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Characteristics of Six types of Motor Performance Tests in Relation to the Body Size of Young Children

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ABSTRACT

A physical measurement and motor performance test were conducted on 940 preschool children aged 4 to 6 years. The results showed that the performance records in the six motor ability test items improved with age. Gender differences were observed in the 25-meter run, standing long jump, and tennis ball throw, with boys demonstrating better performance than girls. In the five-point evaluation, the percentage of boys classified as A or B (higher motor skill group) decreased from 4.0 to 5.0 years of age, then increased until 6.0 years of age, but decreased again at 6.5 years of age. The percentage of boys classified as D or E (lower motor skill group) increased from 4.0 to 5.0 years of age, then decreased until 6.0 years of age, but increased again at 6.5 years of age. Among girls, the A and B classification rates for the higher motor performance group increased from 4.0 to 5.5 years of age, but then decreased until 6.5 years of age. The D and E classification rates for the lower physical ability group increased from 4.0 to 4.5 years of age, then decreased until 5.5 years of age, but increased at 6.0 and 6.5 years of age. A partial correlation analysis of the overall motor performance scores in early childhood and the six measured items revealed a high correlation with body size. In particular, height, weight, and the Kaup index showed a high correlation with the three items of 25-meter run, standing long jump, and hard tennis ball throw. This suggests that running, jumping, and throwing are the main indicators of motor ability in early childhood.

Keywords: early childhood, motor performance test, five-point evaluation, partial correlation coefficient.

INTRODUCTION

In recent years, the decline in children's physical fitness due to a lack of exercise has become a social issue [21] [22] [32] [40]. According to the “Survey on Physical Fitness and Motor Abilities" published annually in October by the Ministry of Education, Culture, Sports, Science and Technology, the physical fitness of adolescents showed significant improvement until the mid-1980’s, but has been declining since around 1985. However, the 2010 report indicates that children's physical fitness has begun to show signs of improvement after reaching a bottom in the 2009 decline [16]. Since the introduction of the five-day school week system in 2002, a

polarization has emerged between children with active physical activity and those without, resulting in a higher proportion of individuals with low physical fitness levels. Particularly concerning is the phenomenon of physical inactivity and disengagement from physical activities among children in the lower performance groups in physical fitness and performance tests [1] [7] [22] [30].

In response to this situation, the Ministry of Education, Culture, Sports, Science and Technology implemented a three-year program from fiscal 2004 to 2006 targeting elementary schools called the "Children's Physical Fitness Improvement Project." The program reported that physical fitness improvement programs were more effective for younger students, and highlighted the need for physical fitness improvement programs starting in early childhood [18] [22]. Subsequently, from fiscal year 2007 to 2009, as a practical incentive to develop the physical fitness of young children, a three-year project titled "Research Survey on the Practical Implementation of Early Childhood Programs for Cultivating the Foundations to Improve Physical Fitness" was conducted to investigate the current state of physical fitness among preschool children in 21 regions nationwide. After that, exercise programs for physical fitness improvement were developed, and a project team was formed consisting of prefectural and municipal boards of education, kindergartens, and university research institutions to assess the current state of physical fitness among preschool children nationwide and to develop countermeasures [18] [22]. Furthermore, in 2010, the Early Childhood Physical Activity Guidelines Committee was established, and based on the results of the above research, the committee deliberated and published the "Early Childhood Physical Activity Guidelines" in March 2012. These guidelines were distributed to education boards nationwide, as well as to public and private kindergartens, childcare centers, and certified childcare facilities, and promotional activities have been conducted to spread the message that "young children should engage in fun physical activity for a total of 60 minutes or more each day, centered on various types of play."

Motor performance tests for early childhood were first developed in 1965 by Matsuda, Kondo, and others, who created a five-point evaluation scale based on five events: 25-meter dash, standing long jump, softball throw, body support duration, and two-legged consecutive jumps. Additionally, the Physical Education Science Center developed scoring criteria for a "Coordination Test" comprising four events: jumping over and ducking under obstacles, repeated side jumps, zigzag run, and bar-gripping reaction time [38], but there was no established method for accurately measuring and evaluating motor skills in early childhood at the national level. Subsequently, Kondo et al. conducted a nationwide assessment in 1986, analyzing the then current state of motor skills [10], comparing results with those from 1973, and creating a reference table [11]. Additionally, Sugihara et al. reported on the results distribution of various events, comparisons among kindergartens and childcare facilities [33], and relationships between the results and the preschool environment [34].

The Ministry of Education, Culture, Sports, Science and Technology has been conducting a national physical fitness and motor ability survey targeting individuals aged 10 to 59 since 1964, and a new physical fitness test targeting individuals aged 6 to 79 has been implemented since the 2011 fiscal year. Physical fitness in early childhood is measured by muscle endurance (body support time, hanging time, hopping); muscle strength (grip strength, back muscle

strength, leg muscle strength); speed (20m run, 25m run); agility (two-legged consecutive jumps, signal run test, 5m shuttle run); balance (balance beam walking, one-legged stance with eyes open and closed, one-legged stance on a bar); coordination (tennis or softball throw, rope skipping, ball throw, ball catch, ball bounce); flexibility (seated forward bend, prone trunk extension), and explosive power (standing long jump, vertical jump). The above events are used to measure their physical fitness and motor ability [23] [24]. In the 2007 physical fitness improvement program for early childhood, a revised version of the motor performance test developed by the Department of Physical Education and Psychology at Tokyo University of Education [25] [33] [34] was adopted, and a nationwide survey of six motor performance tests for preschool children (25-meter run, standing long jump, ball throw, two-legged consecutive jumps, body support duration, and ball catch) was conducted [25]. It is of note that in 2012, the Ministry of Education, Culture, Sports, Science and Technology published Guidelines for Physical Activity in Early Childhood, recommending six motor performance tests (25-meter run, standing long jump, tennis ball throw, two-legged consecutive jumps, body support duration, and ball catch). However, there is a lack of basic research on the characteristics of motor performance in early childhood and the appropriate measurement methods. Ota et al. (1975) reported a significant correlation between height and motor performance [28]. Additionally, according to Ozawa (2003), the development of running ability is likely to be strongly related to increases in height. Therefore, while height is suggested to influence the results of motor performance tests, it remains unclear whether factors such as weight or the Kaup index have any impact.

In this study, we conducted physical measurements and six types of motor ability tests on children aged 4 to 6 years. Using the results and evaluations, we aimed to clarify the characteristics by conducting a partial correlation analysis with physical characteristics (height, weight, and Kaup index) as control variables.

RESEARCH METHODS

Participants

The participants were 940 children aged 4 to 6 years old (507 boys and 433 girls) attending 10 public and private kindergartens in Osaka Prefecture.

Survey Period

May 2022 to October 2023

Physical Measurements

Physical measurements included height and weight, and the Kaup index was calculated as a body composition index based on the obtained values. The Kaup index is calculated using the following formula: Weight (g) ÷ {Height (cm)× Height (cm)} × 10. The normal range is 15 to 18, with more than 18 up to 20 classified as overweight, more than 20 as obese, and less than 15 as underweight.

Motor Performance Test

The motor performance test was conducted based on the “Report on the Survey and Research on Practical Activities for Cultivating the Foundation for Physical Fitness in Early Childhood (March 2011) [20]” issued by the Ministry of Education, Culture, Sports, Science and

Technology, and included six events: 25-meter run, standing long jump, hard tennis ball throw, consecutive double-leg jumps, body support duration, and ball catch. The overall evaluation of the six events was conducted using a comprehensive evaluation criteria table, with a five-point evaluation of A, B, C, D and E.

Ethical Considerations

Prior to the study, the directors of the kindergartens and childcare facilities attended by the participants, as well as the teachers, were informed about the content of the survey, and their permission was obtained. Subsequently, the parents of the participants were notified in writing about the survey content, and their consent was also attained. The data obtained were handled in a manner that ensured the anonymity of the participants. This study was conducted with the approval of the Ethics Committee of Osaka Seikei University (Approval Number: H Dai 29-52).

Statistical Analysis

All values obtained were presented as mean ± standard deviation. To test whether there were differences in the data based on age and gender, a two-factor analysis of variance was performed. When significant differences were found, multiple comparison tests were conducted using the Bonferroni method. The association between the overall motor performance score and the six measured items was analyzed using partial correlation analysis with body composition (height, weight, and Kaup index) as control variables. All partial correlation coefficients were presented as absolute values. SPSS version 25.0 was used for all analyses. The significance level was set at less than 5% for all analyses.

RESULTS

Physical Measurements

Table 1 shows the physical measurement results of the target infants by gender. Height and weight showed significant main effects of age and gender.

Table 1: Results of physical measurements of the participants.

Boys Age	n =507	Height (cm)		Weight (kg)		Kaup index	
		mean	S.D.	mean	S.D.	mean	S.D.
4.0	63	101.9	3.7	16.3	2.0	15.7	1.4
4.5	75	104.2	4.2	16.7	1.7	15.4	1.1
5.0	110	106.9	4.1	17.6	2.1	15.2	2.0
5.5	105	110.9	4.1	18.7	2.0	15.2	1.2
6.0	120	114.2	4.7	20.3	3.0	15.5	1.7
6.5	34	115.4	4.3	21.5	8.1	16.1	6.4

Girls Age	n =433	Height (cm)		Weight (kg)		Kaup index	
		mean	S.D.	mean	S.D.	mean	S.D.
4.0	60	100.8	4.7	15.7	2.0	15.4	1.4
4.5	90	103.2	3.5	16.1	1.7	15.1	1.2
5.0	97	107.1	4.1	17.4	2.3	15.1	1.3
5.5	86	109.2	4.6	18.3	2.6	15.3	1.3
6.0	70	112.7	4.1	19.2	2.8	15.1	1.6
6.5	30	116.2	4.2	21.3	3.6	15.7	2.0

As for height, boys from 4.0 to 6.0 years of age, and girls at any age, showed an increase with significant differences ($p < 0.05$). Sex differences were observed at 5.5 years ($p < 0.01$) and 6.0 years ($p < 0.05$), with boys showing higher values than girls. As for weight, boys aged 5.0 to 6.0 years and girls aged 4.5, 5.0, 6.0 and 6.5 showed an increase with significant differences ($p < 0.05$). Sex differences were observed at age 6.0 ($p < 0.01$), with boys showing higher values than girls, indicating a significant difference. The Kaup index showed no significant main effects, with no significant differences observed for age or sex. Additionally, no significant interaction effects were observed for height, weight, or the Kaup index.

Motor Performance Tests

Gender and Age Differences:

Figure 1 shows the gender and age-related differences in six motor performance tests. Significant main effects of age and gender were observed in the 25-meter run, standing long jump, and tennis ball throw. Significant main effects of age alone were observed in the two-legged consecutive jumps, body support duration, and ball catch.

In the 25-meter run, boys aged 4.0 to 6.0 years and girls aged 4.0 to 5.5 years showed lower values (faster times) with the age increase, with significant differences observed ($p < 0.05$). Significant gender differences were observed in the 6.0-year-old age group ($p < 0.01$) and the 6.5-year-old age group ($p < 0.05$), with boys showing lower values (faster times) than girls.

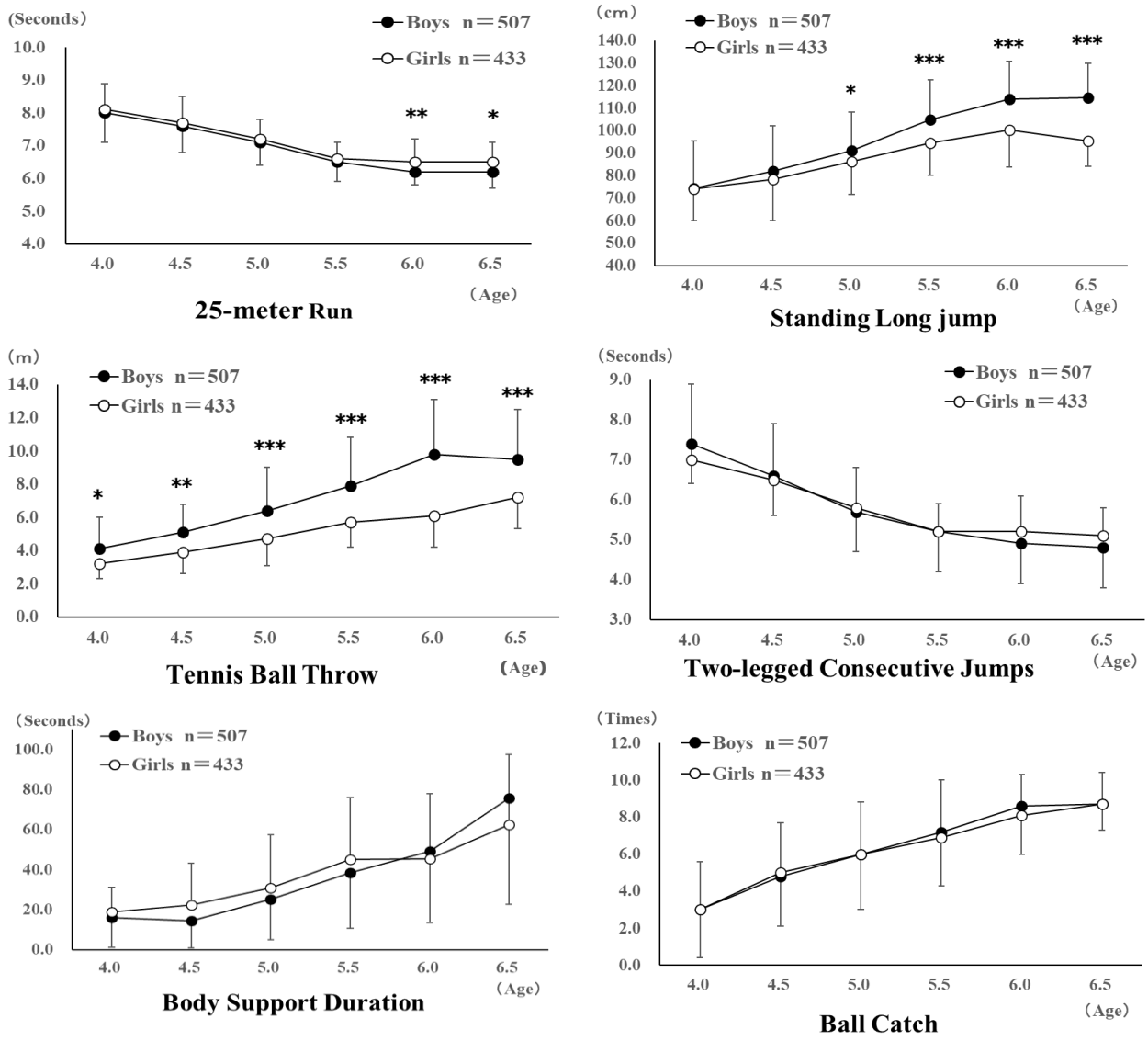
In the standing long jump, boys aged from 4.5 to 6.0 and girls aged from 4.5 to 5.5 showed higher values (longer distances) as they grew, with significant differences ($p < 0.05$). Significant gender differences were observed at 5.0 years ($p < 0.05$) and 5.5 years and older ($p < 0.001$), with boys showing higher values (longer distances) than girls.

In tennis ball throw, boys from age 4.5 to 6.0 and girls from age 5.0 to 5.5 showed higher values (longer distances) as they grow, with significant differences observed ($p < 0.05$). Significant gender differences were observed at ages 4.0 ($p < 0.05$), 4.5 ($p < 0.01$), and 5.0 and older ($p < 0.001$), with boys showing higher values (longer distances) than girls at all ages.

In the two-legged consecutive jumps, boys aged from 4.0 to 5.5 and girls aged from 4.5 to 5.5 showed lower values (faster times) as they grow, with significant differences ($p < 0.05$). No significant gender differences were observed.

In the body support duration, boys between ages 5.0 and 5.5, and between 6.0 and 6.5, and girls between ages 5.0 and 5.5 showed significant value increase (longer duration) with age, with significant differences ($p < 0.05$). No significant gender differences were observed.

In ball catch, boys from 4.0 to 6.0 years and girls between 4.0 and 4.5 years showed higher values (more times) as they grow, with significant differences ($p < 0.05$). No significant gender differences were observed. Additionally, significant interaction effects were observed only in standing long jump and tennis ball throw.



※Significant Differences by Gender：＊ $p < 0.05$, ＊＊ $p < 0.01$, ＊＊＊ $p < 0.001$

Figure 1: Gender differences and age-related differences in six motor performance tests.

Overall Evaluation of Motor Performance Tests:

Figure 2 classifies the survey results based on the criteria for the overall evaluation (A, B, C, D, E) of the motor performance test (six events). The overall evaluation (A, B, C, D, E) is based on the "Report on the Survey and Research on the Appropriate Practices for Fostering the Foundations of Physical Fitness in Early Childhood" issued by the Ministry of Education, Culture, Sports, Science and Technology (March 2011) [20]. The scores were calculated based on the motor performance test records, and the overall scores for the six events were used to classify participants into five categories, with A being the highest. For boys, at 4.0 years of age, 7.9% received an A rating, 22.2% a B rating, 30.2% a C rating, 27.0% a D rating, and 12.7% an E rating. The percentages of A and B ratings in the higher motor performance group decreased from age 4.0 to 5.0, then increased until age 6.0, but decreased at age 6.5. The percentages of D and E ratings in the lower motor performance group increased from age 4.0 to age 5.0, then

decreased until age 6.0, but increased at age 6.5. Girls showed the following results at age 4.0: 8.3% A, 30.0% B, 36.7% C, 21.7% D, and 3.3% E. The A and B classification rate for the higher physical ability group increased from age 4.0 to 5.5, then decreased until age 6.5. The rates for the lower physical ability group (D and E) increased from age 4.0 to age 4.5, then decreased until age 5.5, but increased again at ages 6.0 and 6.5.

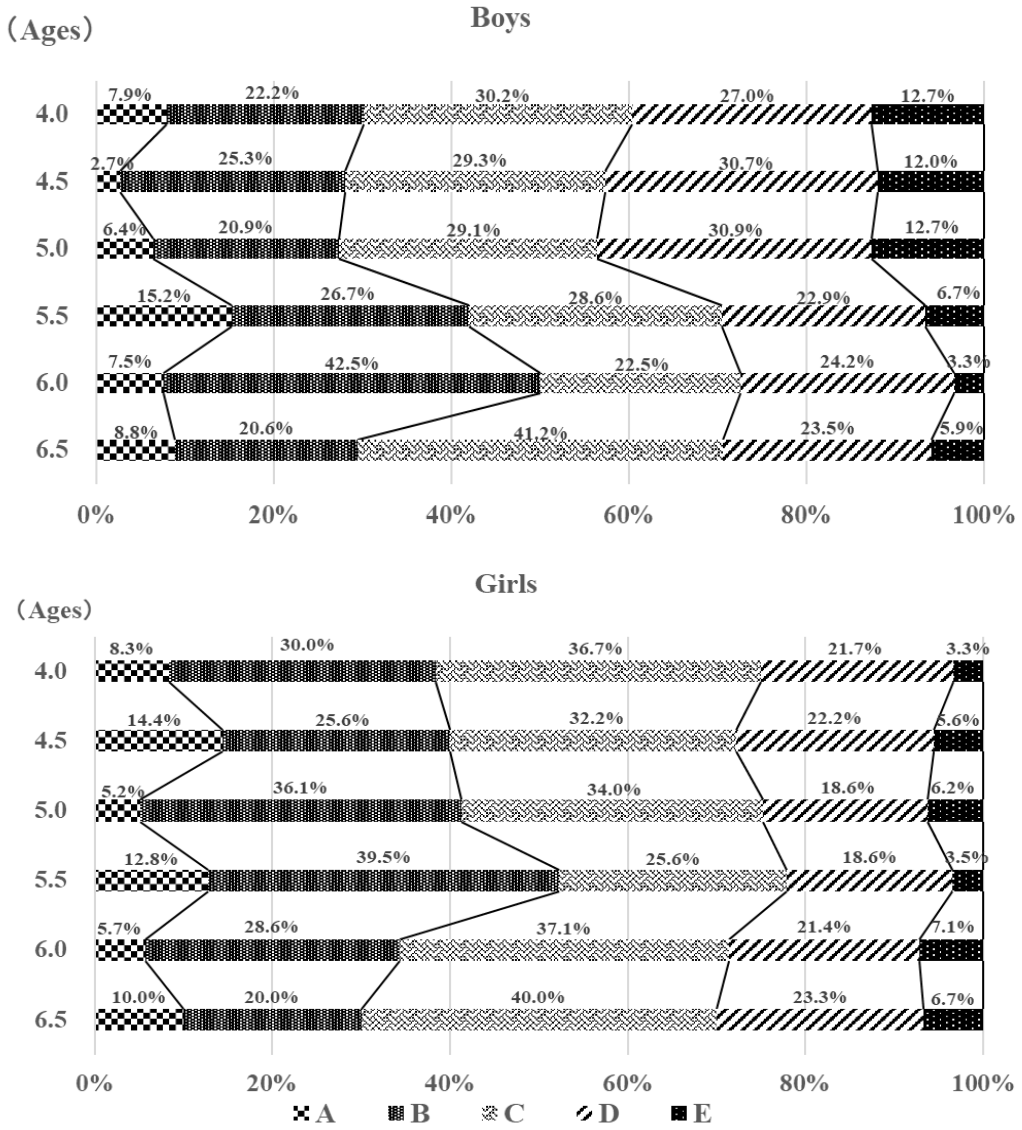


Figure 2: Overall evaluation (A, B, C, D, E) of motor performance test (6 events).

Relationship between the Overall Motor Performance Score and the Six Measured Items: An analysis of the correlation between the overall score of the motor performance test and the measurement items of the six events revealed a significantly high correlation in both boys and girls ($p < 0.01$). In particular, for boys, significantly higher correlations were observed in the 25-meter run at ages 4.5 and 5.0, and in the standing long jump at ages 4.0, 5.5, 6.0, and 6.5. For girls, significant positive correlations were observed in the 25-meter run at ages 4.0, 4.5, and 6.5, and in the standing long jump at ages 5.0, 5.5, and 6.0.

Additionally, Figures 3, 4, and 5 show the partial correlation coefficients calculated with different elements in body composition (namely height, weight, and Kaup index) as control variables, illustrating the relationship between the overall motor performance score and the six measured items.

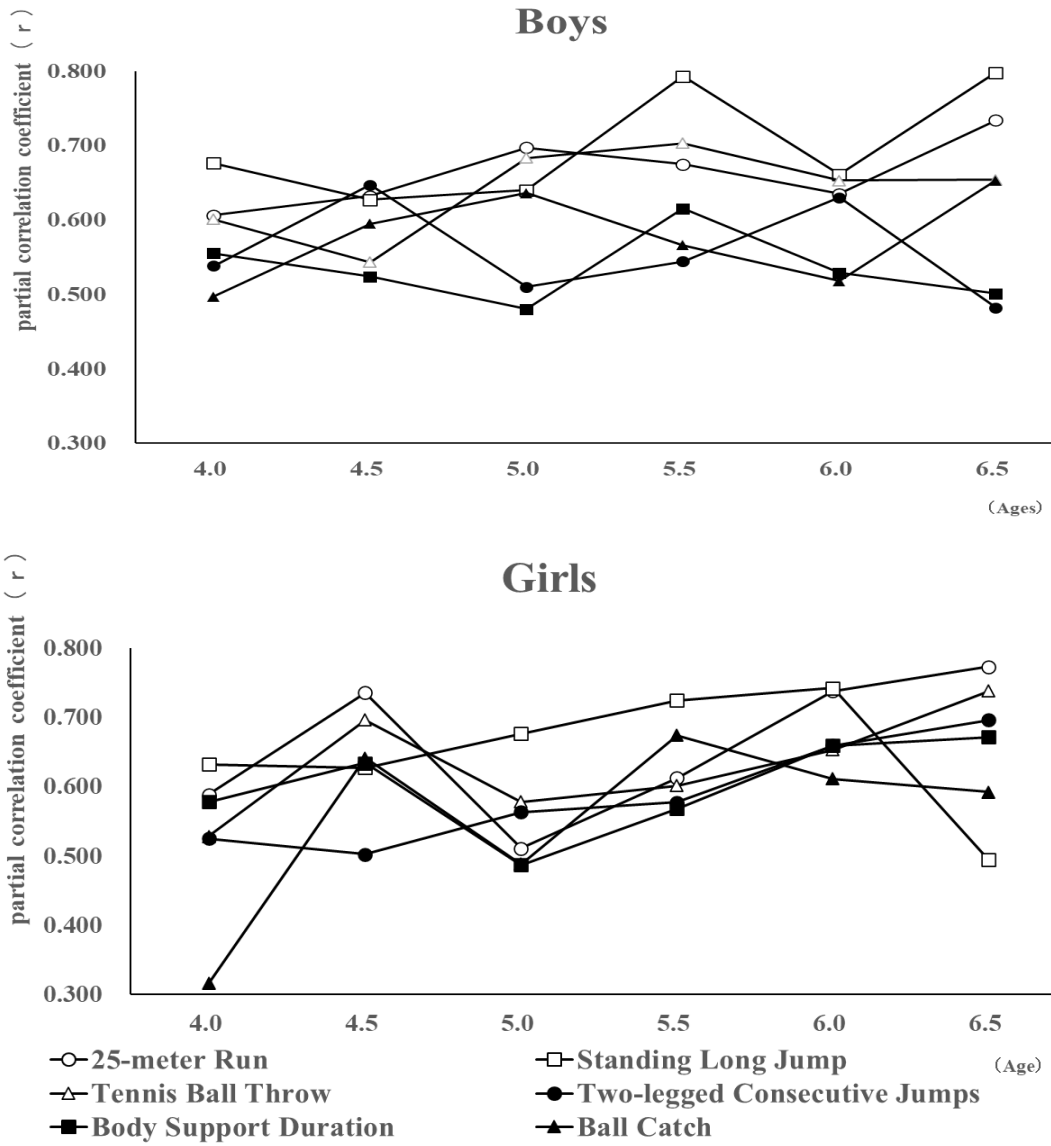


Figure 3: Relationship between the overall motor performance test scores and six measured items (when height is used as a control variable).

When height was used as a control variable, boys tended to show higher values in the 25-meter run, standing long jump, and tennis ball throw, compared with other events. In particular, the standing long jump showed higher values at ages 4.0, 5.5, and 6.5, while the values of body support duration tended to be lower. Girls also tended to show higher values in the 25-meter run, standing long jump, and tennis ball throw compared with other events. In particular, their 25-meter run showed high values at ages 4.5 and 6.5, and their standing long jump showed

higher values at ages 5.0 and 5.5, but their standing long jump showed lower values at age, 6.5, and so did their ball catch at age 4.0.

When weight was used as a control variable, similar trends were observed to those for height. In particular, girls showed higher values in the 25-meter run at ages 4.5 and 6.5, and in the standing long jump at ages 4.0, 5.0, 5.5, and 6.0, but lower values in the standing long jump at age 6.5, and in ball catch at age 4.0.

When analyzing the data with the Kaup index as a control variable, similar trends were observed. The partial correlation coefficients for the 25-meter run, standing long jump, and ball throw were found to have a higher correlation with one another compared to the other three events, with both boys and girls.

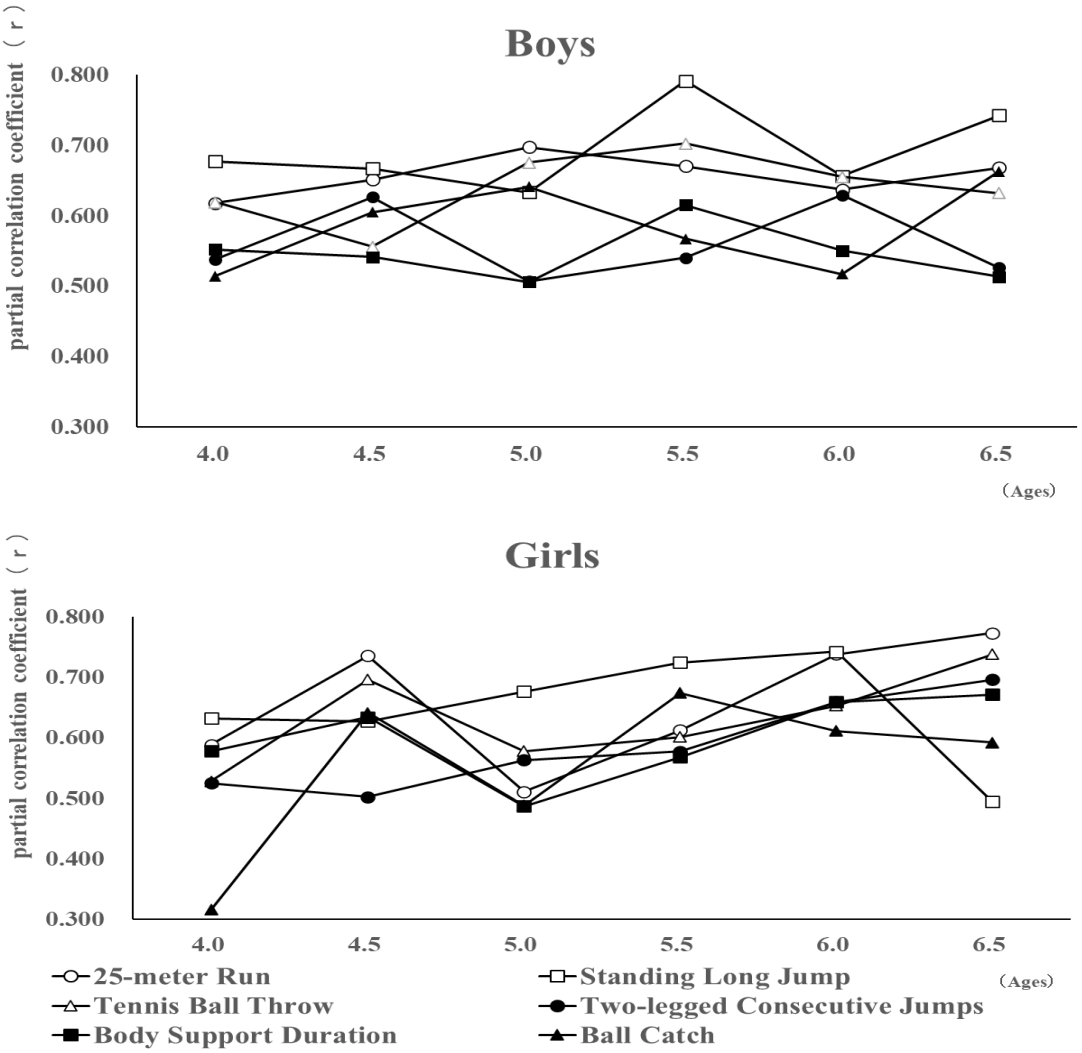
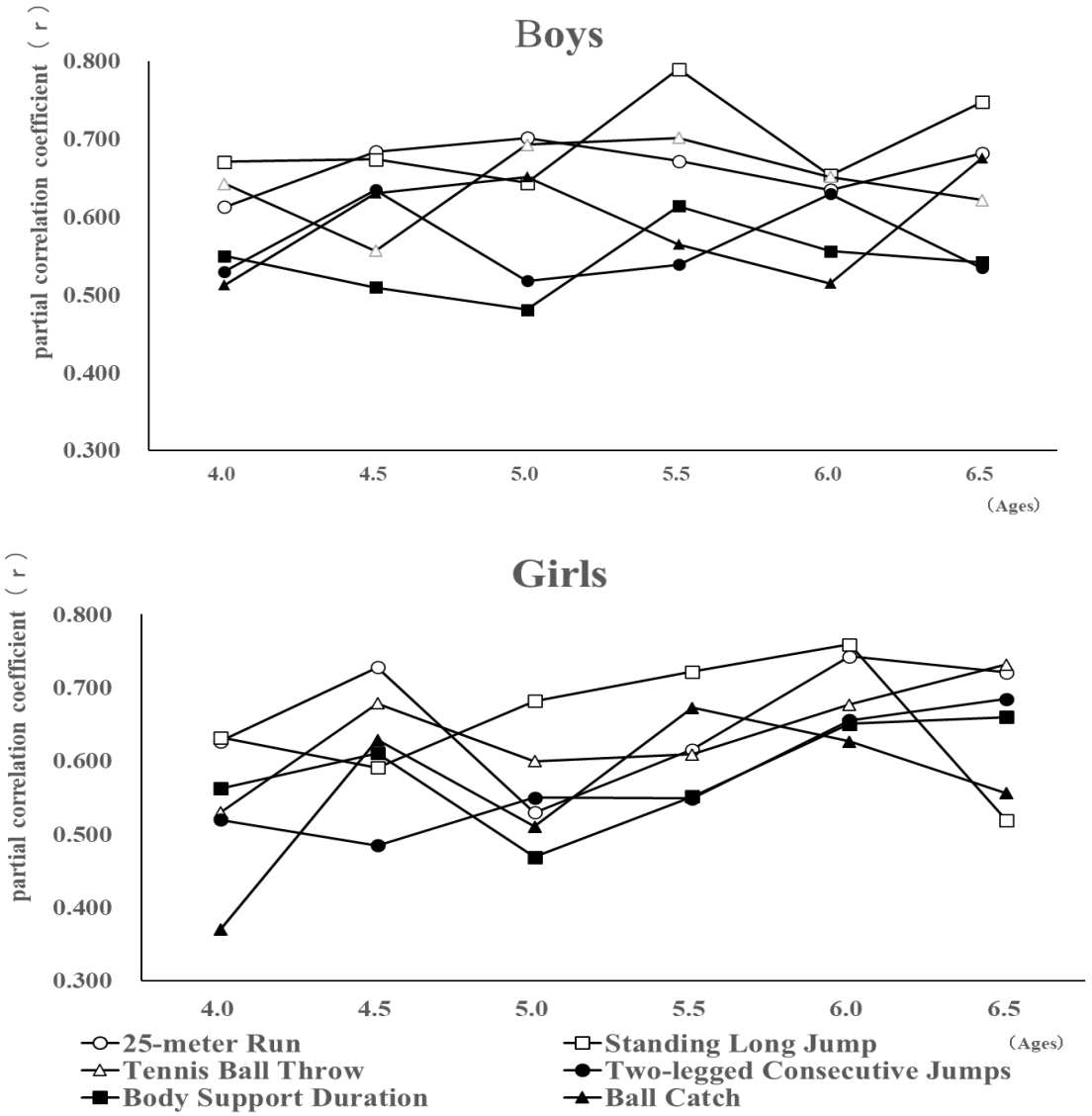


Figure 4. Relationship between the overall score of the motor performance test and the overall scores of the six Events



(when weight is used as a control variable).

Figure 5: Relationship between the overall score of the motor performance test and the overall scores of the six events (when the Kaup index is used as the control variable).

DISCUSSION

Children's height and weight are measured as indicators of growth status. Particularly during early childhood, they are measured monthly at kindergartens, childcare facilities, and certified childcare centers. The Kaup index is an indicator of growth status in infants and young children. The height and weight of the 940 participants in this study were comparable to the national average for the same age group reported by the Ministry of Health, Labour and Welfare, and the Kaup index ranged from 15.2 to 16.1, which is generally considered standard [11].

This study conducted six measurements, and the results showed that the 25-meter run time decreased with age for both boys and girls from age 4.0, but remained stable between ages 6.0

and 6.5 (at age 4.0, boys 8.0 seconds and girls 8.1 seconds; at ages 6.0 and 6.5, boys 6.2 seconds and girls 6.5 seconds).

This study categorized age based on the date of the motor performance test, with each age group divided into six-month intervals, resulting in some groups with children from two different grades of the youngest and the middle, and others with children from the middle and the eldest grades. However, the age 6.5 group consisted solely of the eldest grade, and the smaller sample size in this age group compared with others may be a contributing factor to the stability. Additionally, as for the ability to run, infants are said to become able to walk at around age 1, and they are also said to become able to run by the time they are 2 years and 2 months old. Regarding gender differences, no significant differences were observed among participants aged from 4.0 to 5.5. However, from age 6.0 onwards, gender differences became evident, with boys demonstrating faster times than girls. This may be attributed to the different amounts of experience between boys and girls in play activities involving running during preschool and home life. It is considered that the ability to run is acquired through play, and differences in play experience are the factors contributing to gender differences observed from age 6.0 onwards.

In standing long jump, both boys and girls showed an improvement in the ability to jump farther with age, particularly from age 5.0. However, the values remained flat or declined between ages 6.0 and 6.5 (91.1 cm for boys and 86.2 cm for girls at age 5.0; 113.9 cm for boys and 100.3 cm for girls at age 6.0, and 114.5 cm for boys and 95.4 cm for girls at age 6.5). These results are also thought to be related to the number of participants, as in the case of the 25-meter run, with girls showing a decline in performance at age 6.5. As for the ability to jump, in regard to the growth and development of children, it is considered that the motion of instantly jumping forward with both feet becomes possible when children reach around age 3, and that with age they learn to use their arms effectively, until they can use their entire body to increase jumping distance. Regarding gender, differences were observed from 5.0 years of age, with the gap widening with age. Boys demonstrated faster development of explosive power and superior ability to jump farther compared with girls. The difference in play experience between boys and girls is considered a factor contributing to the observed gender differences from 5.0 years of age.

In tennis ball throw, both boys and girls showed an improvement in throwing distance with age, but boys exhibited a decline in performance between age 6.0 and 6.5 (9.8 m for boys and 6.1 m for girls at age 6.0, and 9.5 m for boys and 7.2 m for girls at age 6.5). This result is also thought to be related to the number of participants, as in the cases of the 25-meter run and standing long jump, with boys showing a decline in performance at age 6.5. The ability to throw is believed to develop with age, as individuals learn to use their legs more effectively and eventually adopt a form that allows them to throw farther using their entire body. This is commonly observed in early elementary school, where children often begin by throwing with their hands alone, likely due to limited experience of play that involves throwing. Gender differences were recognized from age 4.0, with the gap widening with age. It is thought that children acquire throwing ability through play experiences in early childhood. Boys acquire throwing skills earlier, which served as the main factor of the observed gender differences.

The basic movements for the three events of 25-meter run (running), standing long jump (jumping), and tennis ball throw (throwing) are said to become possible from around age 3. The three events are believed to be influenced by developmental age, play environment, and preschool environment.

The two-legged consecutive jumps showed faster times with age in both boys and girls from age 4.0, but tended to level off between ages 6.0 and 6.5, and from 6.0 years of age, girls showed better results than boys (at age 4.0, boys 7.4 seconds and girls 7.0 seconds; at age 6.0, boys 4.9 seconds and girls 5.2 seconds; at age 6.5, boys 4.8 seconds and girls 5.1 seconds). These results are also thought to be related to the number of participants, as observed in running, jumping, and throwing, with girls showing better performance than boys, especially from age 6.0. This test involves quickly jumping over 10 stacked blocks, and participants may not have experience with such play in their daily lives. It is important to recognize the spacing between the blocks and instantly respond with the appropriate action. Regarding gender differences, no significant differences were observed across any of the age groups. It can be inferred that both boys and girls may have limited experience with play involving jumping over blocks with both feet in their daily lives, and that there may be few opportunities for such experiences in everyday settings, either.

Body support duration improved from age 4.5 for boys and age 4.0 for girls, with a decline in boys at age 4.5 (at age 4.0, 15.9 seconds for boys and 18.9 seconds for girls, and at age 4.5,14.5 seconds for boys and 22.3 seconds for girls). This test requires muscle strength, muscle endurance, and balance, in order to support the body with both arms, resulting in significant individual differences (0 to 120 seconds). Additionally, no gender differences were observed across any of the age groups, suggesting that both boys and girls have limited opportunities for body-supporting play and for daily activities that involve supporting the body.

In ball catch, both boys and girls showed an increase in the number of catches from age 4.0 to age 6.5 (at age 4.0, 3.0 catches for boys and 3.0 catches for girls; at age 6.0, 8.6 catches for boys and 8.1 catches for girls, and at age 6.5, 8.7 catches for boys and 8.7 catches for girls). These results are also thought to be related to the number of participants, as seen in running, jumping, and throwing, with boys showing a plateau trend between 6.0 and 6.5 years of age. This test included infants who were completely unable to catch a ball, and the large individual differences (0 to 10 times) are considered to be the cause. Additionally, no significant gender differences were observed across any of the age groups, and improvements in performance were similar between boys and girls. This is likely due to a lack of experience catching balls, including in daily life, and limited opportunities to play with balls.

The above two-legged consecutive jumps, body support duration, and ball catch are three events that, unlike running, jumping, and throwing, are not abilities that are naturally acquired through play. Instead, they require an understanding of the test and motivation to participate, making them events that are difficult to perform without prior experience. Furthermore, based on the results of the six motor performance tests conducted in this study, it is considered that the restrictions on movement due to the COVID-19 pandemic, which prevented children from playing in the playground or having sufficient outdoor play experiences at home, have influenced the test results.

Furthermore, when comparing the results of this survey with those of Akitake (2016) [3], in the 25-meter run and body support duration, both boys and girls in this study showed lower values. In the standing long jump, boys in this study showed similar results to the preceding survey. In the two-legged consecutive jumps, boys in this study showed higher values. In the tennis ball throw and ball catch, girls in this study showed higher values. Furthermore, according to Kozaki et al. (2020), in a study of 199 preschool children aged 3 to 6 years, significant main effects of age and gender were observed in the 25-meter run, ball throw, and standing long jump, while significant main effects of age alone were observed in the two-legged consecutive jumps, body support duration, and ball catch [12]. The results of the current study were similar, with improvements in performance observed across all motor performance tests with age increase. Furthermore, in this study, significant interaction effects were observed only in standing long jump and tennis ball throw.

The overall evaluation is based on the total score of six motor performance tests, which is evaluated on a five-point scale (A, B, C, D, E) according to the comprehensive evaluation criteria table. When the overall evaluation is categorized into the upper group (A and B), middle group (C), and lower group (D and E), the results for boys aged 4.0 were 30.1%, 30.2%, and 39.7%, respectively. At ages 5.5 and 6.0, the upper group showed an increasing trend, while the lower group showed a decreasing trend. For girls aged 4.0, the percentages of the three groups were 38.3%, 36.7%, and 25.0%, respectively. The upper group showed an increasing trend until age 5.5, followed by a decreasing trend, while the lower group temporarily decreased at age 5.5 but then showed an increasing trend. From these results, for boys, the proportion of the upper group (A and B) was higher at age 6.0, while the proportion of the lower group (D and E) was lower. In girls aged 5.5, the upper group (A and B) accounted for a higher percentage, while the lower group (D and E) accounted for a lower percentage. In this study, among the participants aged 6.5, right before entering elementary school, the percentage of the lower group (D and E) showed an increasing trend. Therefore, it is important to focus on young children in the lower group (D and E). Currently, there are many children who dislike physical activity and physical education, and the polarization between children who engage in physical activity and those who do not is a pressing issue. As children progress to upper elementary school, the number of children who dislike physical activity and physical education has been increasing. Therefore, it is necessary to create an environment where children can become familiar with physical activity through physical education classes during the lower and middle elementary school years. To achieve this, it is essential to incorporate play into physical activities that do not focus on skill development, allowing children to experience the joy of physical activity. We believe that it is necessary to develop a program that incorporates play-based physical activities for preschoolers, who are the target population of this study. In particular, it is important to ensure the physical play activities of children in the lower performance group in their daily lives and to create and implement effective physical play programs. Comprehensive evaluations of physical abilities serve as one indicator of children's physical fitness during the preschool years, and can serve as a reference for developing safe and effective physical play programs tailored to individual children. According to the Ministry of Education, Culture, Sports, Science and Technology (2011), preschoolers who participated in a physical play program designed to improve physical fitness at kindergarten showed significantly higher scores than those who did not participate in the New Physical Fitness Test after entering elementary school in the 50-meter run, softball throw, grip strength, sit-ups, sit-and-reach, repeated side jumps, and 20-

meter shuttle run, and also had higher total scores [21]. This suggests the importance of implementing physical fitness improvement initiatives from early childhood, providing individualized physical play guidance, and conducting physical fitness assessments. For the improvement of motor performance, enjoyable practice from an early stage of childhood of various physical play activities such as running, jumping, throwing, and grasping, has been suggested to be effective.

In terms of the correlation between the overall motor performance score and the six measurement items, both boys and girls showed a significant positive correlation with the overall motor performance score. Therefore, it is suggested that all six measurement items serve as indicators of the overall motor performance of young children. Additionally, to examine the relationship between the overall motor performance score and the six measurement items, partial correlation analysis was conducted with body size (height, weight and Kaup index) as control variables, as shown in Figures 3, 4, and 5. According to Ota et al. (1975) and Ozawa (2003), height has been reported to be associated with motor performance [28][29]. In this study, significant correlations were also observed for body weight and the Kaup index. Specifically, the partial correlation coefficients for the 25-meter run, standing long jump, and tennis ball throw were lower for girls aged 6.5 in the standing long jump compared with other events, but showed a tendency toward higher correlations than the other three events for both boys and girls.

Based on these findings, it can be concluded that the basic motor skills of running, jumping, and throwing demonstrated in this study are characteristics of motor abilities in early childhood. Running, jumping, and throwing movements in early childhood are thought to be influenced by various factors, such as increases in muscle mass and maturation of the nervous system, and it has been reported that these movements develop through “spontaneous differentiation” [28][29][39]. Therefore, we consider that running, jumping, and throwing are primary indicators of motor ability in young children.

CONCLUSIONS

This study conducted physical measurements and motor ability tests on 940 preschool children aged 4 to 6 years, and obtained the following findings.

1) The performance records of the six motor performance test items improved with age, and gender differences were observed in the 25-meter run, standing long jump, and tennis ball throw, with boys showing better performance than girls.
2) The 5-point evaluation of the motor performance test showed that at age 4.0, boys had the following percentages: A (7.9%), B (22.2%), C (30.2%), D (27.0%), and E (12.7%). The percentage of A and B ratings (indicating higher physical ability) decreased from age 4.0 to 5.0, increased until age 6.0, and then decreased at age 6.5. The rates for the lower physical ability group (D and E) increased from age 4.0 to 5.0, then decreased until age 6.0, and increased again at age 6.5. At age 4.0, girls showed 8.3% A, 30.0% B, 36.7% C, 21.7% D, and 3.3% E, and the A and B classification rate for the high physical ability group increased from age 4.0 to 5.5, but then decreased until age 6.5. The rate of D and E ratings in the lower physical ability group increased from age 4.0 to 4.5, then decreased until age 5.5, but increased again at ages 6.0 and 6.5.
3) A partial correlation analysis was conducted between the overall motor ability scores of

preschool children and six measured items, revealing a high correlation with body composition. In particular, a strong correlation was observed between height, weight, and the Kaup index in the three specific events of the 25-meter run, standing long jump, and tennis ball throw. This suggests that running, jumping, and throwing are primary indicators of motor ability in preschool children.

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