the maximum scores possible. Thus, no further statistical analyses were conducted between groups or between pre- and post-tests and no significant differences were found (p>0.05). Bruininks and Bruininks (2005) state that due to the developmental nature of some BOT-2 subtests, these subtests produce little variability in the performance for some age groups. Thus, this may have been the case for balance and bilateral coordination in the current study. Wuang and Su (2009) found a similar occurrence for the balance subtest during their study with intellectually impaired children. They found that most of the items on the balance subtest were too easy for the sample as more than half of the group achieved the maximum scores.

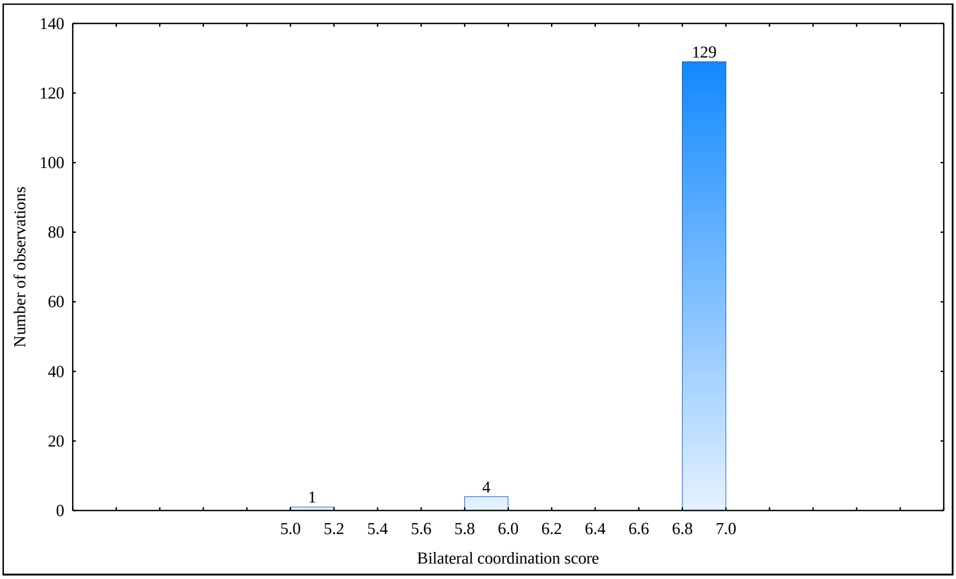


FIGURE 4. **BILATERAL COORDINATION ACTIVITIES (Short Form): NUMBER OF OBSERVATIONS**

The fact that almost all participants were able to achieve the maximum score may indicate that these activities were too easy and may not be suitable for measuring balance and/or bilateral coordination efficiently. Therefore, using these Short Form activities of the BOT-2 as the only evaluation of balance and bilateral coordination may limit the ability to investigate the true effect that the motor skills intervention programme had on these motor skills. Gupta *et al*. (2011) found similar results regarding balance and described no variation between the pre- and post-tests or between the two sample groups due to a ceiling effect where the median score achieved during the pre-test already was the maximum score. Therefore, no significant improvement in balance was observed at the post-test after completion of the motor skills development programme.

Balance and bilateral coordination play an important role in the physical activity participation of children. According to the literature, children should have mastered the basic motor skills by the age of 7 years (Gallahue & Donnelly, 2003). Yet, as seen in this study, children between the ages of 9 and 12 years still struggle to perform some of the most basic balance and bilateral coordination tasks, such as skipping or balancing on one leg. This suggests that the children of today are struggling to master motor skills during the relevant windows of opportunity resulting in experience delays in motor skill proficiency, subsequently affecting their participation in physical activity.

CONCLUSIONS

Improvements in balance and bilateral coordination were observed in the experimental group after completion of the 12-week motor skills intervention programme. The improvement in balance was not significant, yet presented a strong trend towards improvement when compared to the control group. These changes in the experimental group suggest that the motor skills development programme may have played a role in the improvement of balance. Gupta *et al*. (2011) found similar results after implementing a six-week strength and balance training programme.

A significant improvement was seen in the bilateral coordination of the experimental group, especially amongst the girls, when compared to the control group. This improvement may be ascribed to participation in the motor skills intervention programme. Similarly, Van Niekerk *et al*. (2007) found corresponding results after implementing a 10-week intervention programme. Kaur (2013) studied the effects of robot-child-interactions on the bilateral coordination skills of typically developing children aged between four and 11 years in a six-week intervention program. The post-test results indicated that the experimental group improved their bilateral coordination skills (Kaur, 2013).

Therefore, reiterating the words of Logan *et al*. (2011), early childhood education centres, especially pre- and primary schools, should implement planned movement programmes, such as the 12-week motor skills development programme implemented during the current study, as a strategy to promote FMS development in children. These programmes may be beneficial to all primary school children, including those with possible movement difficulties, especially from previously disadvantaged schools.

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REFERENCES

BAUMGARTNER, T.; STRONG, C. & HENLEY, L. (2002). *Conducting and reading research in health and human performance*. New York, NY: McGraw-Hill.

BRUININKS, R.H. & BRUININKS, B.D. (2005). *BOT-2 Bruininks-Oseretsky test of motor proficiency manual* (2^{nd} ed.). Minneapolis, MN: NCS Pearson.

BURTON, A.W. & MILLER, D.E. (1998). *Movement skill assessment*. Champaign, IL: Human Kinetics.

CHEATUM, B.A. & HAMMOND, A.A. (2000). *Physical activities for improving children's behaviour: A guide to sensory motor development.* Champaign, IL: Human Kinetics.

CONNOLLY, B.H.; MORGAN, S.B.; RUSSEL, F.F. & FULLITON, W.L. (1993). A longitudinal study of children with Down syndrome who experienced early intervention programming. *Physical Therapy*, 73(3): 170-181.

COOLS, W.; DE MARTELAAR, K.; SAMAEY, C. & ANDRIES, C. (2009). Movement skill assessment of typically developing preschool children: A review of seven movement skill assessment tools. *Journal of Sport Science and Medicine*, 8(1): 154-168.

DBE (DEPARTMENT OF BASIC EDUCATION) (2011). Curriculum and Assessment Policy Statement (CAPS), Life skills, final draft. Pretoria: Department of Basic Education.

DEITZ, J.C.; KARTIN, D. & KOPP, K. (2007). Review of the Bruininks-Oseretsky test of motor proficiency, second edition (BOT-2). *Physical and Occupational Therapy in Paediatrics*, 27(4): 87-102.

DINOFFER, J. (2011). "Activities to build balance." *Prevent child obesity 101*. Hyperlink: [http://www.preventchildobesity101.com/Activities/BalanceActivities.php]. Retrieved on 20 November 2011.

ERICSSON, I. (2008). To measure and improve motor skills in practice. *International Journal of Paediatric Obesity*, 3: 21-27.

ERICSSON, I.R. (2013). Physical activity and learning in the Swedish Bunkeflo Project evaluation of motor skills training in compulsory school. *Journal of International Scientific Publications: Educational Alternatives*, 11(1): 134-144.

FAUGHT, B.E.; CAIRNEY, J.; HAY, J.; VELDHUIZEN, S.; MISSIUNA, C. & SPIRONELLO, C.A. (2008). Screening for motor coordination challenges in children using teacher ratings of physical ability and activity. *Human Movement Science*, 27(2): 177-189.

FOLIO, M.R. & FEWELL, R.R. (2000). *PDMS-2 Peabody developmental motor scales examiner's manual* (2nd ed.). Austin, TX: Pro-ED.

GALLAHUE, D.L. & DONNELLY, F.C. (2003). *Developmental physical education for all children* (4th ed.). Champaign, IL: Human Kinetics.

GRAVETTER, F.G. & FORZANO, L.B. (2003). *Research methods for the behavioural sciences*. Belmont, CA: Wadsworth.

GUPTA, S.; BHAMINI, K.R. & KUMARAN, S.D. (2011). Effect of strength and balance training in children with Down's syndrome: A randomised controlled trial. *Clinical Rehabilitation*, 25(5): 425-432.

HANDS, B.P. (2012). How fundamental are fundamental movement skills*? Active and Healthy Magazine*, 19(1): 14-17.

HARDY, L.L.; KING, L.; FARRELL, L.; MACNIVEN, R. & HOWLETT, S. (2010). Fundamental movement skills among Australian preschool children. *Journal of Science and Medicine in Sport*, 13(5): 503-508.

HAY, J.A. & MISSIUNA, C. (1998). Motor proficiency in children reporting low levels of participation in physical activity. *Canadian Journal of Occupational Therapy*, 65(2): 64-71.

KAPP, J.A. (1991). Diagnosis. In J.A. Kapp (Ed.), *Children with problems: An orthopedagogical perspective* (pp.35-48). Hatfield, Pretoria: J.L. van Schaik.

KAUR, M. (2013). The effects of robot-child interactions on the bilateral coordination skills of typically developing children between 4 and 11 years of age. Unpublished Master's thesis. Paper 467. Hyperlink: [http://digitalcommons.uconn.edu/gs_theses/467]. Retrieved on 1 June 2015.

LE ROUX, T. (2011). "OT mom's bilateral coordination activities." OT mom learning activities. Hyperlink: [http://www.ot-mom-learning-activities.com/bilateral-coordination-activities.html]. Retrieved on 20 November 2011.

LEWIS, C.L. & FRAGALA-PINKHAM, M.A. (2005). Effects of aerobic conditioning and strength training on a child with Down syndrome: A case study. *Paediatric Physical Therapy*, 17(1): 30-36.

LOGAN, S.W.; ROBINSON, L.E.; WILSON, A.E. & LUCAS, W.A. (2011). Getting the fundamentals of movement: A meta-analysis of the effectiveness of motor skill interventions in children. *Child care, Health and Development*, 38(3): 305-315.

MORGAN, P.J.; BARNETT, L.M.; CLIFF, D.P.; OKELY, A.D.; SCOTT, H.A.; COHEN, K.E. & LUBANS, D.R. (2013). Fundamental movement skill interventions in youth: A systematic review and meta-analysis, *Paediatrics*, 132(5): e1361-e1383.

NOURBAKHSH, P. (2006). Perceptual-motor abilities and their relationships with academic performance of fifth grade pupils in comparison with Oseretsky scale. *Kinesiology*, 38(1): 40-48.

PIENAAR, A.E. (2012). *Motoriese ontwikkeling, groei, motoriese agterstande, die assessering en intervensie daarvan. 'n Handleiding vir nagraadse studente in Kinderkinetika* (5de uitgawe) (*trans*.: *Motor development, growth, motor deficiencies: The assessment and the intervention thereof. A Textbook for postgraduate students in Kinderkinetics* (5th ed.). Potchefstroom: Xerox.

PLIMPTON, C.E. & REGIMBAL, C. (1992). Differences in motor proficiency according to gender and race. *Perceptual Motor Skills*, 74(2): 399-402.

REEVES, L.; BROEDER, C.; KENNEDY-HONEYCUTT, L. & EAST, C. (1999). Relationship of fitness and gross motor skills for five- to six-year-old children. *Perceptual and Motor Skills*, 89(3): 739-747.

SMYTH, T.R. (1992). Impaired motor skill (clumsiness) in otherwise normal children: A review. *Child Care and Health Development*, 18(5): 283-300.

VAN NIEKERK, L.; PIENAAR, A.E. & COETZEE, M. (2007). The effect of an intervention programme on the motor development of street children. *South African Journal for Research in Sport, Physical Education and Recreation*, 29(1): 159-176.

VENETSANOU, F.; KAMBAS, A.; AGGELOUSSIS, N.; FATOUROS, I. & TAXILDARIS, K. (2009). Motor assessment of preschool age children: A preliminary investigation of the validity of the Bruininks-Oseretsky test of motor proficiency – Short form. *Human Movement Science*, 28(4): 543-550, June.

VENETSANOU, F.; KAMBAS, A.; AGGELOUSSIS, N.; SERBEZIS, V. & TAXILDARIS, K. (2007). Use of the Bruininks-Oseretsky test of motor proficiency for identifying children with motor impairment. *Developmental Medicine and Child Neurology*, 49(11): 846-848.

WROTNIAK, B.H.; EPSTEIN, L.H.; DORN, J.M.; JONES, K.E. & KONDILIS, V.A. (2006). The relationship between motor proficiency and physical activity in children. *Paediatrics*, 118: 1758-1765.

WUANG, Y-P. & SU, C-Y. (2009). Reliability and responsiveness of the Bruininks-Oseretsky test of motor proficiency: Second edition in children with intellectual disability. *Research in Developmental Disabilities*, 30(5): 847-855.

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