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Title: Fundamental motor skill proficiency of Hong Kong children aged 6-9 years
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Running title: Fundamental motor skill of Hong Kong children

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Abstract

This study investigated the fundamental motor skill proficiency of Hong Kong children aged 6-9. Ninety-one and 76 Chinese male and female students (mean age = 7.6 years) from six local primary schools in Hong Kong participated in this study. The Test of Gross Motor Development – Second Edition (TGMD-2) was administered to assess the mastery of gross motor skills by an experienced physical education instructor. The performance was videotaped, and was rated by the same physical education instructor again (one week apart) to show the reliability (0.88-0.97). Results showed that the participants were in general superior to the normative samples from TGMD-2 manual, scoring a Gross Motor Quotient of 56.8-80.9. In overall, 24% of the participants were rated as superior, 36% as above average, 47% as average and 2% as below average. Excellent proficiency (>80% in every sub-item) was observed in running, galloping, leaping, sliding, catching, and throwing skills. In comparing the results with other studies, the participants were superior to the data reported in previous studies in United States, Brazil and Australia. This study added valuable information to the establishment of a world-wide normative reference for the comparison of future studies in other countries.

Keywords

Movement skills, locomotor, object control, paediatrics exercise, gross motor development

Introduction

The mastery of fundamental motor skills among children and adolescent through quality physical education is a potentially important contribution to satisfying participation in sports, games and other physical activities (Booth et al., 1999). Fundamental gross motor skills provide a foundation for later sport-specific movement skills, and were well accepted as building blocks for participation in popular forms of sports and games. It is important for children to develop neuromuscular coordination and to learn complex and advance sport skills. Fundamental motor skills can also enhance students' interpersonal, cognitive, and emotional development.

Fundamental motor skills must be taught. They are not acquired simply through activities of various sorts. Rather, they must be continually refined and combined with other movement skills in a variety of physical activities. Researches indicated that learners acquire new fundamental motor skills most successfully during the preschool and elementary years (Olrich, 2002). It is because students' neurological pathways are developing rapidly during this period and are receptive to the development of fundamental movement patterns and basic skills. Also, students at this stage have not yet developed bad habits. They are not embarrassed by poor performance in learning, and are not as fearful of being injured or ridiculed by peers (Butcher & Eaton, 1989).

Fundamental movement skills and habitual physical activities are related in childhood and adolescence (Fisher et al., 2005). A deficiency in mastery of fundamental motor skills may discourage a child from participating in sport activities in future (Butcher & Eaton, 1989). Those who lack fundamental motor skills are likely to experience frustration and difficulty in learning more advanced skills, which reduces their enjoyment of sports and other physical activities. As a result, this may reduce their motivation to develop a healthy life-style (Okely, Booth, & Patterson, 2001). McKenzie et al. (2002) reported that enhancing movement skills in children is a measure to promote subsequent physical activity.

In Hong Kong, there is an education curriculum reform in recent years (Curriculum Development Council, 2002). Key learning areas are identified as important parts in the new curriculum, and Physical Education is identified as one of these key learning areas, which provides

a context for the development and application of generic skills and participant-specific skills, positive values and attitudes through appropriate use of learning and teaching activities and strategies. Students are classified into four key stages according to their grading: (1) primary 1-3; (2) primary 4-6; (3) secondary 1-3; and (4) secondary 4 and above. Different areas of activities are implemented in different key stages in order to fulfill different learning targets. Fundamental motor skills are regarded as the key learning activity in the Physical Education learning area of key stage one (primary 1-3, age = 6-9). These young students are expected to develop locomotor movement skills, stability movement skills and manipulative movement skills through fundamental movement activities. This aims to help students to develop motor skills and acquire necessary knowledge through physical activities and cultivate positive values and attitudes for the development of an active and healthy lifestyle.

Fundamental skills assessments have been conducted in other countries to evaluate level of fundamental motor skills proficiency (Cooley, Oakman, McNaughton, & Ryska, 1997; Booth, Macaskill, Phongsavan, McLellan, & Okely, 1998; Miyahara et al, 1998; Sanders & Kidman, 1998; Karabourniotis, Evaggelinou, Tzetzis, & Kourtessis, 2002). However few attempts have been made to determine the mastery level of fundamental motor skill among Hong Kong children. Moreover, there is currently a lack of information about the standards of children's abilities in this area. There was only one preliminary study on the fundamental skill performance of Hong Kong children conducted (Choi Tse, 2001). The purpose of this study was to evaluate the current proficiency level of fundamental motor skills of Hong Kong children aged 6-9 (key stage one, primary 1-3).

Methods

Sample

Ninety-one and 76 Chinese male and female students (age = 6-9 years, mean age = 7.6 years, S.D. = 0.9 years) from six local primary schools in Hong Kong were recruited to participate in this study. The six schools were located throughout the territory of Hong Kong to provide a representable sample for this study. Institutional approval of the research protocol and informed

consents from students and parents were obtained prior the study. Participants were divided into six age groups at 6-month or 12-month intervals for comparison (Age-Month: 6-0 to 6-5, 6-6 to 6-11, 7-0 to 7-5, 7-6 to 7-11, 8-0 to 8-11, 9-0 to 9-11).

Instrumentation

The Test of Gross Motor Development – Second Edition (TGMD-2) was employed in this study (Ulrich, 2000). The instrument was widely used to measure gross motor abilities that develop early in life (Cleland & Gallahue, 1993; Cooley et al, 1997; Goodway, Crowe, & Ward, 2003; Evaggelinou, Tsigilis, & Papa, 2002; Karabourniotis et al., 2002). There are two subtests of items, Locomotor and Object Control. The Locomotor subtest measures running, galloping, hopping, leaping, horizontal jumping and sliding. The Object Control subtest measures striking, dribbling, catching, kicking, throwing and rolling. The TGMD-2 measures twelve gross motor skills that may be taught to children in preschool, early elementary and special education classes. It was designed to assess the gross motor functioning in children aged three to 10. Mastery was evident if the component was demonstrated two out of two trials.

Protocol

Prior to testing, participant information was recorded on the data sheet. All trials were conducted in the school playground during physical education lessons. Twelve gross motor skills (Locomotor and Object Control subtests) were assessed with the guideline from the TGMD-2 manual (Ulrich, 2000). Preceding assessment, an accurate demonstration and verbal description of the skill were performed by an experienced physical education instructor. Participants were given one trial to assure that the child understood what to do. If the child did not appear to understand the task, one additional demonstration was performed again by the physical educator. Each participant then performed two trials for each gross motor skill. The assessment was videotaped. The same physical education instructor rated the performance of each participant in each gross motor skill while reviewing the video. Prior to the assessment, the physical educator was well trained to gain

competence to be the examiner, by studying the content carefully and practicing giving and scoring the subtest items to a group of three persons thoroughly, as suggested by the manual. Each gross motor skill consisted of several (3 to 5) performance criteria. If the behavioral component was presented, one mark would be given. If the behavioral component was absent, no mark would be given. There were a total of 48 performance criteria from all 12 gross motor skills. The rating process was performed again one week later to indicate the intra-rater reliability. Reliability coefficients for the locomotor subtest, object control subtest and gross motor quotient were presented to indicate the reliability among the two assessment from videotapes.

Descriptive statistics were obtained in this study. The total scores of the two trials of each gross motor skill were summed to obtain a skill score for that particular gross motor skill. The skill scores were then added up to a raw Locomotor subtest score (0-48) and Object Control subtest score (0-48), which were then converted to percentile ranking, standard scores (0-20) and age-equivalent to show the comparison between the normative data from the TGMD-s manual, which was obtained from 1208 persons from ten states in the United States of America (Ulrich, 2000). A percentile ranking of 50 and a standard score of 10 indicates that the participant performed as well as the normative samples did in average. The age-equivalent indicates that the participant performed as well as an individual of that age from the normative samples. The two subtest standard scores were added up to a total standard score, and were further converted to an overall Gross Motor Quotient (GMQ) and percentile ranking. A total standard score of 20, a GMQ of 100 and a GMQ percentile ranking of 50 indicates that the participant performed as well as the normative samples did in average.

Descriptive rating of each participant was reported as Very Superior (Subtest Standard Score = 17-20, GMQ > 130), Superior (Subtest Standard Score = 15-16, GMQ = 121-130), Above Average (Subtest Standard Score = 13-14, GMQ = 111-120), Average (Subtest Standard Score = 8-12, GMQ = 90-110), Below Average (Subtest Standard Score = 6-7, GMQ = 80-89), Poor (Subtest Standard Score = 4-5, GMQ = 70-79) and Very Poor (Subtest Standard Score = 1-3, GMQ < 70) from the suggestion from the TGMD-2 manual (Ulrich, 2000). The distribution of frequency of the rating of

each age group was reported. The percentage of participants correctly performing each skill item was also reported.

Comparison with other countries

In order to perform a cross-cultural comparison with other countries, literature search of Sports Discus was performed. The search keyword string was “(Test of Gross Motor Development) OR (TGMD)”, which appeared in the title, abstract or keyword fields. Studies administrating the Test of Gross Motor Development – Second Edition (TGMD-2) on healthy normal participants were included for comparison, while studies administrating TGMD first version were discarded, as the results would not be comparable to that from this study. The descriptive information of the included studies, including the location of study, the number, race, age of the participants, and the research findings were summarized.

Results

Overall performance

Table 1 showed the locomotor, object control and overall performance of the participants in this study. In locomotor and object control subtests, participants in both gender in all age groups performed better than the US normative samples (mean percentile > 50 and standard score > 10), except the male with age 9-0 to 9-11 years who showed a slightly inferior object control ability as they scored a mean percentile of 46.6 and standard score of 9.6. The overall performance was all better than the US normative samples, having a Gross Motor Quotient of 56.8 to 80.9.

Table 2 showed the distribution of descriptive rating among each age group in each gender. All female scored a rating of average or above in both locomotor and object control subtests, while 99% and 96% of male did so in both locomotor and object control subtests respectively. Half of the male (52%) and female (47%) scored a rating of Above Average or better in locomotor subtest. In overall, 98% of the participants were rated average or above, in which 36% were rated as above average and 14% as superior.

Performance of each behavior criteria in each subtest

In locomotor subtests, most participants could master all behavior criteria well in running (94%-100%), leaping (95-99%) and sliding (100%). In galloping, 81% of the participants could perform a step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot. In hopping, a half (51%) could swing the nonsupport leg forward in pendular fashion to produce force. Seventy-eight percent of the participants could flex arms and swing forward to produce force. In horizontal jump, only 51% could extend the arms forcefully forward and upward reaching full extension above the head. In general older participants could master these items better.

In object control subtests, the catching (84%-100%) and throwing (83%-99%) subtests were performed well. In striking, 68% could hit the ball with the bat and 72% could transfer body weight to front foot during striking. In dribbling, 64% could push the ball with fingertips (not a slap), and maintain control of the ball for four consecutive bounces without having to move the feet to retrieve it. Only 39% of the participants could perform an elongated stride or leap immediately prior to ball contact in kicking, and the female participants showed relatively inferior ability in this skill (21%). In rolling, 82% could swing the preferred hand down and back, reaching behind the trunk while chest faces cones, 79% could strike forward with foot opposite the preferred hand towards the cone, 76% bent their knees to lower the body while rolling the ball, and 92% released the ball close to the floor so that the ball did not bounce more than 4 inches high.

Intra-rater reliability

The coefficient alphas for locomotor score, object control score and gross motor quotient were presented in Table 5. The coefficients ranged from 0.88 to 0.97, which indicated that the intra-rater reliability is high.

Comparison with other countries

Three studies were identified to administrate TGMD-2 to obtain normative data (Goodway et al, 2007; Southall et al, 2004; Valentini et al, 2007). The descriptive information and findings were summarized in Table 6.

Discussion

Excellent overall performance of fundamental motor skills

Participants in all age groups in both gender except the male of age 9 years old performed better than the normative samples. The performance of the Locomotor subtests outweighed the performance of the Object Control subtests. A total of 49% of all participants were rated as above average or superior for Locomotor subtests while for the Object Control subtests, only 24% of all participants could achieve the above average or superior level. In Locomotor subtest, the age equivalent was about or even over 10 years old in most of the groups. This indicated a really excellent performance in Locomotor subtest. In Object Control subtest, the performance was also outstanding. All groups scored an age equivalent which was above their age. In general, the female participants scored a higher Gross Motor Quotient Percentile. This showed that the female were showing much better fundamental skill performance than the normative samples.

In overall, 98% of participants (163 out of 167 participants) displayed an average or above mastery of fundamental motor skills in this study. Half (50%) of them were above average or superior in the overall performance. Only 2% of the participants were rated as below average in their proficiency. This finding indicated that the participants possessed a satisfactory mastery level of fundamental motor skills. A previous study in Hong Kong on 180 children showed that percentage of participants achieving average, below average and poor level were 27.6%, 27.6% and 40% respectively (Choi Tse, 2004). The results of this study on 168 participants showed much better competence.

Among gender, a higher percentage of males (52%) than females (42%) achieved the average level while a higher percentage of females (57%) than males (45%) achieved the above average or superior level. Among age, a higher percentage of the younger participants were rated superior and

above average, while a higher percentage of the older participants were rated average. They may be due to a relative lower performance of the younger participants in the normative samples. This also indicated that the participants in this study achieved the fundamental motor skills earlier than the normative samples did.

Performance in Locomotor subtest

All the participants displayed full scores in sliding. They also displayed nearly full scores in running (94-100%) and leaping (95-99%). A suggested reason is that these motor skills were part of their daily movement. They always run with the leaping and sliding techniques in their free play. Participants could master these skills without extra practice and effort. However, it was obvious that much more effort would be required to enhance the performance of galloping, hopping and horizontal jumping among the participants.

In galloping, only 81% of the participants could demonstrate “a step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot”. From our observations, some students had the tendency to change to use the contralateral foot as the leading foot in every cycle when performing galloping. Some of them could maintain a rhythmic pattern of using one foot as the lead foot for two or three consecutive gallops but they would use the contralateral foot as the leading foot suddenly in the fourth or more consecutive gallops. We also observed that most students could perform galloping with alternating leading foot with full proficiency. This is the kind of gallop they usually do for fun in playground. It is suggested that if the TGMD-2 manual is to be revised, the authors may incorporate galloping with alternative foot as leading foot as an option.

In hopping, only a half (51%) and three quarters (78%) of the participants could demonstrate “nonsupport leg swings forward in pendular fashion to produce force” and “arms flexed and swing forward to produce force” respectively. From our observations, most who failed to perform only flexed their arms and legs, and left the remaining limb for hopping. Some even had difficulty in balancing, and so they could hardly perform these two items. In horizontal jump, only 51% could

extend their arms forcefully forward and upward reaching full extension above the head before the jump. The limb motions in these two skills are important to move the body center of gravity to the desired direction, which is forward and upward in these jumps. Moreover, it is also important in some upward jumping motion, such as spiking and blocking in volleyball. Therefore, emphasis should be addressed in teaching these skill items.

Performance in Object Control subtest

In striking, only 72% could transfer the body weight to front foot, and only 68% could hit the ball with the bat. Since striking was not included in the Physical Education syllabus (Curriculum Development Council, 2002), this was the first time for most participants to try striking a ball. This fundamental skill is important in most court sports such as tennis, badminton and squash. Therefore, it is suggested that striking should be included in the further development of the physical education curriculum. In dribbling, only 64% could push the ball with fingertips but not a slap. For the others, most used their palms to contact the ball. For the youngest female participants (age = 6-0 to 6-5), most of them really had difficulty in manipulating the ball – 39% of them could not contact the ball with one hand at about belt level, 78% could not push the ball with fingertips, and 56% could not maintain control of ball for four consecutive bounces without moving their feet. Catching was well performed by the participants. Only 16% could not catch the ball with hands only. Some of them had the ball slipped to the chest, and some had the ball fallen to the ground.

In kicking, most items were performed well, except the “elongated stride or leap immediately prior to ball contact”, which was successfully performed by 39% of the participants. The young female especially performed badly in this item. Most of them only ran to the ball and hit the ball with one foot, instead of delivering a forceful strike to the ball. In throwing, 17% failed to transfer the weight by stepping with the foot opposite the throwing hand. They kept a straight and stiff body without moving their body forward following the throw. In rolling, 18% failed to swing down and back the rolling hand behind the trunk with the chest facing the cones, 21% failed to stride forward with foot opposite the rolling hand towards the cone, and 24% failed to bend their knees to lower

the body.

In general, all results from the three included studies were inferior to the TGMD-2 normative samples. Both Hispanic and African American preschoolers showed very poor object control performance, as indicated by a percentile rank of 16.24 and 24.69 respectively (Goodway et al, 2007). Australia children (age = 11) also showed poorer overall, locomotor and object control motor skill performance, as indicated by standard scores of 14.44, 6.93 and 7.52 respectively (Southall et al, 2004). A group of sample is assessed to be performing as well as the TGMD-2 normative samples if they score a mean percentile rank of 50, a total standard score of 20, or a locomotor or object control subtest standard score of 10. In this study, the Chinese participants obtained a mean percentile rank of 64.4-85.2 and 46.6-69.8, and standard scores of 11.3-14.0 and 9.6-12.0 in locomotor and object control subtests respectively. The total standard scores ranged from 20.9-25.7. Brazil children (age = 5-11) also do not perform well in each of the 12 skill test, as indicated by a low percentage of participants mastering each skill (4-38%) (Valentini et al, 2007). In this study, most of the 12 skill tests were mastered with full proficiency (>80% in every sub-item), i.e., running, galloping, leaping, sliding, catching, and throwing. The results showed that the participants in this study were superior to the normative samples from US, Brazil and Australia.

The TGMD-2 was released in year 2000 and there were not many studies reporting normative data from different countries. This study added valuable information to the establishment of a country-wide normative reference for the comparison of future studies in other countries.

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Table 1 – Locomotor, object control and overall performance of the participants in this study (standard deviation in bracket)

	N	Locomotor				Object Control				Total	Gross	GMQ
		Raw Score	Mean Percentile	Standard Score	Age equivalent	Raw Score	Mean Percentile	Standard Score	Age equivalent	Standard Score	Motor Quotient	Percentile
Male												
6-0 to 6-5	15	43.8 (2.5)	84.6 (15.7)	13.7 (2.1)	10-0	38.6 (4.7)	57.7 (20.1)	10.5 (1.7)	6-9	24.3 (2.7)	112.6 (8.5)	77.0 (16.4)
6-6 to 6-11	12	43.4 (2.5)	74.8 (17.1)	12.4 (2.0)	8-6	41.3 (4.3)	59.3 (21.0)	10.8 (1.8)	7-3	23.3 (2.9)	109.8 (8.6)	71.5 (17.1)
7-0 to 7-5	15	44.6 (2.5)	75.9 (19.0)	12.5 (1.9)	>10-9	43.2 (4.0)	61.7 (23.2)	11.0 (2.0)	8-6	23.5 (3.4)	110.4 (10.1)	72.6 (21.2)
7-6 to 7-11	13	44.7 (2.7)	72.5 (19.4)	12.0 (1.7)	>10-9	44.5 (2.7)	64.0 (19.1)	11.2 (1.7)	10-6	23.2 (3.1)	109.7 (9.4)	71.5 (20.3)
8-0 to 8-11	28	44.9 (2.5)	69.4 (21.5)	11.7 (1.8)	>10-9	44.6 (2.1)	56.4 (15.3)	10.5 (1.3)	10-6	22.2 (2.1)	106.5 (6.2)	65.8 (14.7)
9-0 to 9-11	8	45.5 (2.6)	64.4 (22.6)	11.3 (1.9)	>10-9	44.0 (3.3)	46.6 (26.8)	9.6 (2.4)	9-3	20.9 (3.1)	102.6 (9.3)	56.8 (22.1)
Female												
6-0 to 6-5	9	44.1 (3.5)	85.2 (19.9)	14.0 (2.4)	10-0	35.7 (6.1)	66.6 (27.7)	11.7 (2.6)	7-6	25.7 (4.4)	117.3 (13.2)	80.9 (22.7)
6-6 to 6-11	10	43.9 (1.8)	79.8 (16.1)	12.9 (1.8)	10-0	37.8 (6.3)	69.8 (26.5)	12.0 (2.6)	8-0	24.9 (3.9)	114.7 (11.6)	78.8 (22.5)
7-0 to 7-5	21	43.6 (1.8)	69.6 (16.3)	11.7 (1.5)	10-0	38.9 (3.6)	67.3 (15.4)	11.5 (1.6)	8-3	23.2 (2.5)	109.6 (7.6)	71.8 (15.3)
7-6 to 7-11	8	43.5 (2.0)	65.9 (17.2)	11.4 (1.5)	10-0	41.0 (4.9)	67.6 (24.6)	11.6 (2.2)	9-6	23.0 (2.9)	109.0 (8.6)	70.3 (18.6)
8-0 to 8-11	28	45.0 (2.6)	68.5 (21.4)	11.6 (1.8)	>10-9	42.5 (3.0)	72.6 (20.0)	12.0 (1.8)	>10-9	23.6 (3.1)	110.9 (9.4)	73.8 (20.4)

Table 2 – Descriptive rating of the locomotor and object control performance of the participants in this study

	Locomotor				Object Control				Overall Performance			
	Superior	Above Average	Average	Below Average	Superior	Above Average	Average	Below Average	Superior	Above Average	Average	Below Average
Male												
6-0 to 6-5	6 (40%)	4 (27%)	5 (33%)			3 (20%)	12 (80%)		5 (33%)	7 (47%)	3 (20%)	
6-6 to 6-11	2 (17%)	3 (25%)	7 (58%)			2 (17%)	10 (83%)		2 (17%)	3 (25%)	7 (58%)	
7-0 to 7-5	2 (13%)	5 (33%)	8 (53%)			3 (20%)	11 (73%)	1 (7%)	2 (13%)	7 (47%)	5 (33%)	1 (7%)
7-6 to 7-11		6 (46%)	7 (54%)			4 (31%)	9 (69%)		2 (15%)	4 (31%)	6 (46%)	1 (8%)
8-0 to 8-11		16 (57%)	11 (39%)	1 (4%)		1 (4%)	26 (93%)	1 (4%)		9 (32%)	19 (68%)	
9-0 to 9-11		3 (38%)	5 (63%)			1 (13%)	5 (63%)	2 (25%)	2 (25%)	5 (63%)	1 (13%)	
Total Male	10 (11%)	37 (41%)	43 (37%)	1 (1%)		14 (15%)	73 (80%)	4 (4%)	9 (10%)	32 (35%)	47 (52%)	3 (3%)
Female												
6-0 to 6-5	5 (56%)	2 (22%)	2 (22%)		1 (11%)	3 (33%)	5 (56%)		4 (44%)	3 (33%)	2 (22%)	
6-6 to 6-11	2 (20%)	4 (40%)	4 (40%)		2 (20%)	2 (20%)	6 (60%)		4 (40%)	3 (30%)	3 (30%)	
7-0 to 7-5		5 (24%)	16 (76%)		1 (5%)	2 (9%)	18 (86%)		1 (5%)	6 (29%)	14 (67%)	
7-6 to 7-11		3 (38%)	5 (63%)			3 (38%)	5 (63%)		1 (13%)	3 (38%)	4 (50%)	
8-0 to 8-11		15 (54%)	13 (46%)			12 (43%)	16 (57%)		5 (18%)	13 (46%)	9 (32%)	1 (4%)
Total Female	7 (9%)	29 (38%)	40 (53%)		4 (5%)	22 (29%)	50 (66%)		15 (20%)	28 (37%)	32 (42%)	1 (1%)
Male and female												
6-0 to 6-5	11 (46%)	6 (25%)	7 (29%)		1 (4%)	6 (25%)	17 (71%)		7 (29%)	10 (42%)	7 (29%)	
6-6 to 6-11	4 (18%)	7 (32%)	11 (50%)		2 (9%)	4 (18%)	16 (73%)		6 (27%)	6 (27%)	10 (46%)	
7-0 to 7-5	2 (6%)	10 (28%)	24 (67%)		1 (3%)	5 (14%)	29 (81%)	1 (3%)	3 (8%)	13 (36%)	19 (53%)	1 (3%)
7-6 to 7-11		9 (43%)	12 (57%)			7 (33%)	14 (67%)		3 (14%)	7 (33%)	10 (48%)	1 (5%)
8-0 to 8-11		31 (55%)	24 (43%)			13 (23%)	42 (75%)	1 (2%)	5 (9%)	22 (39%)	28 (50%)	1 (2%)
9-0 to 9-11		3 (38%)	5 (63%)			1 (13%)	5 (63%)	2 (25%)		2 (25%)	5 (56%)	1 (11%)
Grand Total	17 (10%)	66 (39%)	83 (50%)	1 (1%)	4 (2%)	36 (22%)	123 (74%)	4 (2%)	24 (14%)	60 (36%)	79 (47%)	4 (2%)

* Very Superior, Poor and Very Poor categories omitted in this table.

Table 4 – Percentage of participants mastering each sub-item in each skill in the Object Control subtests

Behavior Components	Male						Female					All male	All female	All male and female
	6-0 to 6-5	6-6 to 6-11	7-0 to 7-5	7-6 to 7-11	8-0 to 8-11	9-0 to 9-11	6-0 to 6-5	6-6 to 6-11	7-0 to 7-5	7-6 to 7-11	8-0 to 8-11			
Striking														
1. Dominant hand grips bat above nondominant hand	100%	100%	100%	100%	100%	100%	83%	100%	100%	100%	98%	100%	97%	99%
2. Nonpreferred side of body faces the imaginary tosser with feet parallel	90%	100%	100%	100%	98%	100%	89%	100%	98%	100%	96%	98%	97%	97%
3. Hip and shoulder rotation during swing	80%	92%	90%	100%	100%	100%	83%	85%	81%	69%	89%	94%	84%	89%
4. Transfers body weight to front foot	73%	71%	77%	85%	88%	75%	56%	60%	52%	75%	70%	80%	63%	72%
5. Bat contacts ball	47%	58%	87%	65%	68%	50%	89%	60%	74%	75%	71%	64%	73%	68%
Dribbling														
1. Contacts ball with one hand at about belt level	87%	88%	100%	100%	100%	100%	61%	90%	98%	88%	100%	96%	92%	94%
2. Pushes ball with fingertips (not a slap)	57%	33%	67%	73%	86%	88%	22%	50%	57%	63%	73%	69%	59%	64%
3. Ball contacts surface in front of or to the outside of foot on the preferred side	93%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	99%
4. Maintains control of ball for four consecutive bounces without having to move the feet to retrieve it	77%	100%	93%	92%	96%	100%	44%	85%	83%	88%	95%	93%	84%	89%
Catching														
1. Preparation phase where hands are in front of the body and elbows are flexed	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
2. Arms extend while reaching for the ball as it arrives	67%	83%	93%	100%	100%	100%	78%	70%	95%	100%	100%	91%	92%	92%
3. Ball is caught by hands only	53%	67%	87%	100%	100%	100%	67%	50%	81%	100%	93%	86%	82%	84%
Kicking														
1. Rapid continuous approach to the ball	87%	96%	100%	96%	100%	100%	89%	90%	86%	81%	98%	97%	91%	94%
2. An elongated stride or leap immediately prior to ball contact	33%	58%	47%	65%	55%	75%	6%	10%	26%	63%	14%	54%	21%	39%
3. Nonkicking foot placed even with or slightly in back of the ball	97%	100%	100%	100%	98%	100%	89%	100%	90%	94%	93%	99%	93%	96%
4. Kicks ball with instep of preferred foot or toes	97%	100%	97%	100%	100%	100%	94%	100%	93%	94%	98%	99%	96%	98%
Throwing														
1. Windup is initiated with downward movement of hand/arm	100%	100%	97%	100%	100%	100%	100%	90%	95%	100%	100%	99%	97%	99%
2. Rotates hip and shoulders to a point where the nonthrowing side faces the wall	97%	100%	100%	100%	100%	100%	100%	75%	98%	88%	98%	99%	94%	97%
3. Weight is transferred by stepping with the foot opposite the throwing hand	80%	83%	100%	100%	100%	100%	67%	65%	45%	63%	91%	95%	69%	83%
4. Follow-through beyond ball release diagonally across the body toward the nonpreferred side	97%	96%	97%	100%	100%	100%	83%	90%	93%	100%	88%	98%	90%	95%
Rolling														
1. Preferred hand swings down & back, reaching behind the trunk while chest faces cones	90%	92%	93%	92%	86%	81%	67%	60%	74%	56%	86%	89%	74%	82%
2. Strides forward with foot opposite the preferred hand towards the cones	67%	79%	80%	88%	91%	100%	56%	65%	67%	63%	89%	84%	73%	79%
3. Bends knees to lower body	77%	75%	73%	73%	70%	63%	72%	95%	60%	100%	89%	72%	81%	76%
4. Releases ball close to the floor so ball does not bounce more than 4 inches high	87%	92%	83%	92%	95%	69%	89%	100%	100%	94%	95%	88%	96%	92%

Table 5 – Coefficient alphas for Locomotor score, Object Control score and Gross Motor Quotient for different age and gender

	Male			Female			Male and Female		
	Locomotor	Object Control	Gross Motor Quotient	Locomotor	Object Control	Gross Motor Quotient	Locomotor	Object Control	Gross Motor Quotient
6-0 to 6-5	.92	.94	.95	.90	.93	.97	.91	.92	.96
6-6 to 6-11	.90	.94	.93	.89	.92	.94	.90	.93	.93
7-0 to 7-5	.91	.91	.91	.92	.91	.94	.91	.91	.92
7-6 to 7-11	.94	.93	.93	.92	.92	.90	.93	.92	.92
8-0 to 8-11	.89	.92	.91	.88	.94	.91	.88	.93	.91
9-0 to 9-11	.92	.96	.92	-	-	-	.92	.96	.92
Total	.91	.93	.93	.90	.92	.93	.91	.93	.93

Table 6 – Comparison of normative results from other studies administrating TGMD-2

Source	Location	Race of participants	N	Age	Findings
Goodway et al, 2007	United States	Hispanic	164	Preschooler	Object control percentile rank = 16.24
Goodway et al, 2007	United States	African American	194	Preschooler	Object control percentile rank = 24.69
Southall et al, 2004	Australia	-	99	11	Total standard score = 14.44 Locomotor standard score = 6.93 Object control standard score = 7.52
Valentini et al, 2007	Brazil	-	258	5-11	Percentage of participants mastering the skills: Running (38%), Galloping (8%), Hopping (4%), Leaping (5%), Jumping (12%), Sliding (28%), Striking (12%), Dribbling (28%), Catching (28%), Kicking (5%), Throwing (13%), Rolling (6%)