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Fundamental Movement Skills and Academic Performance of 5- to 6-Year-Old Preschoolers

Elna de Waal[1]

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Abstract

Fundamental movement skills (FMS) are foundational and therefore play an important role in the overall development, sport-specific skills, and academic achievement of children. The aim of the study was to determine if a correlation exists between FMS and the academic performance of 5- to 6-year-old preschoolers. An empirical study including one pre-primary school in Bloemfontein, South Africa, was conducted. Five- to six-year-old learners ($N=69$) with an average age of 6.10 years (± 0.37) were assessed with the Kinderkinetics Screening Assessment to determine their FMS abilities. Academic reports, provided by the school, were used to analyse academic performance within three academic learning areas. Statistical analysis (SAS version 9.2.) included descriptive statistics, Pearson correlation analyses and associated p values ($\leq .05$), while the following correlation coefficient cut-off values were used: $r \approx .1$ (small), $r \approx .3$ (moderate) and $r \geq .5$ (large). The results indicated that static and dynamic balancing skills correlated with all three learning areas; these correlations were moderate to large and also statistically significant. Furthermore, it became evident that gliding, skipping and star jumps correlated especially with mathematics, as well as with Home Language and Life Orientation. Of all the learning areas included, Mathematics revealed the most and largest significant correlations with FMS in general. In conclusion, FMS, especially dynamic and static balance skills, of 5- to 6-year-old preschoolers correlate significantly with their academic performance. Children in the fundamental movement stage should be exposed to activities including balancing, vestibular stimulation, bilateral integration, rhythm and spatial orientation.

Keywords Fundamental movement skills · Academic performance · Preschool · Child

Introduction

During the early years of motor development, children actively explore and experiment with the body's potential to move. These explorations lead to the development of basic movement skills, also known as fundamental movement skills (FMS). FMS are defined as observable patterns of motor behaviour, which consist of three constructs and can be classified into initial, emerging and proficient stages (Gallahue et al. 2011). The three constructs which make up FMS are locomotor skills (run, hop, jump, slide, gallop, leap), object control skills (strike, dribble, kick, throw, underarm roll, catch), and stability skills (non-locomotor skills such as body rolling, bending, and twisting) (Gallahue et al. 2011). The fundamental movement phase follows a sequential progression that can be subdivided into the initial, elementary, and mature stages (Gallahue et al. 2011).

FMS are considered to be the building blocks for further development (Goodway and Robinson 2006) and it is important for FMS to be in place and well developed for a child to be able to perform more advanced forms of movement later in life and apply it to sport-specific skills as they get older (Gallahue et al. 2011). Improved motor competency leads to increased functional capacity, which promotes positive lifespan trajectories of functional capability and contributes to long-term health outcomes (Cattuzzo et al. 2016). Vameghi et al. (2013) reported in this regard that children who did not receive optimal stimulation during childhood would be prone to underdeveloped motor skills and would be less active in school, leading to the inability to master movement skills later on in life. FMS also contribute to the general development and well-being of young children (Pienaar

✉ Elna de Waal
dewaale@ufs.ac.za

[1] Department of Exercise and Sport Sciences, Faculty of Health Sciences, University of the Free State, Bloemfontein, South Africa

2009, 2014), while age, gender, physical activity, preschool settings, and preschool programmes influence FMS (Iivonen and Sääkslahti 2014). Well-mastered FMS also result in improved scholastic adjustment and social behaviour (Bart et al. 2007) during the transition to formal schooling. These researchers indicated that, in addition to good visual-motor integration abilities, good motor abilities might serve as a buffer to the normative challenges presented to children during the transitioning period, whereas poor motor ability might lead to vulnerability (Bart et al. 2007).

Gross motor skills have been indicated as an important contributor to later cognitive achievement by various researchers (Lopes et al. 2013; Morales et al. 2011; Piek et al. 2008; Son and Meisels 2006), possibly because cognitive and motor functions use the same brain structures (Diamond 2000; Westendorp et al. 2011). Diamond (2000) stated that the prefrontal cortex and cerebellum were important for not only movement control, but also for cognitive functioning. Amongst typically developing learners, both fine motor skills (Luo et al. 2007; Piek et al. 2006) and gross motor skills (Lopes et al. 2013) play important roles in scholastic ability and academic achievement.

According to Pienaar et al. (2014), academic performance of South African Grade 1 learners correlates with their general motor proficiency. Van Niekerk et al. (2015) found that the motor competency (fine and gross motor abilities) of 13- to 14-year-olds in Potchefstroom, South Africa, was significantly related to their academic performance, after the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2) had been used to assess these children. After longitudinally assessing Australian children from the ages of 4 months to 12 years, Piek et al. (2008) also confirmed that gross motor skills served as a significant predictor for subsequent cognitive performance. According to Lopes et al. (2013), 9- to 11-year-old children in Portugal show weaker academic performance when their gross motor coordination abilities are limited. As part of a longitudinal study in the United States, the motor skills and cognitive performance of 21,260 preschool children were assessed and results showed that visual-motor skills, and to a lesser extent gross motor skills, correlated with reading and especially mathematical performance (Son and Meisels 2006). According to the above literature, gross motor coordination therefore plays an important role in cognitive development and later academic achievement of children.

Good motor competence allows children to participate in many different types of physical activities, which not only enhance their physical health but also improve their overall cognitive development and academic achievement. From the above literature it is evident that there is a relationship between cognitive development and early gross and fine motor skills. However, only a limited number of studies were found that investigated the relationship specifically between FMS and academic performance early in life. Determining the nature of this relationship may offer insights to teachers and movement specialists who work with children during the critical fundamental movement developmental phase. The aim of this study is therefore to determine if a correlation exists between the FMS and academic performance of 5- to 6-year-old preschoolers.

Methods

Study Design

This study was empirical in nature and made use of qualitative and quantitative data along with descriptive statistics. Data were collected at one school during a single testing procedure using the Kinderkinetics Screening Assessment as well as academic reports of the participants. After obtaining ethical approval, data gathering commenced on 69 learners, aged 5 and 6 years old, who voluntarily participated over a period of 2 days. The Kinderkinetics Screening Assessment was mainly used to evaluate qualitative execution of various FMS (video analysis). However, some quantitative data on FMS execution were also gathered by means of this screening tool. Video recordings of FMS execution were made and enabled the researcher to analyse the quality of the execution at a later stage in a quiet and focused setting. Academic performance was determined by means of academic reports of the first two school terms, as captured by the applicable school's teachers and provided by the headmaster. A qualified Kinderkineticist and honours students specializing in Kinderkinetics were responsible for qualitative and quantitative FMS data collection and capturing.

Participants

Learners from one pre-primary school in Bloemfontein formed the participant group. Data was collected by evaluating 69 participants between the 5 and 6 years of age. The group ($N=69$) consisted of 38 boys and 31 girls with an average age of 6.10 years (± 0.37). The sample population was from a high socio-economic background and mainly consisted of Caucasian learners. Inclusion criteria for participants were met when the children were 5 or 6 years of age, when parental consent was given for the child to partake, and when the learner expressed willingness to participate in this study. Exclusion of participants occurred when permission from the above-mentioned parties had not been received, if the child was absent on the day of testing, or if serious neurological backlogs were present and brought to light by the parents or teachers.

Data collection

The Kinderkinetics Screening Assessment evaluates the basic fundamental movement skills used by children aged 3–6 years which are later refined for the specialized phase during sports participation. The skills assessed are divided into the following main components: fundamental locomotor skills, dynamic and static balance (stability), coordination and ball skills (object manipulation), body awareness and spatial orientation. Fundamental locomotor skills included two-legged jumps, one-legged jumps (left and right), running, standing long jump, gliding (left and right) and skipping. Standing on the left and the right leg (with eyes open and closed), walking forward and backwards on a balance beam and walking heel-toe (forward and backwards) were activities within the balance component. Coordination and ball skills were comprised of catching, kicking, overhand throwing, and star jumps. Body part identification and the copying of hand signals made out the body awareness and spatial orientation component. This screening tool measures the qualitative and quantitative aspects of the movement performed, while the qualitative criteria is based on the fundamental developmental phases. The fundamental developmental phases include the initial phase (2–3 years), elementary phase (4–5 years) and the mature phase (6–7 years). For the purpose of this study it was expected of the participants to show mainly elementary- and mature-phase execution of the various FMS. This assessment tool has been used by Kinderkineticists in practice for more than 15 years, and moderate validity and acceptable reliability based on comparison with other test batteries have been reported. The screening instrument has good construct and content validity with moderate test–retest reliability for the different fundamental movement skills in the screening protocol, with the strongest reliability found for the process-orientated or qualitative assessments (>0.75) (Pienaar et al. 2016).

Academic Performance

In 2010 the Department of Basic Education made available a document entitled, *Foundations for Learning: Assessment Framework Grade R*. This document's main aim is to assist teachers throughout the year in their planning and the assessment of Grade R learners in different learning areas. This study made use of three learning areas, namely Mathematics (measurements, numbers, patterns, space and shapes), Life Orientation (start knowledge, creativity and physical education), and Home Language (reading, writing, listening and speaking). Upon receiving academic reports from the headmaster, data were captured and standardised national codes for the Foundation Phase (Grade R to 3) were used to interpret the average percentages for each learning area. A rating code from 1 to 7 was awarded to a specific percentage range, with an achievement description also allocated. A code of "7" was allocated for outstanding achievement, while a "6" was allocated for meritorious achievement. If a "5" was allocated it indicated substantial achievement, a code of "4" was the result of adequate achievement, and a "3" was awarded for moderate achievement. A code of "2" was allocated for elementary achievement, while a "1" was allocated if the goal had not been achieved (Department of Basic Education 2010).

Procedure

Ethical Considerations

Before commencement of the study, ethical approval, based on the 1964 Helsinki Declaration and its later amendments or comparable ethical standards, was obtained from the Ethics Committee of the University of the Free State (UFS/HSD2017/0280). The headmaster of the participating school gave permission for the necessary data to be obtained during school hours by means of the Kinderkinetics Screening Assessment, while the academic reports of the first two school terms (from January to July) were also made available. The parents or legal guardians were informed of the testing and received an informed consent form to complete. In cases in which parental consent was granted, participants received an assent form and were informed of the voluntary nature of the study and that they could withdraw at any time without explanation. Privacy was considered critical throughout the testing and names of participants were kept confidential by means of providing a number for each participant. Video recordings were only used for analysis purposes. All the data and videos were safely stored on a computer that is password protected and only accessible to the researcher.

Statistical Methods

The researcher captured data electronically in Microsoft Excel. Analysis was done by a biostatistician using SAS version 9.2. Descriptive statistics, namely frequencies and percentages, were calculated for categorical data, and means (*M*) and standard deviations (*SD*) for numerical data. Pearson correlations and associated p values were calculated between FMS and academic performance, using the following cut-off values for the correlation coefficient: $r \approx .1$ indicated a small correlation, $r \approx .3$ a moderate correlation and $r \geq .5$ a large correlation (Cohen 1988). If no correlations are present or if correlations are of small size, the applicable FMS will not be reflected in the table.

Results

Table 1 summarizes the demographic data of the 69 participants included in the study. The average age of the participants was 6.1 years (± 0.37 years; range 5.1–6.9 years). The average height was 114.01 cm (± 4.59 cm), while the average weight was 23.1 kg (± 3.41 kg).

The data presented in Table 2 suggest that the majority of the participants showed elementary- and mature-phase execution of the fundamental locomotion skills, as expected of 5- to 6-year-olds. With regard to the participants' balancing skills, a larger than expected number of participants showed initial-stage execution, especially struggling to balance with their eyes closed ($n = 19$, 27.54%—right leg and $n = 21$, 30.43%—left leg) and to walk heel–toe ($n = 10$, 14.49%).

Table 1 Descriptive statistics of the participant group

	N	Boys	Girls	5-Year-olds	6-Year olds
Participant group	69 (100.00%)	38 (55.07%)	31 (44.93%)	22 (31.88%)	47 (68.12%)

	Mean	*SD*	Minimum	Maximum
Age (years)	6.10	0.37	5.10	6.90
Weight (kg)	23.11	4.59	16.40	32.80
Height (cm)	114.01	3.41	102.00	126.00

N total number of learners, *SD* standard deviation

Table 2 Qualitative mastery of fundamental movement skills

	Initial *n* (%)	Initial/elementary *n* (%)	Elementary *n* (%)	Elementary/mature *n* (%)	Mature *n* (%)
Fundamental locomotor skills					
Two-legged jump	5 (7.25)	3 (4.35)	33 (47.83)	1 (1.45)	27 (39.13)
One-legged jump (right)	7 (10.14)	1 (1.45)	35 (50.72)	2 (2.90)	24 (34.78)
One-legged jump (left)	6 (8.70)	1 (1.45)	28 (40.58)	3 (4.35)	30 (43.48)
Running	4 (5.80)	0 (0.0)	28 (40.58)	1 (1.45)	36 (52.17)
Standing long jump	3 (4.35)	1 (1.45)	33 (47.83)	1 (1.45)	31 (44.93)
Gliding (right)	7 (10.14)	1 (1.45)	27 (39.13)	2 (2.90)	32 (46.38)
Gliding (left)	9 (13.04)	2 (2.90)	28 (40.58)	1 (1.45)	29 (42.03)
Skipping	9 (13.04)	0 (0.0)	38 (55.07)	3 (4.35)	19 (27.54)
Dynamic and static balance					
One leg (R)—eyes open	8 (11.59)	0 (0.0)	24 (34.78)	1 (1.45)	36 (52.17)
One leg (L)—eyes open	7 (10.14)	1 (1.45)	25 (36.23)	0 (0.0)	36 (52.17)
One leg (R)—eyes closed	**19 (27.54)**	1 (1.45)	26 (37.68)	2 (2.90)	21 (30.43)
One leg (L)—eyes closed	**21 (30.43)**	1 (1.45)	27 (39.13)	1 (1.45)	19 (27.54)
Balance beam forward	5 (7.25)	1 (1.45)	31 (44.93)	8 (11.59)	24 (34.78)
Balance beam backwards	9 (13.04)	1 (1.45)	39 (56.52)	3 (4.35)	17 (24.64)
Heel–toe forward	**10 (14.49)**	0 (0.0)	40 (57.97)	5 (7.25)	14 (20.29)
Heel–toe backwards	5 (7.25)	1 (1.45)	37 (53.62)	3 (4.35)	5 (7.25)
Coordination and ball skills					
Catching	4 (5.80)	0 (0.0)	22 (31.88)	2 (2.90)	**41 (59.42)**
Kicking	**11 (15.94)**	1 (1.45)	38 (55.07)	0 (0.0)	19 (27.54)
Overhand throw	5 (7.25)	4 (5.80)	46 (66.67)	0 (0.0)	14 (20.29)
Star jumps	**12 (17.39)**	0 (0.0)	31 (44.93)	3 (4.35)	22 (31.88)
Body awareness and spatial orientation					
Body-part identification	4 (5.80)	0 (0.0)	20 (28.99)	0 (0.0)	**45 (65.22)**
Copying hand signals	1 (1.45)	0 (0.0)	8 (11.59)	1 (1.45)	**59 (85.51)**

Bold values indicate important occurences or significant correlations

N number of learners, *R* right, *L* left

A larger than expected number of participants portrayed poor qualitative performance when kicking a ball ($n = 11$, 15.94%) and performing star jumps ($n = 12$, 17.39%). The majority of the learners' body awareness skills were found to be in the mature stage ($n = 45$, 65.22%—body-part identification and $n = 59$, 85.51%—copying hand signals). This observation is of importance with regard to further analysis of the results. As there was very little variation in these variables (Table 2) the calculation of correlations with academic performance may have been affected.

In Table 3 significant correlations of moderate size between Home Language performance and fundamental locomotion skills, specifically gliding to the left and skipping, are evident. The dynamic and static balance activities all show moderate correlations of statistical significance with Home Language performance. Therefore, efficient balancing skills seem to be associated with Home Language performance. Regarding coordination and ball skills, star jumps show moderate and statistically significant correlations with Home Language performance. Only small correlations were observed for catching, while none of these were statistically significant. Body awareness and spatial orientation abilities correlate with Home language performance, although these correlations are small and not statistically significant. FMS with no correlations or only correlations of small size were not included in the table.

Table 4 shows that two-legged jumping and one-legged jumping (to the right) correlated on a moderate to large scale with most of the mathematical aspects, while these correlations were statistically significant. Mathematical measurement performances were however the exception and showed no significant correlations with locomotion skills. Gliding to the right and left, as well as skipping, showed moderate to large correlations of statistical significance with performance in Mathematics. Most of the dynamic and static balancing skills (except for balancing on the left leg with eyes closed) showed moderate to large statistically significant correlations with Mathematics performance. As seen in Tables 3, 4 and 5, the star jumps again correlated largely and significantly with academic performance, this time specifically with mathematics performance. Identification of body parts (body awareness and spatial orientation subtest) significantly correlated on a moderate scale with Mathematics performance in general, and specifically with the data handling aspect and the spaces and figures aspect.

With regard to Life Orientation, Table 5 suggests that one-legged jumping (right leg) significantly correlated on a moderate size level with most of the Life Orientation components, except for creative arts and physical education. Gliding (right and left) and skipping have small to moderate correlations with Life Orientation skills in general. Balancing on one leg, walking on a balance beam, as well as walking heel–toe forward show moderate to large correlations with Life Orientation skills, while these correlations are also statistically significant. As with the previous two learning areas, balancing skills (static and dynamic), of all the FMS,

Table 3 Pearson correlations between fundamental movement skills and Home Language

Home language										
Fundamental movement skills	Reading		Writing		Listen & speak		Total percentage		Achievement description	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Fundamental locomotor skills										
One-legged jump (right)	0.22#	0.073	0.22#	0.078	0.24#	0.050*	0.25#	0.045*	0.26#	0.033*
Gliding (right)	0.20#	0.099	0.28#	0.020*	0.19#	0.120	0.23#	0.065	0.23#	0.060
Gliding (left)	0.31##	0.011*	0.36##	0.003*	0.23#	0.065	0.29#	0.019*	0.30##	0.014*
Skipping	0.26#	0.035*	0.32##	0.008*	0.26#	0.032*	0.29#	0.017*	0.35##	0.004*
Dynamic and static balance										
One leg (R)—eyes open	0.36##	0.003*	0.40##	0.001*	0.32##	0.009*	0.36##	0.009*	0.41##	0.003*
One leg (L)—eyes open	0.30##	0.014*	0.37##	0.002*	0.30##	0.013*	0.34##	0.005*	0.37##	0.002*
One leg (R)—eyes closed	0.39##	0.004*	0.31##	0.002*	0.33##	0.007*	0.36##	0.003*	0.39##	0.001*
One leg (L)—eyes closed	0.35##	0.004*	0.28#	0.021*	0.29#	0.019*	0.32##	0.009*	0.36##	0.003*
Balance beam forward	0.37##	0.002*	0.38##	0.002*	0.22#	0.074	0.30##	0.014*	0.32##	0.009*
Balance beam backwards	0.43##	0.000*	0.43##	0.000*	0.38##	0.002*	0.43##	0.000*	0.46##	0.001*
Heel–toe forward	0.40##	0.001*	0.38##	0.002*	0.35##	0.004*	0.39##	0.001*	0.38##	0.001*
Heel–toe backwards	0.36##	0.010*	0.44##	0.002*	0.33##	0.022*	0.39##	0.005*	0.37##	0.009*
Coordination and ball skills										
Star jumps	0.27#	0.029*	0.35##	0.004*	0.34##	0.005*	0.35##	0.004*	0.37##	0.003*

R right, *L* left; #$r > .1$ (small); ##$r > .3$ (moderate); ###$r > .5$ (large); *$p \leq .05$

Table 4 Pearson correlations between fundamental movement skills and Mathematics

Mathematics														
Fundamental movement skills	Data handling		Measurements		Numbers		Patterns		Spaces and figures		Total percentage		Achievement description	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Fundamental locomotor skills														
Two-legged jump	0.51$^{\#\#\#}$	0.015*	0.03	0.060	0.43$^{\#\#}$	0.045*	0.40$^{\#\#}$	0.065	0.36$^{\#\#}$	0.002*	0.32$^{\#\#}$	0.007*	0.23$^{\#}$	0.053
One-legged jump (right)	0.59$^{\#\#\#}$	0.004*	0.01	0.919	0.55$^{\#\#\#}$	0.008*	0.48$^{\#\#}$	0.003*	0.30$^{\#\#}$	0.012*	0.31$^{\#\#}$	0.011*	0.26$^{\#}$	0.030*
Gliding (right)	0.69$^{\#\#\#}$	0.000*	0.01	0.956	0.62$^{\#\#\#}$	0.002*	0.74$^{\#\#\#}$	0.000*	0.34$^{\#\#}$	0.005*	0.28$^{\#}$	0.021*	0.25$^{\#}$	0.035*
Gliding (left)	0.57$^{\#\#\#}$	0.005*	0.03	0.814	0.49$^{\#\#}$	0.020*	0.61$^{\#\#\#}$	0.003*	0.34$^{\#\#}$	0.004*	0.30$^{\#\#}$	0.011*	0.26$^{\#}$	0.028*
Skipping	0.39$^{\#\#}$	0.074	0.01	0.935	0.43$^{\#\#}$	0.047*	0.49$^{\#\#}$	0.020*	0.14$^{\#}$	0.243	0.17$^{\#}$	0.164	0.22$^{\#}$	0.069
Dynamic and static balance														
One leg (R)—eyes open	0.69$^{\#\#\#}$	0.000*	−0.11	0.349	0.60$^{\#\#\#}$	0.003*	0.72$^{\#\#\#}$	0.000*	0.42$^{\#\#\#}$	0.000*	0.45$^{\#\#}$	0.000*	0.45$^{\#\#}$	0.000*
One leg (L)—eyes open	0.57$^{\#\#\#>}$	0.006*	0.02	0.860	0.50$^{\#\#\#}$	0.017*	0.62$^{\#\#\#}$	0.002*	0.34$^{\#\#}$	0.004*	0.36$^{\#\#}$	0.003*	0.33$^{\#\#}$	0.006*
One leg (R)—eyes closed	0.59$^{\#\#\#}$	0.004*	−0.09	0.474	0.52$^{\#\#\#}$	0.012*	0.52$^{\#\#\#}$	0.012*	0.23$^{\#}$	0.055	0.26$^{\#}$	0.031*	0.26$^{\#}$	0.032*
One leg (L)—eyes closed	0.31$^{\#\#}$	0.156	0.07	0.589	0.40$^{\#\#}$	0.066	0.34$^{\#\#}$	0.117	0.24$^{\#}$	0.052	0.25$^{\#}$	0.041*	0.26$^{\#}$	0.301
Balance beam forward	0.52$^{\#\#\#}$	0.014*	0.05	0.686	0.57$^{\#\#\#}$	0.006*	0.60$^{\#\#\#}$	0.003*	0.44$^{\#\#}$	0.000*	0.43$^{\#\#}$	0.000*	0.43$^{\#\#}$	0.000*
Balance beam backwards	0.45$^{\#\#}$	0.035*	0.08	0.528	0.41$^{\#\#}$	0.059	0.56$^{\#\#}$	0.006*	0.39$^{\#\#}$	0.001*	0.40$^{\#\#>}$	0.001*	0.39$^{\#\#}$	0.001*
Heel–toe forward	0.52$^{\#\#\#}$	0.012*	0.10$^{\#}$	0.412	0.54$^{\#\#\#}$	0.009*	0.57$^{\#\#\#}$	0.006*	0.44$^{\#\#}$	0.000*	0.46$^{\#\#}$	0.000*	0.46$^{\#\#}$	0.000*
Heel–toe backwards	0.03	0.220	0.35$^{\#\#}$	0.011*	0.37$^{\#\#}$	0.161	0.48$^{\#\#}$	0.061	0.26$^{\#\#}$	0.060	0.37$^{\#\#}$	0.008*	0.34$^{\#\#}$	0.014*
Coordination and ball skills														
Catching	0.27$^{\#}$	0.216	−0.07	0.580	0.41$^{\#\#}$	0.058	0.34$^{\#\#}$	0.118	0.21$^{\#}$	0.086	0.17$^{\#}$	0.160	0.17$^{\#}$	0.171
Overhand throw	0.58$^{\#\#\#}$	0.005*	−0.03	0.817	0.33$^{\#\#}$	0.128	0.33$^{\#\#}$	0.128	−0.03	0.780	−0.03	0.833	−0.03	0.814
Star jumps	0.67$^{\#\#\#}$	0.001*	0.08	0.528	0.71$^{\#\#\#}$	0.000*	0.71$^{\#\#\#}$	0.000*	0.40$^{\#\#}$	0.001*	0.40$^{\#}$	0.001*	0.45$^{\#\#}$	0.000*
Body awareness and spatial orientation														
Body-part identification	0.47$^{\#\#}$	0.028*	−0.05	0.698	0.37$^{\#\#}$	0.090	0.32$^{\#\#}$	0.150	0.30$^{\#\#}$	0.011*	0.27$^{\#}$	0.024*	0.23$^{\#}$	0.057

R right, *L* left; "–" no correlation calculated; $^{\#}r > .1$ (small); $^{\#\#}r > .3$ (moderate); $^{\#\#\#}r > .5$ (large); $^{*}p \leq .05$

Table 5 Pearson correlations between fundamental movement skills and Life Orientation

Life Orientation										
Fundamental movement skills	Initial knowledge		Creative arts		Physical education		Total percentage		Achievement description	
	r	p	r	p	r	p	r	p	r	p
Fundamental locomotor skills										
One-legged jump (right)	0.39##	0.001*	0.21#	0.087	0.26#	0.033*	0.31##	0.010*	0.31##	0.010*
Gliding (right)	0.42##	0.000*	0.28#	0.022*	0.38##	0.001*	0.38##	0.001*	0.39##	0.001*
Gliding (left)	0.42##	0.000*	0.32##	0.007*	0.37##	0.002*	0.39##	0.009*	0.40##	0.001*
Skipping	0.28#	0.018*	0.20#	0.096	0.31##	0.010*	0.28#	0.020*	0.29#	0.012*
Dynamic and static balance										
One leg (R)—eyes open	0.47##	0.000*	0.35##	0.004*	0.41##	0.000*	0.44##	0.000*	0.44##	0.000*
One leg (L)—eyes open	0.40##	0.001*	0.22#	0.070	0.33##	0.005*	0.34##	0.004*	0.35##	0.003*
One leg (R)—eyes closed	0.24#	0.044*	0.21#	0.077	0.23#	0.056	0.24#	0.044*	0.24#	0.044*
One leg (L)—eyes closed	0.27#	0.027*	0.24#	0.044	0.25#	0.039*	0.27#	0.026*	0.29#	0.015*
Balance beam forward	0.48##	0.000*	0.29#	0.017*	0.41##	0.000*	0.42##	0.000*	0.45##	0.000*
Balance beam backwards	0.50###	0.000*	0.36##	0.002*	0.47##	0.000*	0.47##	0.000*	0.50###	0.000*
Heel–toe forward	0.44##	0.000*	0.35##	0.003*	0.35##	0.003*	0.41##	0.001*	0.43##	0.000*
Heel–toe backwards	0.24#	0.088	0.20#	0.160	0.26#	0.062	0.26#	0.071	0.24#	0.085
Coordination and ball skills										
Catching	0.25#	0.035*	0.16#	0.198	0.18#	0.134	0.21#	0.079	0.20#	0.103
Star jumps	0.32##	0.009*	0.36##	0.003*	0.34##	0.004*	0.36##	0.003*	0.36##	0.003*
Body awareness and spatial orientation										
Body-part identification	0.25#	0.042*	0.09	0.470	0.17#	0.170	0.18#	0.133	0.17#	0.153
Copying hand signals	0.28#	0.021*	0.11#	0.381	0.20#	0.099	0.21#	0.079	0.21#	0.077

R right, *L* left, #$r \geq .1$ (small), ##$r \geq .3$ (moderate), ###$r \geq .5$ (large); *$p \leq .05$

show the largest correlations with academic performance. Star jumps show moderate correlations with Life Orientation skills. Only small correlations were observed between the body awareness and spatial orientation skills and Life Orientation, with statistical significance only between copying hand signals and initial knowledge.

Discussion

This study aimed to determine whether FMS significantly correlate with the academic performance of 5- to 6-year-old preschoolers. The main finding confirms that moderate to large correlations of statistical significance exist between several FMS and academic learning areas of 5- to 6-year-old preschoolers. Pienaar et al. (2014) confirmed relationships between learners' overall perceptual-motor proficiency and basic numeracy and literacy academic achievement. Although correlations in general are evident from our results, certain FMS showed correlations with specific academic learning areas. The importance of specific relationships between certain areas of cognitive and motor performance are confirmed by recent findings of Stöckel and Hughes (2016). This holds strong implications for persons involved in early childhood development. As was the case for the current study, Vuijk et al. (2011) found that specific relationships occurred between specific academic domains. In their study balance correlated with mathematics, dexterity with spelling, and ball skills with reading ability, although it should be noted that this study was conducted amongst learners with learning problems. Westendorp et al. (2011) reported specific relationships between reading and locomotor skills, as well as between mathematics and object control skills, among children with learning disabilities. The latter finding of Westendorp et al. (2011) is not completely in accordance with our results, as the current study found no significant correlations between mathematics and object manipulation skills.

Secondly, static and dynamic balance seem to be the FMS showing the most significant correlations with Home Language, Life Orientation, and especially Mathematics. Vuijk et al. (2011) also found specific significant correlations between balance and mathematics. Balancing, especially without vision, greatly relies on effective functioning of the vestibular system (Cheatum and Hammond 2000). According to Cheatum and Hammond (2000), this system is involved in the execution of controlled movements such as moving through space and performing sport skills.

Vestibular system problems not only lead to motor proficiency delays, but can also negatively impact the execution of classroom activities (Cheatum and Hammond 2000). With the results of the current study in mind, it is important to not only address balance as an isolated fundamental motor skill, but also take into account the importance of the vestibular system's role and address balance holistically as a perceptual-motor skill. In a recent systematic review, the findings of Macdonald et al. (2018) differed from the current study's results: they stated that balance did not significantly correlate with academic performance if other motor abilities such as speed, agility, and upper-limb coordination were taken into account. In the study of Pacheco et al. (2016) body coordination, including balance, and bilateral coordination significantly correlated with the academic performance of children aged 8–11 years. However, it is important to note that these researchers stated that the aforementioned relationship was due to bilateral coordination rather than balance, as bilateral coordination had the highest impact on academic performance.

Bilateral coordination activities (gliding, skipping, and star jumps) in our study showed significant correlations with all three learning areas and, as stated by Pacheco et al. (2016), are important for academic performance. Magalhaes et al. (1989) stated that jumping jacks (star jumps) were an effective screening measurement of bilateral coordination in children, thereby confirming that correlations with regard to star jumps in the current study can be interpreted with bilateral coordination in mind. After evaluation of the motor abilities of first graders from two different social settings, the importance of including interlimb coordination activities during the early childhood developmental years was emphasised (Bobbio et al. 2010). In addition to bilateral coordination, jumping jacks, skipping and gliding also rely on good perceptual-motor components such as spatial awareness and rhythm (Gallahue et al. 2011).

With regard to academic performance, especially in mathematics, it is evident from the results of the current study that not only balance and bilateral coordination showed correlations, but also that body-part identification and the act of imitating hand signals correlated with the spatial characteristics of academic activities and domains. According to Fredericks et al. (2006), increased spatial development of an experimental group who participated in a 10-week movement programme led to improved reading and mathematical skills among 53 Grade 1 learners in South Africa. In the assessment of 12 099 children participating in the Millennium Cohort Study, spatial skills at 5 years of age significantly explained mathematical achievement at 7 years of age (Gilligan et al. 2017). In another longitudinal study, by Casey et al. (2015), early spatial skills in Grade 1 acted as long-term predictors of spatial mathematics reasoning in Grade 5, highlighting the importance of the known connection between mathematics and spatial awareness (Mix and Cheng 2012).

Finally, it is important to note that, overall, the participant group struggled more than expected with the qualitative execution of the static balance activities (without vision), with kicking, and with star jump execution. This is of importance as two of these three skills (balance and star jumps) significantly stand in a positive relationship with all three learning areas investigated. According to a study done by Hardy et al. (2012) in Australia, children's FMS competency improved as they got older, although some children attending high school had not yet mastered basic locomotor skills. In addition to this, the girls in the study still struggled with object manipulation skills (Hardy et al. 2012). Foulkes et al. (2015) further argued that appropriate interventions should be implemented in preschool settings to improve movement skills, with targeted activities for boys and girls, especially because overall motor competence of preschoolers is low.

Conclusion

In conclusion, this study confirms the significant relationship between FMS and academic performance of 5- to 6-year old preschoolers. Specific correlations were observed between FMS and components of all three learning areas, especially Mathematics, the FMS of interest being balance skills, bilateral coordination activities, and activities relying on spatial awareness. Based on the findings of the study it is recommended that movement specialists such as Kinderkineticists effectively address the development of FMS during the fundamental development years. Teachers in early childhood development centres and in the formal school setting should be made aware of this important correlation and should allow children sufficient free play as well as structured play times to increase optimised opportunities for the development of children's FMS. In addition to FMS, balance as a perceptual-motor skill (including vestibular stimulation), bilateral coordination, and spatial awareness should be addressed in movement programmes and play times during the early childhood years.

Strengths of this study include the use of an age-appropriate, reliable and valid screening tool, while video footage made high-quality and correct interpretation of qualitative execution possible. The findings should, however, be seen in the light of slight shortcomings. The study sample comprised only one school with learners of high socio-economic status and cannot be generalised to the typical South African population. Taking the social diversity of South Africa into account, future research on this topic on a larger and more diverse study sample is advised. Pearson correlation analyses only indicated significant correlations and did not determine the direction of influence or the causational relationship between FMS and academic performance. Further statistical limitations include calculating many correlations, which may cause some correlations to emerge as significant even when it is not the case. Lastly it should be noted that calculations determining practical significance were not included in the data analysis. It is advised that studies of longitudinal nature, with more advanced statistical analyses (such as a regression analysis) should be conducted, taking cognitive intelligence and other perceptual-motor skills into account.

The author declares that this study complies with all the ethical standards (including obtained informed consent) as presented in the "ECEJ Instructions for Authors" document.

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Compliance with Ethical Standards

Conflict of interest The author declare that there is no conflict of interest.

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