International Journal of Sociologies and Anthropologies Science Reviews
Volume 4 Issue 3: May-June 2024: ISSN 2985-2730
Website: https://so07.tci-thaijo.org/index.php/IJSASR/index

Comprehensive Method for Testing and Evaluating the Motor Skills of Children in Guangzhou City

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Received 28/12/2023 Revised 08/01/2024 Accepted 20/01/2024

Abstract

Background and Aim: Motor skill evaluation of 5-6-year-old children is a hot topic in current research. The objective of this research was to construct a test for measuring and evaluating the motor skills of preschool children.

Materials and Methods: Research component one constructs the motor skill ability testing program for 5-6-year-old children. This part is composed of 17 experts, through the survey of 17 experts, to construct the motor skill ability testing scheme for 5-6-year-old children; Research content II, to validate the motor skill ability testing scheme for 5-6-year-old children constructed in this study.

Result： The results show (1) After analyzing the experts' questionnaires, the mobility class indicators were determined as: 15.2m running, two-legged continuous jumping, one-legged continuous jumping; throwing movement skills were determined as: overhand tennis ball throwing, one-handed in-situ ball slapping; and the stability skills were determined as: one-legged standing with eyes open, one-legged standing with eyes closed, walking on the balance beam, and walking in a straight line backward. (2) The results of the experimental test showed that according to the percentile method, first, second, third, fourth, and fifth classes were set. Different age samples will not show significance ($p>0.05$) for 15.2m fast running, one-legged continuous jumping, overhand tennis ball tossing, one-handed in-situ ball slapping, one-legged in-situ standing with eyes open and walking backward in a straight line totaling 6 items.

Conclusion: This test can better evaluate the motor skills of children aged 5-6, which will help promote the development of motor skills of children aged 5-6.

Keywords: Young Children; Motor Skills; Guangzhou

Introduction

Children's physical health is currently attracting much attention. The problems of insufficient physical activity, health loss, and overweight and obesity rates in children are still highlighted (Tao, et al, 2021). The "China Childhood Obesity Report" pointed out that since the 1990s, the obesity rate of children in China has been rising. The obesity rate of children aged 0-7 in major cities is about 4.3%, while the obesity rate of school-age children over 7 years old is about 7.3% (NA & Guan-sheng,2017). Without effective interventions, by 2030, the detection rate of obesity in children aged 0-7 is expected to reach 6.0% (Guansheng & Yu,2020). In recent years, China's education part has introduced a series of policies and documents to try to improve the health of Chinese children. However, the level of physical health in Chinese children and the gap between other countries is still very obvious (Han & Zhou, 2020; Li et al. 2019). Many Chinese scholars believe that improving the health level of children is the core issue in Chinese school sports (Xie, 2022; Li Lehu, Wang Jian, Gao Kuoting & Li Kexing, 2021).

Physical health problems in preschool children are mostly related to physical inactivity (Qinghua,2007). Poor motor skills and physical insufficiency are important reasons for insufficient physical activity. Our previous research report shows that among the 229 kindergartens in TianHe District, Guangzhou, with a total of 51,721 students, the highest rate of compliance in the 20-meter sprint, standing long jump, throwing, single- pedal and racket tests was the 20-meter sprint, with 39,218 students The compliance rate was 75.43%. In terms of throwing with the lowest compliance rate, 31,846 people reached the standard, and the compliance rate was only 52.56%. It can be seen that poor motor skills and insufficient physical fitness in preschool children have become extremely serious problems. At the same time, a large number of studies have shown that the development of physical fitness and motor skills of preschool children not only affects their school age but also affects their later physical development (Ming-hui,2015; Yanmin, et al, 2021; Yueting & Wujin,2019). Therefore, paying attention

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to the physical health of preschool children should start with the teaching and evaluation of preschool children's physical fitness and motor skills. Among them, the comprehensive evaluation of preschool children's physical fitness and motor skills-related tests is the focus of current research.

Objectives

The standard aims to solve the comprehensive evaluation of preschool children's physical fitness and motor skills as a scientific problem, taking 5-6-year-old children in TianHe District, Guangzhou as the research object, through expert interviews and questionnaires, to construct a comprehensive evaluation method for preschool children's physical fitness and motor skills. On this basis, some pre-aged children were selected to conduct experiments on body shape, physical fitness, and basic athletic ability, and build a relevant evaluation system. To provide a theoretical basis and practical measures for improving the health of preschool children, and provide a more comprehensive reference and reference for the physical education of preschool children.

Literature Review

Physical and mental characteristics of children aged 3-6 years

The physical and mental development of 3-6-year-olds is characterized by their age. For example, 3-6-year-olds have rapid physical growth, underdeveloped organ functions, weaker immune systems, accelerated bone development, rapid development of language skills, improved cognitive abilities, greater emotional fluctuations, improved socialization skills, and rich imaginations. Some scholars have pointed out that the age of 3 to 6 years is the period of formation of the personality of young children, and the development of the personality of young children in this period has an immeasurable impact on the individual's childhood and even whole life(Gao Yuwan et al., 2019). In conclusion, the physical and mental development of children aged 3 to 6 has its characteristics, and appropriate measures should be taken to promote their physical and mental development based on an understanding of their characteristics.

Current situation of Related research on motor skills

Classification of motor skills

Some scholars have pointed out that human motor skills can be generally categorized into large-muscle movements and fine movements, and that large-muscle movements are the basis of all kinds of sensory movements and are the earliest motor skills developed by children (Li & Diao, 2013) It is the earliest motor skill developed by children (Li & Diao, 2013). Among them, micromotor movements are the motor skills that researchers pay more attention to nowadays, i.e., basic motor skills, which refer to the unnaturally occurring basic motor learning patterns of the human body, and are the basis for performing complex physical and sports activities, and are categorized into displacement skills (e.g., running, one-legged jumping, two-legged jumping, etc.), object control skills (e.g., throwing, kicking, and patting the ball, etc.), and stabilization skills (e.g., balancing, rotating, etc.) (Xu Jun et al., 2021) The Fine motor skills are mainly the ability to accomplish specific tasks with the movement of small muscles or small muscle groups in the hands and fingers, with the cooperation of sensory perception, attention and other mental activities, which is important for individuals to adapt to survival and realize their development (Li Beilei et al., 2021). It is an important foundation for children to acquire basic learning skills and life skills (Grissmer et al., 2010). The importance of good development of fine motor skills in early life facilitates the maturation of brain structure and function, which in turn promotes the development of cognitive systems (Li Fei et al., 2005). The development of fine motor skills in the early years is conducive to the maturation of brain structure and function, which in turn promotes the development of cognitive systems (Li Fei et al., 2005).

Theoretical studies of action development modeling

In the field of movement research, the theoretical paradigms proposed by some movement researchers provide a useful reference for us to understand the process of motor skill formation and identify the types of motor skill structures, among which the representative models of movement development include the "constraint" model(GregPayne et al., 2008), the "mountain peak" model(Metcalfe & Clark, 2002), the "hourglass" model(Tamplain et al., 2019) "Sequence of Development of Movement Proficiency" model(Greg Payne et al., 2008).

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Related research on common assessment methods for motor skills

Commonly used motor skill assessment scales abroad

The assessment of basic motor skills is widely used in developed countries to determine the overall level of growth and development of a child's adolescent or toddler growth and development(Barnett et al., 2016; Bushnell & Boudreau, 1993). At the same time, the scientific measurement of basic motor skills is a prerequisite for conducting subsequent research on teaching and intervening in motor skills in children and adolescents(Li Bo et al., 2018). At present, there is a proliferation of assessment scales for basic motor skills in adolescents, children, and young children abroad, aiming to help professionals and parents understand the development of children's motor and motor skills and to provide them with targeted training and improvement programs. These scales cover a variety of different motor skills and areas of motor development such as balance, coordination, speed, strength, and agility. Therefore, by using these scales, the developmental level of basic motor skills of children or toddlers can be assessed and guided more effectively. By reviewing the previous studies, it was found that there are more mature tools for measuring basic motor skills. Among them, the main ones that are compatible with young children aged 3-6 years old include BOT2, MOT4-6, PDMS, PDMS-2, MMT, TGMD-3, and MABC-2.

Domestic standards for evaluating the physical health of young children

Domestic literature on the assessment and evaluation of the motor function of young children is relatively small, and the main direction of research at present focuses on the assessment and evaluation of young children's physical fitness and health, with most of the indicators originating from the national indicators for monitoring the physical fitness and health of students, including indicators of physical form and physical fitness categories. For example, the National Physical Fitness Measurement Standards Manual (Early Childhood Section), which has been implemented nationwide on a trial basis since 2002, explains its applicable targets, test items, and evaluation criteria.

However, some scholars believe that the test indicators of the "Physical Fitness Handbook" can reflect the physical development level of young children to a certain extent, but there are fewer evaluation indicators, and individual indicators tend to be adult-oriented, which fail to comprehensively reflect the requirements of the "Guidelines" for learning in different age groups and the development of young children's movement, and even more so, fail to accurately assess the "three-dimensional movement" development ability of children aged 3 to 6 years old. "Three-dimensional movement development ability(Zhuang, et al., 2011) They attempted to develop a model for the three-dimensional development of 3- to 6-year-old children. They attempted to establish a three-dimensional movement ability assessment system for children aged 3-6 to make up for the shortcomings of the "Physical Fitness Handbook" evaluation index system and to help kindergartens implement the requirements of the "Guidelines" and teachers scientifically formulate the "Guidelines" for children.

Literature review

To summarize, the physical and mental development of 3-6-year-old children has its own rules and characteristics, and this period is the key period for the development of basic motor skills of young children. However, there is less literature on the assessment and evaluation research of motor function in young children in China, and the main direction of research now focuses on the assessment and evaluation of physical health in young children, with most of the indicators originating from the national indicators for monitoring the physical health of students, including indicators of physical form and physical quality categories. In practical application, it is necessary to choose appropriate strategies and methods according to the characteristics and needs of individuals, which can effectively promote the development of human motor skills.

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Conceptual Framework

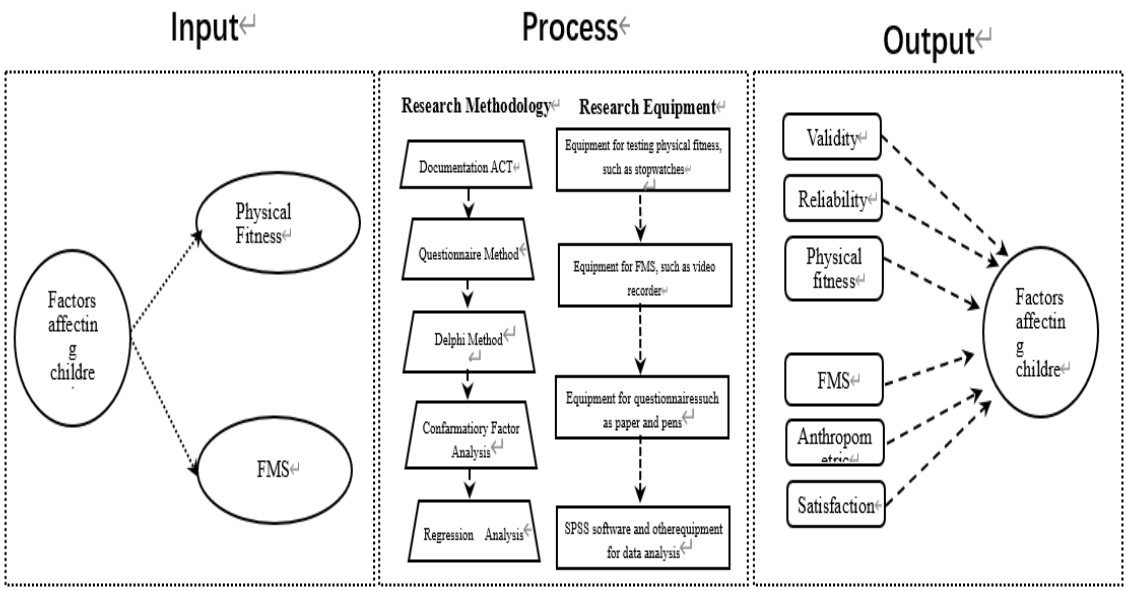

Figure 1 Conceptual Framework

Methodology

Population and Sample

According to the statistics of the Guangzhou Tianhe District Education Bureau's "Guangzhou Tianhe District Pre-school Young Children's Physical Health White Paper 2022", there are currently 51,721 young children in the Tianhe District of Guangzhou, of which 17,040 are 5-6 years old.

The sample size was estimated by the following formula given by Taro Yamane (Yamane,1967). To know the demographic population, a 95% confidence level and (P-value =0.5) are assumed for Equation (1).

$$n = \frac{N}{1 + Ne^2} \qquad (1)$$

n = The size of the sample required
N = Population size
e = Sampling error

According to the formula, 391 children are sampled.

Participants

To determine the content of the indicator system, it was necessary to select experts for the Delphi test. Seventeen experts were selected based on age, nature of work, position, title, and years of experience. All experts were categorized into four groups according to the nature of their work: university professors, pedagogical managers, principals, and teachers.

Research Instrument

To understand what is involved in the development of basic motor skills in young children, it was necessary to develop an outline of an expert interview in which the researcher, administrator, and teacher would provide their opinions and perspectives, respectively, to provide an initial reference and basis for the study.

To construct a system of indicators for the development of basic motor skill development in young children, it was necessary to develop a questionnaire for validation. According to the requirements of the "Learning and Development Guidelines for Children Aged 3-6", "Healthy Physical Fitness

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Standards for Preschool Children", "Guidance Outline for Preschool Education (Trial)", and "Several Opinions of the State Council on Strengthening School Physical Education to Promote the Overall Development of Students' Physical Fitness and Health", a questionnaire for testing the motor skills of young children in Guangzhou City aged 5-6 will be developed. The preliminary questionnaire content mainly includes two parts: 1) the basic information of the research subjects (including gender, age, education level, nature of the unit, title, position, etc.); 2) the indicator content adopts the Likert scale, assigning values of 1-5, which represent the agreeable attitudes from the low to the middle, respectively.

Journal literature and books on Google Scholar, National Knowledge Infrastructure, Wan Fang Data Knowledge Service Platform, VIP Journal Resource Integration Service Platform, Web of Science, Sci-Hub, ProQuest Central, and other platforms were utilized to understand the content related to motor skills of 5–6-year-old children and to provide the construction of the test index system as a Research Basis.

Data Collection

The expert interviews took the form of a telephone interview and a web-based survey. It was distributed to relevant experts from research institutes, administrations, and junior secondary schools to conduct two rounds of surveys together. The two rounds of survey were conducted 14 days apart. Ultimately, 17 were validly recalled in the first round and 17 in the second round.

After identifying the indicators, the test program was prepared and according to the test program, the experiment was conducted in six kindergartens according to the school level.

Results

Establishment of the Basic Motor Skills Test for 5–6-year-olds

In this part, the application process of the Delphi method is introduced, which mainly includes the formation of the expert group of the test system, the construction of the indicator system, the iterative implementation of the expert questionnaire, the development of the indicator selection conditions, the standardization process of the test system, and the schematic diagram of the site and other parts.

Construction of indicators

According to the literature test content as a source of indicators combined. Combined with the principles of indicator system construction, the principles of selecting mature tools mainly include: (1) the tools have been commonly used; (2) the form of movement performance is simple and easy to learn; (3) there is no need for specialized equipment in movement measurement.

Initially, 63 secondary indicators were identified as the indicator content of this study. The index system has specific requirements for the scoring of each index as well as the movement specification.

Implementation of expert group iterations

The Delphi questionnaire distribution started on August 7, 2023, and lasted for 14 days. The anonymity feature of Delphi was fully ensured during the completion of the questionnaire to ensure that experts completed the questionnaire independently from each other. The format of the questionnaire was a combination of paper and electronic questionnaires. The questionnaire consisted of five consecutive sections: (1) obtaining information about the experts, including their demographic information, research interests, etc.; (2) judging the indicators according to the principles of "safety, efficiency, and fun" in terms of "inclusion" and "deletion"; (3) determining the "inclusion" and "deletion" of the indicators; (4) determining the "inclusion" and "deletion" of the indicators. (2) Judge the "inclusion" and "deletion" of the indicators according to the principle of "safety, efficiency and fun"; (3) Ask the experts to recommend the supplementation of the missing secondary indicators (in the form of evaluation of the performance of the action); (4) Obtain the expert's familiarity with the indicators and the basis of the judgment; (5) Ask the experts to rate the importance of the indicators. The questionnaire "feedback" started on August 21, 2023, and lasted for 10 days. The main purpose was to provide "peer-to-peer" feedback on the results of the questionnaire and to listen to the suggestions of experts who had "different opinions" on the selection of indicators. "The Delphi's conducted a total of two rounds. Delphi will conduct two rounds of iterative implementation, to be completed by September 1, 2023, for the entire implementation.

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Results of the first round of indicator screening

Results of the screening of indicators for the mobile category

After collecting the data, the indicators were analyzed, with the following results for the mobile category:

Table 1 Mobile Category Score

term (in a mathematical formula)	average value
1 15.2m run test	4.412±0.492
2 Dodge Run	1.706±0.749
3 Obstacle Curve Run	2.176±0.856
4 Standing long jumps	1.941±0.725
5 Continuous jumps on both feet	4.882±0.322
6 Jumping rope with both feet	1.882±0.900
7 Double-legged hops (hopscotch)	2.353±0.762
8 Continuous jumps on one foot	4.471±0.499
9 7.6m Side Slide Test	4.294±0.456
10 9.5m front straddle jump test	4.647±0.478
11 Continuous side-to-side double-fold jumps	2.235±0.730
12 Continuous jumps on one foot in place	2.059±0.872

In the mobility category, in terms of scores: the highest score was the two-legged continuous jump, followed by the 9.5m front straddle jump test, 15.2m running test, and one-legged continuous jump, and the lowest scores were dodge run, two-legged rope skipping and standing long jump.

After collecting the data, the indicators were analyzed using the hierarchical analysis method, in which the results of the mobile category were as follows:

Manipulation skill indicator screening results

The total number of manipulation skills is 16 and the results of the first round are as follows:

Table 2 Manipulation skills score

Term	Average value
1 Overhand Tennis Throw	4.529±0.499
2 Underhand Tennis Throw	2.176±0.856
3 Catch the ball with both hands	4.588±0.492
4 One-handed in-situ racket	4.353±0.478
5 Changing hands in place to shoot the ball	2.118±0.832
6 Kick Suspension	4.588±0.492
7 Hitting a stationary ball with both hands	4.588±0.492
8 Self-throwing free-fall ball	1.882±0.758
9 Baseball Hits Fixed Balls	1.824±0.758
10 Marching dribble (	2.118±0.832
11 Rollerball	4.353±0.478
12 Needle and thread beads	2.353±0.762
13 Trace drawing	2.118±0.900
14 Unbuttoning	2.235±0.644
15 Trimming	2.059±0.802
16 Balloon in place	2.412±0.771

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Results of the balanced category skills screening

There was a total of 2 items in the balanced category and the results of the first round of scoring were as follows:

Table 3 balanced category skills score

Term	average value
1 Toe stand	4.529±0.499
2 Stand on one foot with eyes open	4.412±0.492
3 Stand on both feet, front and back	2.176±0.785
4 Stand on one leg with eyes closed	4.412±0.492
5 Walk the balance beam	4.647±0.478
6 Backwards in a straight line	4.471±0.499
7 One-legged jumps left and right with the ball in both hands	1.824±0.785
8 Body rolls from side to side	4.529±0.499

Of the balance skill indicators, in terms of scores: the highest score was for walking the balance beam, followed by rolling the body from side to side and standing on tiptoes. The average scores for these two items were very close.

Results of the second round of indicator screening

The results of the second round of questionnaire scores prepared based on the first round of questionnaires are as follows:

Table 4 score for each test item

term	average value
1.1.1 15.2m run test (1)	4.412±0.492
1.2.2 Continuous jumps on both feet (2)	4.529±0.499
1.3.1 Continuous jumps on one foot (3)	4.235±0.424
1.4.1 7.6m front slide test (4)	2.059±0.725
1.5.1 9.1m front straddle jump test (5)	1.824±0.923
2.1.1 Hands-on tennis throw (6)	4.706±0.456
2.2.1 Catching the ball with both hands (7)	2.000±0.686
2.3.1 One-handed in-situ racket (8)	4.471±0.499
2.4.4 Kick Suspension (9)	2.000±0.840
2.5.1 Hitting a stationary ball with both hands (10)	2.176±0.923
2.6.4 Ground balls (11)	2.000±0.907
3.1.1 Toe stand (12)	1.588±0.691
3.1.2 Standing on one foot with eyes open (13)	4.647±0.478
3.1.3 Standing on one foot with eyes closed (14)	4.647±0.478
3.2.1 Walking the balance beam (15)	4.353±0.478
3.2.2 Backward walking in a straight line (16)	4.235±0.424
3.3.1 Body rolls from side to side (17)	2.000±0.840

The indicators for the second round in terms of scores: in descending order, they are overhand tennis ball throwing, standing on one foot with eyes open, and standing on one foot with eyes closed,

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Experiments with the Test of Basic Motor Skills for 5-6-year-olds

In this study, to fully ensure the external validity of this test, 391 young children in the Tianhe District of Guangzhou City were recruited to conduct the field test, which fully verified the stability and validity of the scale. Meanwhile, to ensure the popularization and application of the scale in the future, this part also evaluates the feasibility of the scale, which fully ensures the internal validity of the scale.

Basic results

In this section, the centralized trend and the degree of dispersion of the test data are analyzed descriptively. In the description of the centralized trend, the mean, median, and plurality of the data are presented, and in the description of the degree of dispersion, the standard deviation and extreme value of the data are presented. The list of descriptive statistics of the test data is shown in Table 5.

Table 5 List of descriptive statistics of test data (n=391)

Test metrics	Mean ± standard deviation	variance (statistics)	IQR	kurtosis	Coefficient of variation (CV)
15.2m fast run (s)	4.912±3.337	11.136	0.83	119.839	67.93%
Continuous jumps on both feet (s)	6.202±4.740	22.471	1.25	111.807	76.43%
One-legged continuous jump (s)	3.890±1.301	1.692	1.24	15.018	33.44%
Overhand toss (m)	5.615±1.926	3.711	2.6	1.502	34.31%
One-handed in-situ racket (times)	104.533±29.885	893.093	25	7.395	28.59%
with one's eyes open, in place Standing on one foot (s)	85.393±96.830	9375.989	95	28.025	113.39%
Standing on one foot with eyes closed (s)	19.337±24.949	622.455	16	16.358	129.03%
Walking the balance beam (s)	6.370±4.284	18.349	2.71	10.474	67.24%
Walk backward in a straight line (s)	24.356±9.293	86.355	11.48	0.513	38.15%

To assess more objectively the level of development of motor skills of 5-6-year-old children, it is necessary to formulate evaluation criteria for each test index. At present, the percentile method, index method, and deviation method are mainly used at home and abroad to formulate evaluation standards. Among them, the percentile method is one of the most commonly used methods for constructing evaluation standards in sports measurement and evaluation, i.e., the median of the survey data is the base value, and the rest of the percentiles are used as the discrete distance to carry out the equal score evaluation, and the standards of different grades are usually formulated by using the percentiles such as P3, P10, P25, P50, P75, P90, P97 and so on (Chen & Yu, 1989). The percentile method is simpler and more objective, so it is more common to use the percentile method to formulate grade evaluation standards or percentile scoring standards (Yuan and Huang, 2011). The evaluation criteria of China's National Physical Fitness Measurement Standards (NPFMS) are also developed using the percentile method as the main development method (Jiang, 2004). In this study, the percentile method will also be used to develop the rating scale for mobile motor skills of 5-6-year-old children, which will be divided into five evaluation levels, and the four cut-off points of P10, P25, P75, and P90 will be used to determine the theoretical percentiles of each evaluation level, i.e., to find out the measured values corresponding to the various cut-off points.

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Table 6 Percentile Classification of Evaluation Levels

Rating	Criteria (cut-off points for each level)	Theoretical percentage (%)
excellent	More than 90% of the digits	10
very much	75% to 90% of digits (including 90% of digits)	15
center	25% to 75% digit (including 75% digit)	50
arrive at (a decision, conclusion, etc.)	10% to 25% digit (including 25% digit)	15
differ from	Below the 10th percentile	10

Percentile method is to arrange the data of the indicator in descending order, and then divide the data into 100 equal parts. The percentile method arranges the data of the indicator in descending order and then divides the data into 100 equal parts, and the position of a certain value in the data of the indicator is expressed by the percentile (Pa), for example, the 10th percentile is expressed as P10, ad the calculation formula (2) as follows:: $Pa = Da + \frac{L}{Ha}\left(\frac{a \cdot N}{100} - Fa\right)$

Pa denotes the a-percentile, Da is the lower limit of the value of the group in which the a-percentile is located, L is the group distance, Ha is the frequency of the group in which Pa is located, Fa is the frequency of the group above Da, and N denotes the sample size.

The four percentile scores of P90, P75, P25, and P10 were selected as the cut-off points, and the statistical software SPSS was used to calculate the percentile scores of the data, and the single percentile scores of the evaluation indexes of motor skill development of the 5–6-year-old children were determined respectively.

Table 7 percentile scores for each evaluation indicator of mobile motor skills for 5-6-year-olds

Norm	male percentile scorecard				women percentile scorecard			
	P10	P25	P75	P90	P10	P25	P75	P90
15.2 m fast run (s)	3.75	4.07	4.67	5.15	3.97	4.33	5.08	5.7
Continuous jumps on both feet (s)	4.29	4.9	6.19	7.66	4.92	5.26	6.31	7.22
One-legged continuous jump (s)	2.83	3.07	4.55	5.16	2.77	3.1	4.31	5.17
Overhand toss (m)	3.54	4.6	7.5	9.42	3.8	4.1	5.8	7
One-handed in-situ racket (times)	73.2	90.5	116.5	137	73	92	116.25	125.3
Standing on one foot in place with eyes open (s)	12.6	20.42	71	98	13.21	21.96	73.45	108.8
Standing on one foot with eyes closed (s)	2.65	5.5	16.7	32.82	3.00	5.08	19	25.6
Walking the balance beam (s)	3.25	4.18	7.12	12.26	3.27	4.1	6.74	8.88
Walk backward in a straight line (s)	12.47	17	30.69	40.47	14.04	17.85	28.09	32.59

Citation
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International Journal of Sociologies and Anthropologies Science Reviews
Volume 4 Issue 3: May-June 2024: ISSN 2985-2730
Website: https://so07.tci-thaijo.org/index.php/IJSASR/index

Based on the data measured by the formal test, this study will also use the percentile method to develop the scoring standards for each index of mobile motor skills of 5-6-year-olds. Based on the above table of percentile scores of the children's indexes, we will divide them into five grades. For each grade, we will select the scores at the four cut-off points of P90, P75, P25, and P10 as the nodes of the five grades, namely, first grade, second grade, third grade, fourth grade, fifth grade, with first grade being the highest grade and fifth grade being the lowest grade. Each grade is divided into five evaluation grades. Each grade is then selected as the node between the five grades at the four cut-off points of P90, P75, P25, and P10, respectively, which are the first, second, third, fourth, and fifth grades, with the first grade being the highest and the fifth grade being the lowest. After organizing the data with the statistical software SPSS, the five levels of the motor skills evaluation indexes of the 5-6 age group were determined.

Table 8 Ranking Scale of 15.2m fast run by Indicator for 5- to 6-year-olds

Seconds range (Boys)	Seconds range (Girls)	Meaning
<3.75s	<3.97s	Very good
3.76s-4.07s	3.98s-4.33s	good
4.08s-4.67s	4.33s-5s	average
4.68s-5.16s	5.01s-5.7s	Poor
>5.16s	>5.7s	very poor

Table 9 Ranking Scale of Continuous Jumps on both feet by Indicator for 5- to 6-year-olds

Seconds range (Boys)	Seconds range (Girls)	Meaning
<4.28s	<4.91s	Very good
4.28s-4.89s	4.92s-5.26s	good
4.9s-6.18s	5.27s-6.3s	average
6.19s-7.66s	6.31s-7.21s	Poor
>7.66s	>7.21s	very poor

Table 10 Ranking Scale of One-legged Continuous Jump by Indicator for 5- to 6-year-olds

Seconds range (Boys)	Seconds range (Girls)	Meaning
<2.83s	<2.72s	Very good
2.84s-3.07s	2.73s-3.1s	good
3.08s-4.55s	3.12s-4.3s	average
4.56s-5.17s	4.31s-5.17s	Poor
>5.17s	>5.17s	very poor

Table 11 Ranking Scale of Overhand Toss by Indicator for 5- to 6-year-olds

Number of meters (Boys)	Number of meters (Girls)	Meaning
>9.42m	>7m	Very good
7.5m-9.42m	5.8m-7m	good

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Number of meters (Boys)	Number of meters (Girls)	Meaning
4.6m-7.49m	4.1m-5.79m	average
3.54m-4.59m	3.8m-4.09m	Poor
<3.54m	<3.8m	very poor

Table 12 Ranking Scale of One-handed in-situ Racket by Indicator for 5- to 6-year-olds

Range of times (Boys)	Range of times (Girls)	Meaning
>137 times	>125.3 times	Very good
116.5 times-137 times	116.25 times-125.29 times	good
90.5 times-116.49 times	92 times-116.24 times	average
73.2 times-90.49 times	73 times-91.99 times	Poor
<73.2 times	<73 times	very poor

Table 13 Ranking Scale of Standing on one foot in place with eyes open by Indicator for 5- to 6-year-olds

Seconds range (Boys)	Seconds range (Girls)	Meaning
>98s	>108.8s	Very good
71s-97.99s	73.46s-108.79s	good
20.42s-70.99s	21.96s-73.45s	average
12.6s-20.41s	13.21s-21.95s	Poor
<12.6s	<13.21s	very poor

Table 14 Ranking Scale of Standing on one Foot with Eyes Closed by Indicator for 5- to 6-year-olds

Seconds range (Boys)	Seconds range (Girls)	Meaning
>32.82s	>25.6s	Very good
16.7s-32.81s	19s-25.59s	good
5.5s-16.69s	5.01s-19.99s	average
2.65s-5.49s	3.00s-5.00s	Poor
<2.65s	<3s	very poor

Table 15 Ranking Scale of Walking the Balance Beam by Indicator for 5- to 6-year-olds

Seconds range (Boys)	Seconds range (Girls)	Meaning
<3.26s	<3.75s	Very good
3.27s-4.18s	3.76s-4.1s	good
4.19s-7.12s	4.11s-6.74s	average
7.13s-12.26s	6.75s-8.88s	Poor

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Seconds range (Boys)	Seconds range (Girls)	Meaning
>12.26s	>8.88s	very poor

Table 16 Ranking Scale of Walk backward in a straight line by Indicator for 5- to 6-year-olds

Seconds range (Boys)	Seconds range (Girls)	Meaning
<12.47s	<14.04s	Very good
12.48s-17s	14.05s-17.85s	good
17.01s-30.69s	17.86s-28.09s	average
30.7s-40.47s	28.1s-32.59s	Poor
>40.47s	>32.59s	very poor

Feasibility of testing basic motor skills for 5–6-year-olds

To further validate the research content of this paper, the "Comprehensive Method for Testing and Evaluating the Motor Skills of Children in Guangzhou City" Expert Questionnaire (Final Test Indicator)", and using the snowball method, 9 experts were invited to score the reasonableness of the test items, and the results are as follows:

Table 17 Final project expert scoring results

Norm	N	average value	(statistics) standard deviation	upper quartile	mode (statistics)
15.2m run	9	4.78	0.44	5	5
Double legged jumps	9	4.67	0.50	5	5
jump on one leg	9	4.67	0.50	5	5
Getting Started with Tennis Throwing	9	4.56	0.53	5	5
One-handed slapping of the ball in place	9	4.67	0.50	5	5
Standing on one leg with eyes open	9	4.89	0.33	5	5
Standing on one leg with eyes closed	9	4.78	0.44	5	5
walk the balance beam	9	4.67	0.50	5	5
walk backward	9	4.78	0.44	5	5

Through the questionnaire survey of experts on the final 9 test indicators screened out in the study of basic motor skills assessment model for 5–6-year-old children in Guangzhou, the experts scored the "degree of agreement" of the indicators from a professional point of view. Table 17 shows that experts endorse this protocol

Discussion

Discussion of the metrics analysis of this test system

Discussion of the analysis of indicators in the mobile category

In this study, running skills were screened from distance running, dodge running, and obstacle curve running. The results showed that the 15.2m run test ended up being the test item, excluding the dodge run and obstacle curve run.

In this study, jumping skills were screened from standing long jump, two-foot continuous jump, two-foot jump rope, two-foot open-close jump (hopscotch), one-foot continuous jump, 7.6m side-sliding test, 9.5m front straddle jump test, continuous lateralized two-foot folding jumps, and one-foot

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in situ continuous jumps. Among them, standing long jump, two-footed rope skipping, two-footed open and close jumping (hopscotch), one-footed continuous jumping, continuous lateralized two-footed folding jumping, and one-footed continuous jumping in place were excluded. Jumping motor skills were mostly tested in terms of both bipedal and uni-pedal jumping skills. In terms of single-legged jumping skills, single-legged continuous jump, 7.6m side-sliding test, 9.5m front straddle jump test were selected, continuous lateral two-legged folding jump, and single-legged in-situ continuous jump were rejected. The reason for this may be related to the high requirement of their movement skills.

In the second hierarchical analysis, through analysis, we finally got the indicators of the movement category as: 15.2m running test, two-legged continuous jump, and one-legged continuous jump. The three test items are characterized by strong motor skills and are also in line with the development of motor skills in young children.

Motor skills occupy a central place in early childhood development(Yapici et al., 2022) that lay the foundation for later physical activity and health(Bryant & Duncan et al., 2014; Chen Tian & Gu Song, 2022; Yin, et al., 2023). This study focused on three skill tests: the 15.2m run test, the two-legged continuous jump, and the one-legged continuous jump to explore their associations with motor skills in 5- and 6-year-old children.

First, we focus on the 15.2m run test. According to(Bryant & James et al., 2014) children's performance on the sprint test significantly predicts their later sports participation. In our sample, this association was confirmed in children aged 5-6 years old, suggesting that children in this age group's performance in the 15.2m run test may have predictive value for their subsequent motor skill acquisition.

Continuous jumping on both feet as the next skill measures children's lower limb strength and overall coordination. (Muro et al., 2023) In the present study, the performance of two-legged continuous jumping was positively correlated with other complex skills such as lateralization, balance, and catching ability.

We then turned to the skill of one-legged continuous hopping, which assesses children's balance and single-leg support abilities. In their study, they found that one-legged motor skills were highly correlated with children's neural control and coordination. In our sample, performance in one-legged continuous jumping showed significant associations with children's performance in other demanding motor skills such as jumping rope and kicking a soccer ball.

The results of this study imply that early training and coaching of these three skills may help improve children's overall motor skills. The effectiveness of early intervention in improving children's motor skills.

Analysis and Discussion of Manipulative Skills Indicators

Manipulative skills are a set of skills related to fine hand movements and coordination of large body muscles (Xu, et al, 2023). It is a critical developmental stage for young children aged 5-6 years old (Chen et al., 2016).

In this study, throwing skills were screened from overhand tennis throws and underhand tennis throws. The results showed that overhand tennis throwing became the test item and underhand tennis throwing was excluded. In the hitting category, two-handed catching, one-handed in-situ slapping, kicking and hanging, two-handed hitting of a stationary ball, and ground ball were selected. Self-throwing and catching free-fall balls, hitting a stationary ball with a baseball, and dribbling between lanes were excluded. The fine motor selection did not have a single selection. This is because young children are primarily gross muscle developers and are not sensitive to fine motor movements(Reyes et al., 2019).

As children develop, the acquisition and proficiency of their motor skills become progressively more critical(Ma & Song, 2017). Overhand tennis ball throwing and one-handed in-situ racket are two basic but crucial motor skills that have a specific place in the development of motor skills in 5- to 6-year-old children.

First, the overhand tennis ball throw measures children's upper-body coordination and strength. According to(Keller et al., 2011) study, throwing skills are a key indicator for assessing children's upper extremity function and strength. Secondly, the one-handed in-situ racket tests children's hand-eye coordination. In our sample, there was a positive correlation between 5- and 6-year-old children's performance in one-handed in-situ ball shooting and their performance in other hand-eye coordination-related tasks, such as linear tracking and target localization. In addition, this study found that these two skills were related to children's overall motor skills. (Rea & Arcos, 2023) In their study, it was mentioned that specialized motor skill training can improve children's overall motor skills. Therefore,

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specialized training on overhand tennis ball throwing and one-handed in situ rackets may help improve children's overall motor skills.

Discussion of the analysis of indicators in the category of balance

Homeostasis, as a fundamental physiological function, is crucial for the survival and development of organisms(Skaltsa et al., 2021). In early human life, balance was essential for the body's interaction with the external environment, and it was not only about survival but also closely linked to the overall quality of life(Villalobos-Samaniego et al., 2020)

Balance and coordination are core elements of motor skills, and they provide the foundation for young children's daily lives and preschool physical activity. In this paper, we explored the balance skills of 5-6-year-old children while performing one-legged stand with eyes open, one-legged stand with eyes closed, and walking on a balance beam, to reveal the relationship between these skills and the overall motor skills of children in this age group.

Standing on one foot with eyes open is one of the basic methods of assessing balance in young children. (Overlock & Yun, 2006) In their study, et al. found a significant positive correlation between the duration of standing on one foot with eyes open and the overall motor skill level of 5-6-year-old children.

Standing on one foot with eyes closed adds to the difficulty of assessing the condition, as the absence of visual input makes balancing more difficult(Bas et al., 2020). (Li Bo & Liu Yang, 2022) Children who were able to complete the one-legged stand under the eyes-closed condition were found to have superior performance on other motor skill tests as well. This implies that one-legged standing with eyes closed may be a more sensitive indicator for assessing motor skills in 5-6-year-old children.

Walking the balance beam is a task that highly requires physical coordination and balance. (Overlock & Yun, 2006) In their study, it was noted that the ability to walk the balance beam was strongly associated with children's overall motor skills, especially with jumping and running.

Recommendation

1. Schools should recognize the importance of developing the motor skills of young children. From the long-term perspective of the healthy development of young children's bodies, they should consider the improvement of young children's motor skills as an indispensable part of the program, to achieve macro-coordination and micro-implementation, and to improve young children's motor skills comprehensively.

2. Society as a whole should emphasize the important role of young children's motor skills in the promotion of physical fitness and health, cooperate with physical education in schools, and carry out timely and objective evaluations of young children's motor skills to promote the development of young children's motor skills in a more scientific direction.

3. To make the research more targeted, it should continue to deepen the research on the ability indicators of the various developmental stages of young children's motor skill ability, to provide targeted evaluation and developmental guidance for young children at different developmental stages.

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Citation
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