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Positive effects of a 9-week programme on fundamental movement skills of rural school children

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Background: Motor development of many children in rural areas of South Africa is compromised because of various socio-economic factors, hence, the need to address these developmental needs.

Aim: To examine the immediate and sustainable effects of a 9-week movement programme on fundamental movement skills (FMS) of school children.

Setting: Seven to eight years old school children in Raymond Mhlaba Municipality, Eastern Cape province.

Methods: A two-group, pre-post-re-test research design was used. Fundamental movement skills (FMS) proficiency was assessed using the Test of Gross Motor Development-Third Edition (TGMD-3) at pre-test, post-test and re-test after 6 months. Ninety-three school children (intervention group [IG] = 57) and (control group = 36), with a mean age of 7.12 (± 0.71) participated in the study. The twice-a-week FMS programme of 30 min was conducted during school hours. Statistical analysis included an ANOVA type of hierarchical linear model (HLM) (mixed models) procedure to test for intervention effects with school, time, sex and group as covariants. Cohen's effect size was calculated to assess the practical significance of changes.

Results: Immediate and sustainable effects were found on locomotor ($p < 0.05$; d > 1.7, $p < 0.05$; d > 2.0), ball skills ($p < 0.05$; d > 0.7, $p < 0.05$; d > 1.5) and the gross motor index (GMI) of the IG ($p < 0.05$; d > 1.0, $p < 0.05$; d > 2.0).

Conclusions: A short-duration FMS intervention significantly improve locomotor, ball skills, and GMI of school children in rural areas.

Contributions: Interventions of this nature are encouraged to improve the FMS development of school children, especially in rural areas, as it can enhance the building blocks required in the future development of these children.

Keywords: fundamental movement skills; immediate; movement programme; physical activity; proficiency; rural school children; sustainable effects.

Introduction

Motor competence refers to proficiency in performing different motor acts, including coordination of fine and gross motor skills, which are essential to accomplish activities of daily living (Barnett et al. 2016b; Henderson & Sugden 1992). Gross motor competence is associated with proficiency in a range of fundamental movement skills (FMS) such as throwing, catching, running, walking, jumping and balance that are mostly mastered during the early school years (up to 7 years) (Gallahue & Donnelly 2003; Gallahue & Ozmun 2006). Fundamental movement skills are often described more specifically as basic stability (twisting and balancing), object control or ball skills (kicking, catching and throwing) and locomotor movements (running, sliding and jumping) (Gallahue & Donnelly 2003; Gallahue, Ozmun & Goodway 2012). These movement skills are considered the 'building blocks' for more difficult and context-specific skills (Barnett et al. 2016b; Gallahue & Ozmun 2006) and lifelong participation in physical activity (PA) (Hulteen et al. 2015). Proficiency in FMS is also associated with numerous health benefits, including physical, psychological and overall well-being and is therefore significant for the general development of children (Barnett et al. 2016a; Bolger et al. 2020; Bremer & Cairney 2018; Lubans et al. 2010; Wrotniak et al. 2006).

The belief is that children should have achieved sufficient motor competency levels by age 7 to successfully participate in sports, games and, additional forms of PA that may enable them to apply fundamental movements to a specific task in a proficient manner. This includes using their bodies to move and performing daily tasks such as brushing their teeth and academic tasks such as writing while sitting in a chair (Gallahue et al. 2012). Proficiency in motor skills at an early age is also considered to be an important building block for a healthier lifestyle (Lindsay et al. 2020). A worldwide decline in motor proficiency and basic motor skills is, however, reported. A systematic review by Bolger et al. (2020) of 21 000 children, aged 3–10 years old, from 25 countries and 6 continents (55 studies) using the TGMD-2, revealed that ≤ 5% of children globally are not attaining competence in basic motor skills. A study by Hardy et al. (2012) reported similar findings among over 8000 elementary and secondary school students in New South Wales, Australia. Almost 90% of Grade 2 learners (7 years) in the population sample showed a high prevalence of low FMS competency, which was associated with the low socioeconomic status of the Grade 2 learners.

The Eastern Cape province where this study was conducted in South Africa (SA) is one of the poorest of the nine provinces of this country. The highest percentage of primary schools in this province are classified as low quintile schools where 27.3%, 24.7% and 19.6% are considered as quintiles 1, 2, 3 schools, and 17% and 11.4% as quintiles 4 and 5 schools. Quintile 1–3 schools are the lowest-ranking schools, which are situated in disadvantaged and rural areas, where children are exempt from paying school fees, food schemes are implemented, and infrastructure is poor with a general lack of facilities and qualified teachers to foster PA and sports participation (van Dyk & White 2019). Low socioeconomic status (SES) is associated with at-risk development in many developmental areas, where children growing up in such adverse environments are more likely to be disadvantaged in motor competence, long-term health, social and economic well-being, and as a result not reaching their developmental potential (Barnett et al. 2016a; Walker et al. 2007). Van der Walt and Plastow (2020) reported that 14.5% of 5–7-year-old children from low socioeconomic status enrolled in public schools living in the West Coast District of the Western Cape had low motor skills, 18.1% had balance difficulties and 4.3% experienced difficulty with aiming and catching tasks.

Similar trends of inadequate motor competence are also emerging from different regions in South African studies especially among children raised in low SES environments or rural settings. A study of preschool children in a community with a disadvantaged background in Gugulethu, Cape Town revealed that 8% had very low scores in fine motor skills, while 6% displayed very low scores in gross motor skills (Draper et al. 2012). Pienaar, Van Reenen and Weber (2016) examined the fundamental motor skills of 6-year-old South African children from the Northwest and Northern Cape Provinces in SA where FMS competence ranged from poorly mastered (46.1%) to adequately (76.2%) to well mastered (84%), depending on the nature of the FMS skills that were assessed. Poor mastery was especially reported in overall body coordination (23.6%–58.3%) and throwing skills (48.6%). A randomised study of the motor competency of Grade 1 school children in the Northwest Province of South Africa further indicated below-average (49.63%) to average (48.16%) levels of motor competency (Pienaar & Kemp 2014). The competency in object control skills of 9–10-year-old children living in the same province was also investigated, where at least 23% of the group still lacked proficiency in object control skills (Pienaar, Visagie & Leonard 2015). The mastery of object control skills of children from low-SES schools, especially girls, was also found to be more compromised. More recently, Pienaar et al. (2022) reported from the ExAMIN Youth SA study that although the mastery levels of two locomotor and two object control skills in 6–8-year-old children ranged between adequate and good, the older children were more at risk of not learning these skills to full mastery, signifying a possible lack of opportunities to sustain the quality of FMS mastery that was found at earlier ages.

Motor competence has received worldwide recognition as a possible solution to contest the global epidemic of paediatric overweight and obesity and physical inactivity in children (Holfelder & Schott 2014; World Health Organization [WHO] 2019). A relationship between motor competence (MC) and engagement in PA has been reported by several researchers suggesting that children with limited motor skills will lack the desire to be physically active and will therefore shy away from taking part in PA (Barnett et al. 2022; Robinson et al. 2015; Stodden et al. 2008; Wrotniak et al. 2006). Preliminary evidence of a motor proficiency barrier that hampers physical fitness is also reported (Abrams et al. 2022). Thus, if children do not become motor proficient throughout the early years of childhood, their future engagement in PA could be impeded (Djordjević et al. 2021; Pienaar & Kemp 2014). Lacking MC can therefore serve not only as a constraint of general development but also of PA behaviour, and the progression of healthy PA trajectories with consequences for future healthy living.

Research however, indicated that merely engaging in free play is insufficient for the comprehensive enhancement of children's MC and, consequently, the full development of their FMS (Logan et al. 2012; Wibowo, Budiman & Sumarno 2020). Fundamental movement skills should be taught, learned and strengthened, hence the adding together of active play and structured programmes can result in achieving good FMS (Barnett et al. 2016a). Interventions in several countries to improve FMS competency in school children are common with positive outcomes (Engel et al. 2018; Graham et al. 2022; Palmer, Chinn & Robinson 2019; Logan et al. 2012; Morgan et al. 2013; Wick et al. 2017). The FMS intervention is therefore considered a possible solution for improving the motor skills of children as the development of basic movement skills through intervention has the likelihood to reverse motor skills deterioration in children (Lindsay et al. 2020).

From a South African perspective, children mostly learn FMS to full mastery during physical education (PE) classes during early childhood. Early childhood is considered an essential phase to enhance the movement skills of young children by utilising interventions to address likely motor difficulties that may be encountered by the child. However, Burnett (2018) reported that South African schoolchildren generally lack exposure to regular PE, especially in rural schools, which is seriously compromised by theory-based classes, doing homework and catching up on other subjects. In addition, the low availability of resources and a lack of qualified and experienced PE educators to identify poor FMS and to address it timeously and appropriately are some of the challenges that are also faced by rural schools (Pienaar, Gerber & Van Reenen 2020).

Although evidence shows that intervention is successful in improving motor competence, Wick et al. (2017) reported that only 7 of 30 studies provided long-term follow-ups, of which only three studies provided evidence of sustained effects on FMS. These studies by Robinson and Goodway (2009), Hurmeric (2011), and Roth et al. (2015) engaged their preschool participants aged between 4 and 5 years in 9-week, 8-week, and 11-month intervention programmes, respectively. After these interventions, significant immediate and sustained improvements in FMS were found. Although various South African studies reported disturbing motor competency levels of young school children (Draper et al. 2012; Pienaar & Kemp 2014; Pienaar et al. 2015, 2016, 2022; van der Walt & Plastow 2020), only few intervention studies focused on improving FMS (Botha & Africa 2020; Pienaar et al. 2020; Van der Walt, Plastow & Unger 2020) but more specifically, sustained effects to address these FMS limitations of young children are still mostly lacking in this country. Children at risk of developmental delays and health disparities such as those living in disadvantaged or rural areas were also not exposed to the effects of motor intervention. This study therefore aimed to determine the immediate and sustainable effects on the FMS of 7–8-year-old rural Eastern Cape schoolchildren after participating in a 9-week fundamental movement skills-based programme.

Material and methods

Research design

A quasi-experimental design that involved a pre-post-retest design including two groups (control and intervention) was used to assess the effect of a 9-week movement programme on the FMS of 7–8-year-old rural school children in the Raymond Mhlaba Municipality of the Eastern Cape Province of South Africa. A pre-testing of all the measurements was assessed for both the intervention and control groups. Then, the intervention was delivered during school hours using time allocated for PE. The intervention programme was done twice weekly and each lesson lasted for 30 min. Upon completion of the intervention, both the intervention and control groups were assessed again during post-testing to evaluate the immediate effect on FMS. A re-test followed for both groups to assess the sustainability effects of the intervention on FMS after 6 months of no intervention. The first part of the school year in the first school term (February–March 2022) was used to conduct the pre-test, post-test and intervention. The re-test was conducted near the end of the third term in September. The Curriculum and Assessment Policy Statement (CAPS) of South Africa was used as a guideline to plan the duration of the intervention, which was designed around the school terms (Department of Basic Education 2021). However, it was essential to consider practical considerations as well. South African school terms last for only 12 weeks, leaving a window of 9 weeks that are available for the intervention after accounting for the necessary 3 weeks allocated for recruiting the participants and for pre-and post-testing. This decision was taken to ensure that the results of the study were not influenced by activities during the school recess where schools are closed for 2–3 weeks.

Study population

Seven to eight-year-old school children (Grade 2) attending rural primary schools in Alice town of the Raymond Mhlaba Municipality, Eastern Cape Province of South Africa were the target population for this study. The rural development framework (1997) defined rural areas as having the following two characteristics. Firstly, sparsely populated areas in which people farm or depend on natural resources, including villages and small towns are dispersed through these areas. Secondly, areas that include large settlements in the former homelands, which depend on migratory labour and remittances as well as government social grants for their survival, typically have traditional land tenure systems. In this regard, Alice is classified as a small town in a rural area of South Africa.

Within Alice Town, five primary schools were randomly selected from seven schools to be involved in this study; however, only three of these schools consented to participate in the study. A power analysis was performed employing Statistica for Windows (Statsoft, Statistica for Windows, 2020) to determine the number of participants who needed to be recruited for the study. A power calculation indicated that 60 participants in each group are needed to obtain 80% power (N = 120). We were able to only recruit 106 school children from the three schools who consented that the project may be rolled out at their school, although only 93 consented to participation, representing a 12.2% loss of consent rate. The intervention school was selected based on the higher number of participants who were willing to participate in the study. Because of practical reasons regarding administering the intervention, the other two schools were combined to make the control group to match the number of participants who had to be recruited for the intervention. Fifty-seven school children including 27 boys and 30 girls with mean ages of 6.96 (± 0.68) and 7.07 (± 0.62) years, respectively, at the pre-test and post-test, participated in the intervention programme. Fifty-two of the same participants (24 boys and 28 girls) with a mean age of 7.61 (± 0.59) years participated in the re-test. The loss-to-follow-up at re-test was 8.8% in the intervention group. Reasons for dropout included leaving the school during the intervention period or being absent on the day of testing. The control group included 36 participants (*n* = 17 boys; *n* = 19 girls) with a mean age of 7.36 (± 0.68) at the pre-test that was assessed. Thirty-five participants (*n* = 17 boys; *n* = 18 girls) with a mean age of 7.44 (± 0.61) were also assessed in the post-test. This 2.8% dropout rate was the result of being absent from school during testing. Furthermore, 30 participants (*n* = 14 boys and *n* = 16 girls) with a mean age of 7.89 (± 0.75) were still part of the study during the re-testing. The 16.7% dropout resulted from participants being absent from school on the testing day or leaving the school.

Measuring instruments

Fundamental movement skills proficiency

The Test of Gross Motor Development-Third Edition (TGMD-3; Ulrich 2019) was used to assess and define the gross motor skills development of the participants. The TGMD-3 is a standardised assessment for measuring gross motor development skills in 3–10-years-old children. The TGMD-3 evaluates 13 different skills that are categorised into two domains. These include locomotor skills (e.g. hop, slide and run) and ball skills (e.g. catch, dribble and kick). All testing procedures were performed following the TGMD-3 manual. Before executing the skill, a demonstrator demonstrates the skill live while the participant watches the skill demonstration that meets all criteria for that particular skill. A maximum of two demonstrations were provided for each participant. Each participant then completed the two formal test trials, which were scored live on the day. According to the TGMD-3 manual, the performance of a skill is scored as 1 to show the presence of a performance criterion and 0 to show the absence of that performance criterion.

Two test trials were allowed for all the test items, then added together to provide a total raw score for each locomotor and ball skills item and subtests. The highest scores obtainable are 46 and 54 points for the locomotor subtest and ball skills subtest, respectively. The maximum overall score, known as the gross motor index (GMI) is 158 (Ulrich 2019). The GMI score is calculated by adding the scaled scores of both subtests where after the sum of scaled scores are converted to a GMI score and percentile rank by using Table D1 in the TGMD-3 manual. The subtest scaled score was used for analysis to report the descriptive categories of each participant. Participants with subtest scaled scores of 1–3 are classified as 'impaired or delayed', 4–5 as 'borderline impaired or delayed', 6–7 as 'below average', 8–12 as 'average', 13–14 as 'above average', 15–16 as 'superior' and 17–20 as 'gifted or very advanced/superior' (Ulrich 2019).

The reliability coefficients for the total scale of the TGMD-3, that is, locomotor and ball skills subscales have been reported based on three different sources of error variance: internal consistency which reflects the degree of similarity among the skills tested; reliability coefficients > 0.8 and low standard error measures suggests the TGMD-3 is a reliable test. Time sampling indicates a high magnitude of correlation (≥ 0.88) between the two trials, which is an indication of its reliability in terms of stability over time. Reported inter and intra-score differences of 0.98 reveal a strong intertester reliability, which suggests consistency of scores (Ulrich 2019; Webster & Ulrich 2017).

The TGMD-3 test items were assessed during one school day before and after the intervention period as well as 6 months later after no intervention took place. The participants were grouped into three groups and rotated between three stations until all tests were assessed. Station one consists of locomotor skills (run, gallop, hop, skip and slide). This station was set up in such a way that the tester could sit at a midpoint position while observing the execution of each skill from the side. Station two consists of a wall station (one-hand forehand strike of a self-bounced ball, kick of a stationary ball, overhand throw and underhand throw) and station three includes the two-hand strike of a stationary ball, two-hand catch, one-hand stationary dribble and horizontal jump. All TGMD-3 test items were assessed by trained senior researchers with a Kinderkinetics qualification. All stations had a demonstrator who demonstrated the activities for the participant and a translator who provided understanding for those who were not clear on what was expected from them.

Motor intervention

The motor intervention that was developed for this study was adapted from the SPARK (Sports, Play & Active Recreation for Kids) Physical Education programme compiled by McKenzie Rosengard and Williston (2006), with additions made to align with the intended outcomes of the programme based on the CAPS curriculum of South Africa (Department of Basic Education 2021). The twice-weekly presented lessons (18 sessions) comprised five main components. Each lesson was 30 min in duration, starting with 3 min of warm-up exercises such as jogging and 7 min for aerobic fitness exercises as a group, then followed by rotating in smaller groups of five to different stations (10 min for ball skills, which comprises two different ball skills exercises, 5 min for locomotor exercises and 5 min for balance exercises. The programme was based on instructional learning with a focus on improved mastery by improving the technique of the skills. Each lesson was concluded with breathing exercises to relax the muscles as the participants returned to their classes. A detailed programme is published elsewhere (Idamokoro 2023). To ensure maximum participation and cooperation, participants were grouped into smaller groups of five and these groups were also changed weekly to encourage socialisation. Each activity station was timed with a blow of a whistle to ensure maximum delivery time at each session and to warrant that the planned lesson could be conducted in 30 min. Four well-trained research assistants including the researcher delivered the FMS-based intervention. These assistants were all post-graduate students from the Human Movement Science Department. A workshop was conducted where training was delivered by the researcher to the research assistants before implementing the FMS-based programme. Also, frequent updates on the planned lessons were given to the research assistants. Trained interpreters additionally translated the instructions from English to IsiXhosa to make sure that the participants understood the lesson content. An attendance register was kept in an attendance logbook during each lesson.

Statistical analyses

The Hierarchical Linear Modelling (HLM) (mixed models) procedure on SPSS (version 27) was utilised to analyse the data. Predictors included in the HLM were school, time (pre-test, post-test and re-test), sex (boy and girl) and group (intervention and control). An HLM with the child as a subject was performed to take into account individual differences over time during the study period. The HLM analysis examined various interactions, which include all one-way, two-way and three-way interactions. A significance level of less than 5% ($p < 0.05$) was set to report significant effects, whereas a significance level of 10% (0.099) was reported as marginal effects. Paired *t*-testing and Cohen's d values were used to examine changes over time. Cohen's d was calculated as follows: d = difference between means of two groups/sqrt (total variance in the model) and was used to evaluate the practical significance of findings for each analysis at various time points (pre-, post- and re-test). The interpretation of the effect sizes used in this study based on Cohen's cut-off points is: d > 0.2 = small, d > 0.5 = medium, and d > 0.8 = large (Cohen 1988).

Ethical considerations

The Health Research Ethical Committee (HREC) of the North-West University granted permission for this study to be performed (NWU-00458-20-S1). The researcher first obtained consent to conduct the study from the Department of Basic Education in the Raymond Mhlaba Municipality. Permission was also granted from the principals to conduct the study within the premises of the school. Before the commencement of the study, a parental meeting was scheduled to discuss the objectives of the study with them and to answer any questions related to the study. Parents and children had to complete standardised parental consent forms and child assent forms before participation in the study was allowed. Participants were also informed that they were free to withdraw from the study at any point without any consequences.

Results

Ninety-three children with a mean age of 7.12 years (± 0.71) at pre-test participated in the study. The compliance with the 9-week intervention during PE periods was high (97%).

The descriptive data according to group (intervention and control) and time (pre-test, post-test and re-test) are presented in Table 1. The results of hierarchical linear modelling where school, sex, group, time and the interaction effect of group and sex, group and time, sex and time, group, sex and time are presented in Table 2. The effect sizes (Cohen's d) and *p*-values (ANOVA) of changes in the selected TGMD-3 variables across sex and groups are displayed in Table 3. The locomotor and ball skills raw scores are also graphically displayed over time in Figure 1 and Figure 2. The descriptive ratings received by each group as reported using a gross motor index (GMI) are shown in Table 4 and changes over time in this GMI index in the groups and each gender within the intervention group and control group are graphically shown in Figure 3 and Figure 4, respectively.

TABLE 1: Fundamental movement skills characteristics of the participants according to group and time.

Variables	Intervention group						Control group					
	Pre-test		Post-test		Re-test		Pre-test		Post-test		Re-test	
	Mean	Std Error	Mean	Std Error	Mean	Std Error	Mean	Std Error	Mean	Std Error	Mean	Std Error
Weight (kg)	24.02	0.580	23.84	0.58	25.63	0.58	23.66	0.73	24.07	0.73	25.37	0.73
Stature (cm)	121.81	0.740	123.41	0.74	125.43	0.74	122.08	0.93	123.45	0.93	125.48	0.94
Run	7.30	0.078	7.84	0.08	8.00	0.08	6.78	0.10	7.86	0.10	7.84	0.11
Gallop	4.33	0.270	7.71	0.27	7.23	0.28	3.87	0.33	4.79	0.34	4.28	0.36
Hop	6.44	0.120	8.00	0.12	8.00	0.13	5.19	0.15	7.67	0.15	7.89	0.16
Skip	3.87	0.180	5.90	0.18	5.97	0.18	3.58	0.22	4.62	0.23	4.21	0.24
H/Jump	7.28	0.170	6.82	0.17	7.42	0.17	7.21	0.21	7.39	0.22	7.42	0.23
Slide	7.13	0.130	7.47	0.13	7.95	0.14	7.03	0.17	6.95	0.17	7.33	0.18
LTRS	36.46	0.410	43.74	0.41	44.56	0.43	33.66	0.52	39.30	0.53	38.78	0.56
SSB	7.87	0.210	7.74	0.21	9.08	0.22	7.18	0.27	8.11	0.27	9.15	0.29
SSBB	6.61	0.190	5.38	0.19	7.13	0.20	6.69	0.24	5.18	0.25	6.37	0.26
SD	3.69	0.160	4.97	0.16	5.56	0.17	3.34	0.21	4.87	0.21	5.44	0.22
Catch	4.05	0.140	4.95	0.14	5.81	0.15	3.95	0.17	5.55	0.18	5.94	0.19
Kick	6.71	0.140	7.66	0.14	7.04	0.14	5.34	0.17	6.26	0.18	7.04	0.19
OhT	6.36	0.210	6.29	0.21	7.75	0.22	6.69	0.26	5.90	0.27	7.53	0.28
UhT	6.47	0.150	6.62	0.15	7.29	0.16	6.62	0.19	6.74	0.20	7.21	0.21
BSTRS	41.79	0.560	43.58	0.56	49.70	0.59	39.79	0.71	42.60	0.73	48.63	0.76
GMI	103.91	0.890	113.66	0.89	119.89	0.93	96.32	1.12	106.87	1.15	111.03	1.20

H/jump, horizontal jump; LTRS, locomotor total raw score; SSB, striking a stationary ball; SSBB, strike of self-bounced ball; SD, stationary dribble; OhT, overhand throw; UhT, underhand throw; BSTRS, ball skills total raw score; GMI, gross motor index.

TABLE 2: Possible influences of co-variants on the fundamental movement skills characteristics of the participants.

Varia-ble	Intervention group						Control group						Variance		*p*						
	Boys mean			Girls mean			Boys mean			Girls mean											
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	EST	School	Group	Sex	Time	Group* Sex	Group* Time	Sex* Time	Group* Sex* Time
Run	7.7	7.9	8.0	6.9	8.0	7.8	6.9	8.0	7.8	6.7	7.7	7.9	0.4	< 0.05	0.005	0.014	< 00.001	0.444	0.012	0.024	0.091
Gallop	4.0	7.4	6.6	4.7	8.0	7.8	3.7	4.7	3.4	4.0	4.8	5.1	3.5	0.50	< 0.001	0.009	< 0.001	0.847	< 0.001	0.125	0.729
Hop	6.5	8.0	8.0	6.4	8.0	8.0	4.7	7.5	7.8	5.7	7.8	8.0	0.8	0.04	< 0.001	0.030	< 0.001	0.017	< 0.001	0.292	0.157
Skip	3.5	6.0	6.0	4.3	5.8	5.9	2.4	3.8	3.5	4.8	5.4	4.9	1.4	< 0.01	< 0.001	0.000	< 0.001	< 0.001	< 0.001	0.025	0.896
H/Jump	7.3	6.3	7.4	7.3	7.3	7.4	7.4	7.4	7.4	7.1	7.3	7.5	1.3	0.30	0.364	0.543	0.215	0.244	0.139	0.231	0.278
Slide	7.3	7.2	8.0	7.0	7.8	8.0	6.9	6.6	7.3	7.1	7.3	7.4	0.8	0.20	0.007	0.151	< 0.001	0.474	0.130	0.021	0.622
LTRS	36.2	42.8	44.0	36.7	44.7	45.2	31.9	38.1	36.8	35.4	40.5	40.7	6.4	3.30	< 0.001	< 0.001	< 0.001	0.047	< 0.001	0.764	0.200
SSB	8.5	8.2	9.2	7.3	7.3	9.0	7.5	8.6	9.3	6.9	7.7	9.0	2.3	0.20	0.705	0.002	< 0.001	0.749	0.063	0.372	0.654
SSBB	7.3	5.9	7.3	6.0	4.9	7.0	7.0	5.2	5.9	6.4	5.2	6.9	1.8	0.20	0.145	0.070	< 0.001	0.015	0.136	0.006	0.745
SD	4.5	4.7	5.7	2.9	5.3	5.4	3.4	4.5	5.5	3.3	5.2	5.4	1.2	0.30	0.299	0.440	< 0.001	0.148	0.696	< 0.001	0.076
Catch	3.9	5.0	5.8	4.2	4.9	5.8	4.0	5.4	6.0	3.9	5.7	5.9	1.1	< 0.01	0.111	0.651	< 0.001	0.875	0.082	0.819	0.501
Kick	7.2	7.8	7.4	6.3	7.5	6.7	5.9	6.7	6.9	4.7	5.8	7.2	1.0	0.05	< 0.001	< 0.001	< 0.001	0.976	< 0.001	0.034	0.056
OHT	6.4	6.4	8.0	6.3	6.2	7.5	6.5	6.3	7.4	6.8	5.5	7.7	1.9	0.50	0.692	0.493	< 0.001	0.610	0.210	0.409	0.345
UHT	6.8	6.8	7.3	6.2	6.5	7.3	6.7	6.8	6.7	6.5	6.7	7.7	1.3	< 0.01	0.673	0.729	< 0.001	0.073	0.796	0.038	0.531
BSTRS	44.5	44.6	50.7	39.1	42.5	48.7	41.1	43.4	47.6	38.5	41.8	49.6	13.6	4.40	0.039	0.003	< 0.001	0.062	0.605	0.003	0.299
GMI	104.9	112.2	119.2	103.0	115.2	120.6	94.2	105.4	106.2	98.5	108.3	115.9	32.0	13.10	< 0.001	0.003	< 0.001	0.025	0.513	0.053	0.049

H/jump, horizontal jump; LTRS, locomotor total raw score; SSB, striking a stationary ball; SSBB, strike of self-bounced ball; SD, stationary dribble; OhT, overhand throw; UhT, underhand throw; BSTRS, ball skills total raw score; GMI, gross motor index; EST, estimate of variance.

*, $p < 0.05$ significant; *, $p < 0.01$ significant; *, $p < 0.099$ marginally significant on 10% level.

TABLE 3: Effect size changes in fundamental movement skills between different testing opportunities by sex.

Variables/ time	Intervention group (boys)				Intervention group (girls)				Control group (boys)				Control group (girls)			
	Mean difference (SD)	*df*	*p*	d	Mean diff (SD)	*df*	*p*	d	Mean diff (SD)	*df*	*p*	D	Mean diff (SD)	*df*	*p*	D
LTRS																
Pre-post	6.56 ± 3.89	26	0.001	1.7	8.00 ± 3.76	29	0.001	2.1	6.12 ± 3.46	16	0.001	1.8	5.11 ± 3.12	17	0.001	1.6
Post-retest	1.08 ± 2.06	23	0.017	0.5	0.43 ± 1.43	27	0.123	0.3	-1.86 ± 4.57	13	0.152	0.4	-0.13 ± 2.45	14	0.836	0.1
Pre-retest	7.88 ± 3.81	23	0.001	2.1	8.43 ± 4.12	27	0.001	2.1	4.57 ± 6.15	13	0.016	0.7	5.31 ± 3.42	15	0.001	1.6
BSTRS																
Pre-post	0.11 ± 5.06	26	0.910	0.0	3.47 ± 4.46	29	0.001	0.8	2.65 ± 5.57	16	0.068	0.5	2.89 ± 5.83	17	0.051	0.5
Post-retest	6.29 ± 4.30	23	0.001	1.5	6.14 ± 3.46	27	0.001	1.8	2.71 ± 7.44	13	0.195	0.4	8.13 ± 4.97	14	0.001	1.6
Pre-retest	6.50 ± 4.45	23	0.001	1.5	9.50 ± 5.10	27	0.001	1.9	6.86 ± 7.51	13	0.005	0.9	10.88 ± 5.32	15	0.001	2.1
GMI																
Pre-post	7.30 ± 7.68	26	0.001	1.0	12.20 ± 6.25	29	0.001	2.0	11.41 ± 8.54	16	0.001	1.3	9.50 ± 6.85	17	0.001	1.4
Post-retest	7.13 ± 7.10	23	0.001	1.0	5.32 ± 4.50	27	0.001	1.2	1.29 ± 13.13	13	0.720	0.1	7.27 ± 5.47	14	0.001	1.3
Pre-retest	14.50 ± 7.45	23	0.001	2.0	17.25 ± 7.74	27	0.001	2.2	12.14 ± 13.81	13	0.006	0.9	17.13 ± 8.45	15	0.001	2.0

LTRS, locomotor total raw score; BSTRS, ball skills total raw score; GMI, gross motor index; SD, standard deviation; Mean diff, mean difference.
p-value = probability value < 0.05, *df* = degrees of freedom, d = effect size, d > 0.2 = small, d > 0.5 = medium, d > 0.8 = large, - = decreasing value.

The intervention and control groups showed increased mean scores in most of the locomotor skills from the pre-test to the re-test (Table 1). Higher mean scores were observed in the intervention group than in the control group, although not significantly ($p > 0.05$), which confirms similar motor skills in the groups at pre-testing. Significant improved mean scores were found in the intervention group from pre-test to post-test in five (run, gallop, hop, skip and slide) of the six locomotor skills that were assessed (only horizontal jump did not improve). Likewise, the control group also improved significantly in five (run, gallop, hop, skip and horizontal jump) of the six skills although with a decrease in sliding. A large significant ($p < 0.001$; d > 0.8) improvement was observed in both groups from pre-test to post-test (Table 3, also see Figure 2), although the control group had a lower mean locomotor total raw score (LTRS) compared to the intervention group during post-test (Table 1, also see Figure 2). At the re-test, the intervention group also improved significantly in five (run, hop, skip, horizontal jump and slide) of the six skills while no improvement was seen in galloping.

In the control group, three of these skills (hop, horizontal jump and slide) improved from post-test to re-test, while all skills (run, gallop, hop, skip, horizontal jump and slide) improved significantly from pre-test to re-test. The intervention group significantly improved LTRS from post-

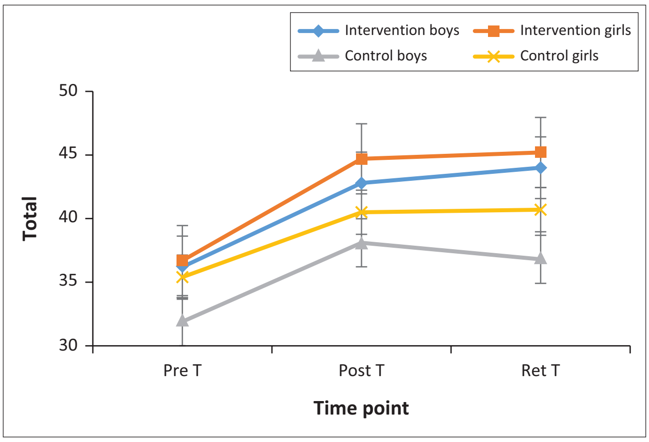

FIGURE 1: Locomotor total raw score.

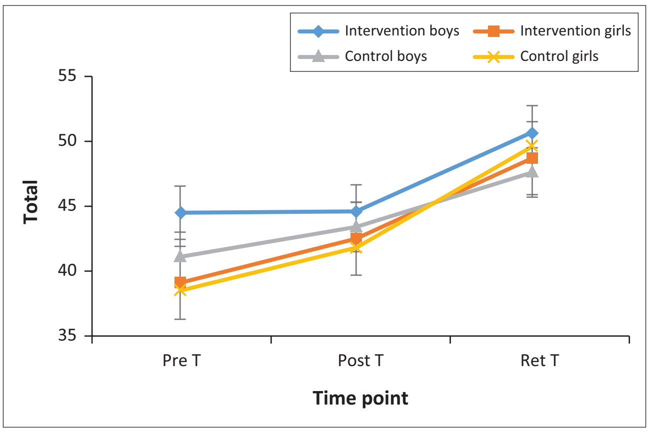

FIGURE 2: Ball skills total raw score.

TABLE 4: Descriptive rating of the gross motor index according to group, time and sex.

Variable	Intervention group boys			Intervention group girls			Control group boys			Control group girls		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
GMI index	104.9	112.2	119.2	103.0	115.2	120.6	94.2	105.4	106.2	98.5	108.3	115.9
Mean (SE)	(1.29)	(1.29)	(1.36)	(1.23)	(1.23)	(1.26)	(1.63)	(1.67)	(1.74)	(1.54)	(1.57)	(1.66)

GMI, gross motor index; T1, pre-test; T2, post-test; T3, re-test; SE, standard error.

GMI index impaired or delayed (< 70), borderline impaired or delayed (70–79), below average (80–89), average (90–109), above average (110–119), superior (120–129), gifted or very advanced (> 129).

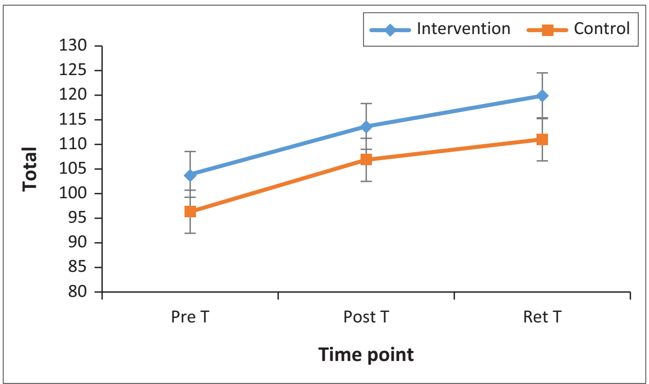

FIGURE 3: Gross motor index according to group and time.

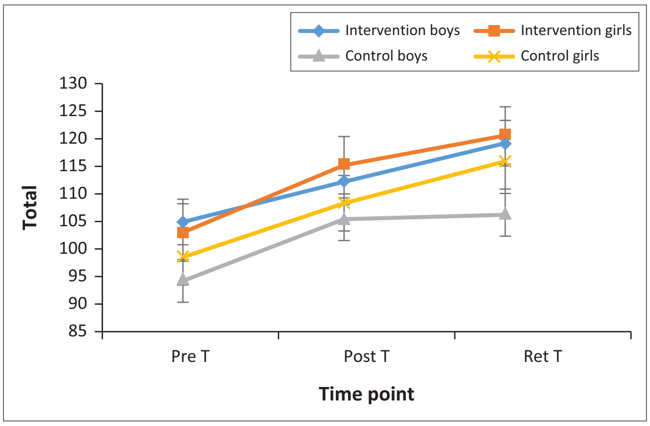

FIGURE 4: Gross motor index according to group, time and sex.

testing to retesting (43.74 ± 0.41 to 44.56 ± 0.43) while the control group deteriorated (39.30 ± 0.53–38.78 ± 0.56) (see Table 1 and Figure 1). This improvement in the intervention group was of large significance ($p < 0.001$; d = 2.1) compared to the significant deterioration that was observed in the control group, which was also of moderate significance ($p = 0.016$; d = 0.7) (Table 3). These changes were influenced by the improvement of the girls ($p < 0.001$; d = 2.1, Table 3; also see Figure 1) in the intervention group compared to a decline in the control group of girls ($p < 0.001$; d = 1.6, Table 3).

In the manipulation (ball) skills, the intervention group improved in four (stationary dribble, catch, kick and UhT) of the seven ball skills from pre-test to post-test, although the control group also improved significantly in five (SSB, stationary dribble, catch, kick and UhT) of the seven ball skills (Table 1). At the re-test, the intervention group significantly improved in six skills (SSB, SSBB, stationary dribble, catch, OhT and UhT) from the post-test, while all seven skills (SSB, SSBB, stationary dribble, catch, kick, OhT and UhT) improved significantly from the pre-test to the re-test in this group. In the control group, all skills (SSB, SSBB, stationary dribble, catch, kick, OhT and UhT) improved from post-test to re-test, while only six of the seven skills, excluding SSBB, improved significantly from pre-test to re-test. However, the intervention group displayed significantly higher mean score changes in BSTRS from the pre-test to the re-test (41.79 ± 0.56 to 49.70 ± 0.59) also showing large practical significance ($p < 0.001$; d > 0.8, Table 3 and Figure 2) compared to what was found in the control group (39.79 ± 0.71 to 48.63 ± 0.76), although once again these changes were also of large practical significance ($p < 0.005$; d > 0.8, Table 3).

The intervention group improved in their clustered GMI score from the pre-test to the re-test (103.91 ± 0.89 to 113.66 ± 0.89, 119.89 ± 0.93) (Table 1) revealing a statistical and large practical significant improvement ($p < 0.001$; d > 0.8, Table 3 also see Figure 4). The control group also improved significantly ($p < 0.001$; d > 0.8, Table 3) from the pre- to the post-test (96.32 ± 1.12). After that, improvement in this group was insignificant ($p > 0.005$; d = 0.1, Table 3) from the post-test to the re-test (106.87 ± 1.15 to 111.03 ± 1.20) (Table 1). A large significant change ($p < 0.001$; d > 0.8, Table 3) was, however, found from the pre-test to the re-test (96.32 ± 1.12 to 111.03 ± 1.20) (Table 1).

The descriptive statistics from the pre-test, post-test and re-test (T1 – T3) of each participant based on sex, group and time are shown in Table 2 and Figure 1 to 4, respectively. The results of the three-way interaction effect analysis (group by sex by time) of the GMI indicated that this index was significantly ($p = 0.05$) affected at different times of the intervention, while the intervention effects on both boys and girls in the intervention group were also different when compared to what was observed in the control group. Table 3 depicts the effect sizes of these changes and a graphical representation of these changes (Figure 4). The two-way interaction analysis revealed that the GMI was affected by group and sex ($p = 0.03$) and sex by time ($p = 0.05$), where boys in the intervention group had a higher mean score at T1 than girls (Table 2), while girls had a higher mean score change with a significantly larger effect size ($p < 0.001$; d = 1.2) from T2 to T3 compared to the boys ($p < 0.001$; d = 1.0) (Table 3). In the control group, girls had a higher mean score from T1 to T3 with a significantly larger effect size ($p < 0.001$; d = 2.0) than boys ($p = 0.006$; d = 0.9) in GMI (Table 3). The group by sex effects in GMI showed that both boys and girls in the intervention group had increasing and higher significant mean scores from T1 to T3 than the control group. The sex-by-time effects revealed that boys in the intervention group had a significantly higher mean score than boys in the control group, which was also observed for the girls. The one-way interaction analysis (group, sex and time) showed a significant interaction effect ($p < 0.001$; $p = 0.003$; $p < 0.001$) on GMI (Table 2).

Locomotor total raw score was significantly influenced by the two-way interaction analysis of the group by sex ($p = 0.047$, also see Figure 1). The LTRS of the boys in the intervention group improved from T1 to T3 ($p < 0.001$; d = 2.1, Table 3, Figure 1), while the LTRS of the boys in the control group improved from T1 to T2 ($p < 0.001$; d = 1.8, Table 3) but decreased from T2 to T3 ($p > 0.05$; d = 0.4, Table 3 see Figure 1). The LTRS of the girls in the intervention group improved significantly with a large significant effect size from T1 to T3 ($p < 0.001$; d = 2.1, Table 3). In the control group, girls also had a significant increase ($p < 0.001$; d = 1.6, Table 3) in LTRS from T1 to T3 (Figure 1). The group-by-sex interaction revealed that girls in both groups improved more than boys. Group-by-time interaction effects were also found in LTRS ($p < 0.001$), where the intervention group improved significantly over time compared to the control group. The one-way interaction analysis (group, sex and time) showed a significant interaction effect ($p < 0.001$; $p < 0.001$; $p < 0.001$) on LTRS (Table 2).

The BSTRS showed intervention effects as a marginally significant group by sex ($p = 0.06$) effect, which is revealed in Table 2 (also see Figure 2). Sex by time ($p = 0.003$) interaction effects were also observed in BSTRS (Table 2, Figure 2). The one-way interaction analysis of BSTRS (group, [$p = 0.039$], sex [$p = 0.003$] and time [$p < 0.001$] revealed a significant interaction effect on these skills (Table 2). Boys in the intervention group improved significantly with a large effect size ($p < 0.001$; d = 1.5, Table 3) from T1 to T3, while the boys in the control group also improved significantly, although with smaller changes ($p = 0.005$; d = 0.9, Table 3) from T1 to T3.

The girls in both the intervention ($p < 0.001$; d = 1.9) and control groups ($p < 0.001$; d = 2.1) improved significantly in BSTRS with large effect sizes from T1 to T3 (Figure 4). Boys in the intervention group showed significantly higher mean scores in BSTRS from T1 to T3 than girls (Table 2). Boys in the control group displayed a significant improvement from T1 to T2 ($p = 0.06$; d = 0.5, Table 3) compared to girls ($p = 0.05$; d = 0.5) and at T3, girls displayed a higher mean value with a significant large effect size increase ($p < 0.001$; d = 1.6) compared to the boys in the group ($p > 0.05$; d = 0.4, Table 3) in BSTRS as displayed in Figure 2.

Based on the GMI descriptive ratings in the TGMD-3 manual as displayed in Table 4 and the changes graphically displayed in Figure 3 and Figure 4, boys and girls in the intervention group moved from the 'average' descriptive category at pre-test to 'above average' at post-test. The boys in the intervention group maintained an 'above average' rating at re-test, while the girls in the intervention group shifted to a 'superior' rating at re-test. On the other hand, both boys and girls in the control group had an 'average' rating on the pre-test and the post-test. The boys maintained an 'average' rating at the re-test, while the girls moved to 'above average' at the re-test. It can be concluded from these shifts that are depicted in Table 4 and graphically displayed in Figure 3 and Figure 4 that the overall motor skills of the intervention group benefitted from the intervention, and this benefit was sustained, while the motor skills of the control group stayed more or less on the same level, especially in the boys. Although maturation effects are clear from these results, the intervention does show sustainable effects on the intervention group that differ from what was seen in the control group.

Discussion

This study investigated the influence of a 9-week FMS programme consisting of 18 lessons on the FMS of 7–8-year-old school children and the sustainability of the programme on their FMS. The main finding is that the intervention had significant positive effects on the FMS of the participants, including locomotor and ball skills, and in the overall gross motor grading of the group. The programme also had practical and sustainable effects on these variables, which was another positive outcome of the programme. Interaction effects related to sex, time and group were also found, demonstrating that the intervention had different influences on boys and girls at different time points of the intervention.

These results should, however, be considered against the improvement that was also found in the control group in most of the above variables. The improvement of the control group was, however, not to the extent found in the intervention group, and sustainability effects were also not found, especially in the locomotor skills of boys in the control group, which rather deteriorated during re-testing. These results, however, confirm that maturation plays a role in early FMS development and should therefore be considered carefully when interpreting the effect of the intervention. It is therefore most likely that some of the follow-up improvements that were evident in this study in both groups may have taken place as a result of growth and maturation. In agreement, Behan et al. (2019) also revealed the possible influence of maturation on the FMS performance of school-aged children from age 5–10 years.

In addition to maturation, another possible explanation can be learning effects that might have been created by the testing environment. The control group was able to observe the demonstrator and also their peers during the demonstration of skills at the different time points of testing. According to researchers (Hodges 2017; Hodges & Ste-Marie 2013; Rohbanfard & Proteau 2011), significant evidence exists confirming that children can learn motor skills from watching others, which can augment physical practice and support motor learning. In agreement, Larssen et al. (2021) observed that the combination of observational learning and physical practice has great benefits in terms of learning effects. Repeated patterns of movement during demonstration also generate stronger neural pathways, which support the learning of movement patterns (Ulrich 2000). In the study of

Ong, Larssen and Hodges (2012), it was reported that children who engaged in observational practice augmented with some irregular physical practice, were more accurate in motor learning. This reasoning may therefore also explain in part why the control group improved their FMS from pre-test to post-test without intervention. In addition, individual discussions with the participants regarding their daily activities, revealed that some participants in the control group were involved in a local team where soccer and cricket were played while engagement in street soccer was also evident, which all could have contributed to the improvement of FMS that was also found in this group. Also, taking into consideration that young children love to move, just the opportunity to learn new motor skills as provided by the testing (observational practice) might have been an impetus for these young developing children, especially girls, to experiment and apply these activities during their playtime (Larssen et al. 2021).

The results revealed that in certain skills, some of the children reached ceiling effects in terms of the TGMD scoring although these children were significantly younger than 10 years. A possible reason for this might be that children from low SES make use of active transport contributing to better fitness and development. Furthermore, and more specifically to the current population, African children participate in various traditional games and sports such as soccer during their free time (lunchtime, after school and recess) may contribute to better overall FMS and abilities. In this regard, a study found that if provided the choice to be active, the combined lunchtime and recess periods can contribute up to 40% towards children's daily PA and in turn will aid in better development (Ridgers, Stratton & Fairclough 2006). Another study indicated that the after-school period is also a 'critical window' for physical activity, where children generally have the discretion to choose their own activities and if engaged in active pursuits, this can contribute to approximately 25% of their daily PA and contribute significantly to their development (Beets et al. 2009). Therefore, combining an active lifestyle with the offered intervention could have contributed to the ceiling effects found in the study.

This positive intervention effect on girls after the FMS intervention was encouraging. The girls showed significant overall improvement, especially in ball skills at the post-test and re-test levels. The study by Lee et al. (2020) reported similar findings, although, boys did better than girls in both locomotor and ball skills on the pre-test and post-test. Still, the improvement or gains in both locomotor skills and ball skills from the pre-test to the post-test were significant. This was also the case in our study, as the girls significantly improved, especially in ball skills, from the pre-test to the post-test compared to the improvement reported for boys, which were also significant. A possible explanation offered by these researchers is that the need-supportive instruction strategy (motivational learning climate) that they used in their study provided boys and girls with equally positive feedback, reinforcement, encouragement and motivation, as well as greater support to engage in the motor skill programme. In addition, Barnett et al. (2010) believed that if girls can obtain valuable instructions and take part in learning experiences in an ideal setting, gender differences in ball skills might be lessened.

A clear sex interaction effect was also revealed that showed that girls reacted differently and more positively to the intervention than boys, especially regarding their locomotor skills (LTRS) and the sustainable effect of the programme on these skills. Girls in both groups outperformed their male counterparts in locomotor skills proficiency at pre-testing, which is consistent with the findings of FMS-based intervention studies (Chan, Ha & Ng 2016; Kelly et al. 2021; Logan et al. 2012; Morgan et al. 2013; Palmer et al. 2019; Pranoto et al. 2021; Wick et al. 2017). Studies by Barnett et al. (2009) on 8–10-years-old rural Australian children, 4–5-years-old Australian preschool children (Hardy et al. 2010) and 6–9-years-old Irish primary school children (Bolger et al. 2018) have also reported girls having higher locomotor scores than boys. However, Lee et al. (2020) contradicted these findings by reporting that boys aged 5–8 years had higher mean locomotor skills scores from the pre-test to the post-test after participating in an 8-week FMS-based afterschool programme, but they failed to explain these findings. It is, however, noteworthy, according to the research by Li et al. (2023) that the influence of gender on locomotor and ball skills is inconclusive, most especially among young children. The greater proficiency in locomotor skills among girls in the current study before the start of the intervention can be attributed to the types of activities that girls in this setting usually participate in, such as cultural dancing, rope skipping and traditional games, which have greater use and dependence on developing locomotor skills (Fauzi et al. 2023; Irawan et al. 2021; Pienaar et al. 2016). Furthermore, the type of activities that boys engage in, especially in low SES environments, might be more focused on manipulation skills, although locomotor skills are part of the activities. Moreover, the actual locomotor tests of the TGMD might be different from the types of locomotor skills performed by the boys and girls daily and the type of test (activity) might have been new and unfamiliar to them, hence the weaker locomotor scores.

It should also be noticed that although boys in the control group had the poorest locomotor skills at the pre-test of all the subgroups and improved slightly on the post-test, they could not sustain this gain at the re-test level; instead, their locomotor skills deteriorated. According to Barnett et al. (2016b), it can be that boys tend to gain greater exposure to ball skills rather than locomotor activities in their daily lives and typically receive greater encouragement, support and opportunities to participate in sports at home, school and in the broader community. As a result, they might be less motivated to explore locomotor skills, which influenced this re-testing or sustainability result in this group. This, however, confirms the intervention effects on the sustainability of the locomotor skills in the boys who participated in the intervention.

Based on the raw subtest scores and observation during the intervention, two of the six locomotor skills that were assessed were not well developed (gallop and skip) and showed very low scores at pre-testing compared to the other locomotor subtest scores in both groups. Regarding the gallop, criterion 1 (arms flexed and swinging forward), and in the skip, criterion 2 (arms flexed and moved in opposition to legs to produce force), was hard to master for the participants. These criteria require overall body coordination and timing from the child to make use of their arms to produce force while maintaining body balance to assist in projecting the body forward. In agreement, Valentini et al. (2022) also report that these criteria seem to make these skills more difficult. Kwon and Maeng (2022) also shared a similar observation by presuming that the gallop and skip skills of the TGMD-3 should be further investigated to verify the learning effects and the comprehensiveness of the performance criteria of these skills.

Boys, on the other hand, from both groups, however, performed significantly better than girls in ball skills at pre-testing. These findings again agree with previous research studies among 3–10-year-old Brazilian primary school children (Spessato et al. 2013), 3–8-years Belgian children (Bardid et al. 2016), 6–9-years-old Irish primary school children (Bolger et al. 2018) and 6-years-old Irish primary school children (Kelly et al. 2021). The rationale behind boys being more proficient in ball skills in this study is that boys participate more in street soccer and sporting activities that involve object manipulation, such as soccer, catching and throwing, kicking and bouncing of balls than girls, which is consistent with the findings from Booth et al. (2006), Pienaar et al. (2015) and Walter (2011).

This study showed that boys in the intervention group had higher mean scores in ball skills from the pre-testing up to the re-testing in comparison to their female counterparts. In girls, the improvement that was seen in ball skills was slightly lower during the retesting compared to what was found in boys in the intervention group, although their improvement of ball skills and thus the sustainable effect of the programme were also of large practical significance. The girls in the control group significantly improved their ball skills from pre-test to re-test with sustainable effects compared to a smaller gain that was observed in the boys' of the control group during the retesting. A possible explanation for this result agrees with an explanation provided by Logan et al. (2013) that less-skilled children are more likely to improve than higher-skilled children, implying that improvements are more difficult to obtain as skill levels improve. Our findings revealed that girls in both the intervention and control groups showed a higher improvement and mean scores in ball skills performance than boys in the control group at follow-up. However, in the intervention group, boys already had a high mean score during the pre-test but improved more on the re-test than their counterparts in the control group, with bigger sustainable changes as a result of the intervention. Following the improved performance of girls in both groups to the boys in the control group, a plausible explanation for this finding is that the boys in the control group already had good ball skills at the beginning (pre-test and post-test, see Figure 2) and therefore it was difficult for them to improve extensively without intervention.

The results of this study furthermore indicated that the GMI of all participants in both groups (intervention and control) at pre-test was at 'average' levels of FMS. These results concur with research findings globally, which reported that children showed below-average-to-average FMS levels (Bolger et al. 2020). A cohort of 3–6-year-old Belgian children showed average proficiency (Bardid et al. 2016) while decreasing trends in motor competency in FMS were reported among Grade 2 learners in Australia (Hardy et al. 2012). Below-average-to-average levels of FMS are also reported among Grade 1 learners in the North West Province of South Africa (Pienaar & Kemp 2014). After completing the programme, the intervention group exhibited 'above average' FMS levels, while the control group maintained their average level of FMS. At retesting, the intervention group (girls) had a 'superior' level of FMS, while the boys maintained an 'above average' level of FMS, with some units above the TGMD-3 standard for the rating of 'above average'. Boys in the control group maintained an 'average' level of FMS, while the girls moved to an 'above average' level of FMS. Based on these conclusions, it may be resolved that the girls profited more from the intervention compared to boys in both locomotor and ball skills. However, the exposure to FMS, such as testing opportunities created a learning opportunities for the girls in the control group, which was also to their advantage. In addition, the explanation provided by Logan et al. (2013) that lowered-skilled children (in this case the ball skills of girls) are prone to improve more than higher-skilled children (in this case, boys) indicates that further improvements are more challenging to attain when higher initial skill levels are already in place.

It is known that FMS ability does not improve naturally; the task, the individual and the environment all significantly influence the mastery of motor skills (Gallahue & Ozmun 2012; Goodway, Ozmun & Gallahue 2019; Logan et al. 2012; Valentine & Rudisill 2004). Likewise, competency levels in FMS can be attained with sufficient practice, instruction and learning opportunities (Logan et al. 2012; Lubans et al. 2010; Valentine & Rudisill 2004), which was proven by our findings. The intervention group had an immediate and sustainable effect on their FMS from pre-test to re-test, which is consistent with the findings of Robinson and Goodway (2009), Hurmeric (2011) and Roth et al. (2015), as this suggests the presence of learning, practising and an engaging effect that all foster the further improvement of these skills. Also, it is important that the teaching of FMS be functional, as this serves as a promising strategy to improve the FMS level of school children. The approach to teaching FMS is pedagogy, which involves the teaching of these competencies through education in PE classes (Barnett et al. 2016a).

These findings, therefore, suggest that young children might perhaps show a bigger improvement in FMS proficiency if they can be provided with developmentally appropriate teaching and practice opportunities in PE classes. This again can foster engagement in game-like activities and sports that rely on these foundational skills, which once again can improve PA in children, daily tasks and academic performance. Holfelder and Schott (2014) reason in this regard that motor proficiency has received worldwide recognition as a likely solution to fight against the worldwide epidemic of paediatric obesity and physical inactivity in children. The sustainable and still improving effect that was evident 6 months after completion of the programme suggests that the intervention group most probably applies these activities in their daily lives in activities that can foster further proficiency in these skills. Proficiency also fosters a mastery climate that is conducive to applying these skills in the everyday lives of children (Valentine & Rudisill 2004).

These results, therefore, urge that PE teachers should incorporate and encourage the practice of FMS into their PE classes. Gallahue et al. (2012) believe that children should have achieved adequate competency levels by the age of seven to successfully engage in games, sports and other practices of PA that require more context-specific skills, but the reverse was the case in this study, as children had difficulties mastering some of these skills at the age of seven because of inadequate opportunities and instruction. Therefore, implementing instructional learning and practice, at this young age, in this study helped the participants to improve the technique and consequently gain mastery that they could then apply in their daily activities, which resulted in a positive outcome. Thus, implementing additional opportunities and instructions for poorly mastered FMS in PE classes can go a long way towards promoting the mastery and proficiency of these skills. Furthermore, PE educators are normally expected to be highly competent in this subject area for a successful outcome (Barnett et al. 2016b) and also because of the health benefits associated with FMS development that track into adulthood (Lubans et al. 2010). Cohen, Goodway and Lidor (2012) suggested that teachers who are highly qualified achieve better FMS outcomes for their children. Teachers who are not qualified may likely revert to their personal experiences of PE as a child to guide their teaching (Morgan & Hansen 2008) with so much emphasis on the game's component of the PE curriculum (Woods et al. 2018).

Study's strength

This motor intervention delivered to school children from a low socioeconomic setting in the rural Eastern Cape schools of South Africa is the first study of its kind in this setting. A further strength of the study is the 6-month period of follow-up to determine the sustainability of the intervention, which is usually a limitation of intervention studies. As no similar studies have been performed in the setting where this study was conducted, the findings bring more understanding not only to the importance of FMS intervention but also to the challenges of rural environments that are faced by these children.

This study also had limitations that need to be acknowledged. Although intervention fidelity was not assessed formally, adherence to the implementation quality of the intervention could have been influenced by aspects out of the control of the researcher. Notwithstanding the fact that 18 lessons were delivered as planned, problems including a transport strike that left children stranded at home, teachers requesting children to stay at home while attending a workshop and rain on some days of the intervention left the researcher with no choice but to deliver the programme some weeks on 4 days of the week instead of twice per week. The time allocation of 30 min, which is allocated for PE classes at the school that was provided for the intervention was also rather limited as time to reinforce and rehearse newly learned FMS skills techniques was inadequate. Similar future research should therefore aim to increase the time allocation for lessons from 30 min to 60 min. The results may perhaps also not be generalised to typical elementary school environments, as the programme was conveyed by the researcher, who is knowledgeable in FMS and has an understanding of facilitating a mastery-based environment. Future studies should target the upskilling of educators who could help convey the teaching following the content and lessons learned from the current study, as well as training teachers and educators to enforce the PE curriculum where FMS is included. Based on the author's knowledge, previous studies in rural areas with comparable objectives were only conducted in preschool learning centres (3–5 years). Only school children between 7 and 8 years were involved in this study; hence, the findings should not be generalised to lower or higher age groups or regions. More research is, however, encouraged with school beginners as this age period is considered a time of opportunity to master FMS. Finally, based on the sustainable effects of the intervention, it was speculated that the children probably applied the activities in their daily lives. To rule out speculation, it is recommended that future studies should use interviews with the participants after 6 months to obtain a clear understanding of the type of activity they engaged in after the pre-, intervention- and post-test.

Conclusions

The results of this study suggest that a short-duration FMS intervention that can be provided during school hours as part of the PE curriculum or time allocated to activities can significantly improve locomotor, ball skills and GMI of school children in rural areas. The application of these mastered skills by children in their everyday lives, such as in the games they play and in sporting activities, can again contribute to higher activity patterns, and, subsequently, to the overall health and well-being of young children. Our findings support the notion that well-developed FMS can therefore be considered a mechanism to improve the health and well-being of young children and should therefore receive the necessary attention of different stakeholders. Achieving sustainable, long-term improvements in FMS depends on the presence of qualified instructors delivering PE lessons. The increase in the time spent on PE and the frequency of exposure to PE lessons are furthermore essential for FMS improvement.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

M.I. and A.E.P. conceptualised the study. M.I., A.E.P., M.M.v.G. and B.G. assisted with data collection. A.E.P. and B.G. provided formal analysis and methodology. M.I. planned and conducted the intervention, assisted with the data curation and wrote the original draft of the study. A.E.P., M.M.v.G. and B.G. reviewed, edited, visualised and supervised the study. A.E.P. contributed to the project administration. All authors have read and agreed to publish the final version of the manuscript.

Ethical considerations

Ethical approval to conduct this study was obtained from the North-West University Health Research Ethics Committee (NWU-HREC) (reference no.: NWU-00458-20-A1).

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Data availability

The data that support the findings of this study are available on request from the corresponding author, M.I.

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