SCREENING OF SIMPLIFYING INDICATORS OF GROSS MOTOR DEVELOPMENT IN PRESCHOOLERS

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https://doi.org/10.35189/dpeskj.2022.61.1.6.

Abstract. *Objective: In order to meet the requirements of large-scale testing in China, the TGMD-2 (Test of Gross Motor Development) was used to screen the simplifying indicators so as to test the gross motor development of preschoolers more accurately, conveniently and efficiently in the future. Methods: A total of 140 children aged 3-6 years (mean 4.8 ± 0.92 years old) from a Beijing kindergarten were selected as participants in the present research. TGMD-2 was used to test and score their gross motor development levels. Firstly, multivariate variance was used to analyse the effects of age and gender. Then, the Pearson coefficient, discrimination D and difficulty coefficient L were used for secondary screening. Finally, the stepwise regression was used to get the optimal equation, and then the reserved data (obtained from testing another 150 children) were substituted to predict the total score. The consistency test was conducted with the actual score to verify the effectiveness of the indicators. Results: Hop was selected as the primary motor indicator, and the equation to predict the total score of TGMD-2 was "TGMD-2 total score = 43.634 + 3.250* Hop score". Conclusion: The simplifying indicator screened in this study is Hop, which has moderate difficulty and good differentiation, can better predict the total score and can be used for a wide range of tests in China.*

Keywords: *TGMD-2 (Test of Gross Motor Development-2), simplifying indicators, preschoolers.*

Introduction

Preschool age is the sensitive period of children's motor development, but also the key period for the formation of good athletic skills (such as running, jumping, throwing, etc.). Especially at the age of 3-8, if there is no correct learning and application of motor skills during this stage, children's motor patterns will be irreparably impaired, and their physical condition will be also affected by a variety of problems. The physical health of children has always been the focus of social attention. As the flower of the Chinese nation, children's physical health is directly related to the prosperity and strength of the motherland. Therefore, it is important to pay attention to the development of preschoolers.

Motor development is a complex process, and its level is closely related to human behaviour, health, intelligence and body. Motor development is mainly divided into two parts: gross movement and fine movement. Gross movement usually requires mobilising more and larger muscle groups to perform it. Numerous studies have shown that, before the age of 8, the plasticity and variability of gross movement are relatively high, and during this period, children acquire gross motor skills that will form the basis for the development of fine motor skills. Early establishment of the correct movement pattern is of great benefit to children's confidence building and enthusiasm for sport (Guo et al., 2018). It can not only enhance children's physique but also play an auxiliary role in their nervous development, psychology, cognition and other aspects. The Test of Gross Motor Development (TGMD), developed in 1985, assesses movement skill tasks in children aged 3 to 10 years. The Second Edition of this test (TGMD-2), which appeared in 2000, has become the most used assessment tool due to its high reliability and validity, being also applied in good domestic conditions (Li & Ma, 2007). However, except for a few movements such as Striking a Stationary Ball or Underhand Roll (similar to baseball or bowling), which have received low ratings in China, most movements are more suitable. Although TGMD-2 has good reliability and validity, there are still subtle localisation problems. Therefore, the index screening is performed to pave the way for us to use local children as research samples and conduct the research again.

Education quality monitoring refers to monitoring students' learning levels, comprehensive quality and various factors that affect their academic performance by means of questionnaire survey, achievement measurement and academic examination. By analysing the monitoring results, we can grasp the status quo of education quality, provide information and basis for the formulation of educational policies, and provide information and means for education quality assurance with ideas and goals for improvement based on the education and teaching activity of schools and teachers (Yang & Li, 2016). The current evaluation system of preschool education quality in China reveals that there are still some problems such as weak universality of monitoring tools and limited coverage of monitoring content. Preschool education quality monitoring is not only the focus of education reform, but also the focus of high attention of the Party and Government (Li & Zhang, 2020).

To sum up, many domestic and foreign literatures can prove that TGMD has high reliability and validity in measuring the gross motor development level of children aged 3-10 years. However, compared to children aged between 6 and 10, preschool children aged 3-6 years show some differences in motor development levels and actually in all aspects. Unfortunately, TGMD has many items, and the test time for each child is about 15 to 20 minutes, which is too long to facilitate large-scale testing.

In this study, the experimental data of TGMD-2 applied to preschoolers from a military kindergarten were analysed to find one or two more representative test actions or indicators for the age group from 3 to 6 years so as to shorten the test time as much possible and thus provide a basic method for future large-scale testing.

Advanced countries have continued to do research on human motor development over the last 60-70 years, but the history of domestic research in this field is not long. According to Keogh (1977), motor development refers to "changes in movement competencies from infancy to adulthood" (p. 76). Obviously, changes in motor development are also influenced by many aspects such as environments and human behaviors, which is why there has been constant controversy around this definition that has not been universally recognised. Payne (2002) refined it, stating that "motor development is the study of the changes in human motor behaviour over the lifespan, the processes that underlie these changes, and the factors that affect them" (p. 426), and this definition has been widely accepted by specialists.

As mentioned before, motor development includes gross and fine motor development. Gross motor skills require coordination of the large muscles in the arms, legs and torso to perform actions such as running, jumping and throwing, and their development is necessary for proprioception, core stabilisation and body control. Fine motor skills require coordination of the smaller muscles in the hands, wrists (and even feet) to perform actions such as picking up or grasping, and their development is necessary to manipulate small objects (Piek et al., 2008).

Preschool age is the sensitive period of gross motor development, and many gross motor skills will undergo major changes between 3 and 10 years old. It is also the focus of preschool and early elementary education, which provides a basis for the subsequent learning of various motor skills. The development of gross movement leads to the development of fine movement, and they are closely related to the learning of complex motor skills, helping children establish a complete movement pattern and build self-confidence, which is of great significance for their emotions, appearance, cognition and other aspects. Children with delayed motor development in this period will experience irretrievable effects on their athletic ability later in life, so special attention should be paid to their motor development.

The Movement Assessment Battery for Children (M-ABC), compiled by Henderson and Sugden (1992) and revised in 2007 (M-ABC-2) (Henderson et al., 2007), is a tool for assessing developmental coordination disorders (Schulz et al., 2011). The validity of this instrument has been confirmed in Hong Kong, Taiwan and China (Jing et al., 2010), and it can be used to assess such disorders in Chinese preschool children. The Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978), whose revised form is BOT-2 that also includes a short form (Bruininks & Bruininks, 2005), is mainly used to assess motor shortcomings in children and disability problems in adolescents (Wuang et al., 2009). It has been proven to have good validity in foreign studies, but there is no research on its application in China. The Body Coordination Test for Children (KTK) was originally compiled by Kiphard and Schilling (1974) to measure motor coordination in children aged 5-14 years (Vandorpe et al., 2012). Currently, it is widely used in Europe and has been proven to have good reliability and validity, but there is no research on this aspect in China. The Developmental Coordination Disorder Questionnaire (DCDQ) was designed by Wilson et al. (2000), being mainly used as a tool to screen for coordination disorders in children (Jin, 2007). At present, its application in Taiwan has been proven to have good validity and reliability, but there is no such research in mainland China. The measuring tools used in domestic contexts, besides TGMD, also include Preschool Children Bulky Action Quality Scale (2010), a test for the motor development of preschool children in Hong Kong, and in China, Children's Developmental Scale (3-6 years old) (1992), which has been identified to have good reliability and validity, but these tools are not tested on a large scale across the country, being obviously regional. In addition, most of these motor assessment tools for children are specialised in testing the gross motor development level, while those specialised in testing fine motor development are relatively rare (Wu et al., 2014).

Developed by Dale Ulrich, Professor at Michigan State University, TGMD (Ulrich, 1985) is a tool specially used to assess gross motor development in children aged 3 to 10 years. After several years of investigation and application, Ulrich revised the TGMD and launched its second version (TGMD-2) in 2000 (Ulrich, 2000). According to the feedback results, it has become one of the most widely used tools for assessing the development of gross motor skills in children (Jing & Guoli, 2005). TGMD-2 is a highly reliable and effective assessment tool whose validity was proven using a normative sample of 1,208 people residing in 10 states of the USA. Moreover, cross-cultural studies on typically developing children and children with special needs in Australia, Belgium, Brazil, Chile, China, Iran, the Philippines, South Korea and many other countries, also show some evidence of the reliability of TGMD-2 (Maeng et al., 2017). In Taiwan and Shandong Province of China, the study conducted by Jing and Guoli (2005) also highlights its good reliability and validity for children aged 3-10 years. However, due to the differences in Chinese culture and regions, it will take some time before it can be widely used in China (Hongxia, 2006).

TGMD-2 is used to: (1) identify children who are significantly behind their peers in gross motor skill development, (2) develop an instructional plan for gross motor skill development, (3) assess children's progress in gross motor skill development, (4) evaluate the success of the gross motor programme, (5) provide a measurement tool for research on gross motor skill development (Aye et al., 2017).

Preschool education quality supervision is a countermeasure to the dilemma of preschool education quality development. In essence, it is about improving preschool education quality and promoting children's physical and mental health development by increasing the quality of the supervision system, and motor development is one of the important monitoring dimensions.

After the Outline of Chinese Education Reform and Development printed by the State Council and the Central Committee of the Communist Party of China in 1993 and the National Working Conference held in 1994, the concept of "comprehensively improving the quality of education" was put forward as the focus of China's reform. Since the establishment of the Basic Education Quality Monitoring Center of the Ministry of Education in 2007, the research on education quality has gradually attracted wide attention from the society, and improving the measurement of education quality has also become an important focus of education reform. After 2010, the development of preschool education has mainly been the concern of the Chinese Government, which has issued various documents to actively establish a unified national system for preschool education quality monitoring. In 2017, the State Council's Opinions on Deepening the Reform of Educational, Physical and Mechanical Quality further proposed the establishment of a preschool education quality monitoring and evaluation system covering the range from older to younger children to provide a scientific basis for improving the science of preschool education (Li & Zhang, 2020).

As the importance of preschool education quality becomes more and more prominent, the requirements for measurement tools are higher and higher. In the current national preschool quality monitoring and evaluation system, there are also some problems: (1) the assessment index is too general, the coverage is not wide, (2) the content of operational assessment tools is not strong, (3) the generality of children's development assessment tools is weak or there is an overall lack of preschool education quality monitoring standard and convenient tool. At present, the monitoring of preschool education institutions in China is mainly reflected in the classification and acceptance degree of kindergartens in various provinces and cities. However, due to the short assessment time and less content, the assessment task is not easy. It is difficult to put forward practical guidance and rectification suggestions for kindergartens. The purpose of the evaluation is to determine the grade and choose the best option. This kind of "label" evaluation emphasises "proof" and is a solid quality assessment method. Dynamic education quality cannot be tracked effectively, weakening the role of evaluation in diagnosis, guidance and quality improvement (Huan & Jing, 2020).

Nowadays, many developed countries have established a complete and unified preschool quality monitoring system. Countries all over the world have adopted various ways to improve the quality of their preschool education, for example, by implementing preschool education quality monitoring. China is still relatively weak in this respect. Improving the quality of education is a common trend in all countries and an inevitable requirement for China to accelerate the establishment of a complete preschool education quality monitoring system (Huijuan & Yifang, 2019).

Because preschool quality monitoring is a work carried out regularly across the country and covers many fields, the long test time is not conducive to large-scale promotion. Therefore, the indicators should be simple and feasible, the selected basic motor skills should be representative, and the test time should be short so as to implement more easily the monitoring system for the gross motor development of preschool children in all regions of the country. At present, there is no recognised tool for testing children's gross motor development in China. There are many TGMD items commonly used in motor development research field, and the test takes a long time. More precisely, it takes 15 to 20 minutes for each child to complete the 12 motor tests. If TGMD indices can be simplified and screened, not only can test time be effectively shortened, but test efficiency can also be improved. Especially in China, a country with a large population base, the TGMD index simplification and screening can lead to promote large-scale testing and provide reference for subsequent quality monitoring work.

Methodology

Participants

Study participants were children aged 3-6 years from a Beijing kindergarten, including the primary class, middle class, small class, baby class, etc. Their total number was 140 (90 boys and 50 girls) (Table 1) and reserved data (obtained from testing another 150 children) were also used (Table 2). Parental consent was obtained and informed consent was signed before the test.

Table 1. *Test sample*

	Number	3 Y	4 Y	5 Y	6 Y
Boys	90	19	26	27	18
Girls	50	12	22	16	0
Total	140	31	48	43	18

Note: Y indicates years old.

Table 2. *Reserved sample*

	Number	3 Y	4 Y	5 Y	6 Y
Boys	80	11	36	27	3
Girls	70	8	30	23	12
Total	150	19	66	50	15

Note: Y indicates years old.

Instruments

The Test of Gross Motor Development (TGMD) was used to test and score childrens' gross motor development levels, comprising two subsets: Locomotor and Object Control, which assess different aspects of gross motor development.

The Locomotor subtest measures gross motor skills that require body coordination while moving in one direction or another and include: Run, Gallop, Hop, Leap, Horizontal Jump and Slide.

The Object Control subtest measures gross motor skills that demonstrate efficient throwing, striking and catching movements and include: Striking a Stationary Ball, Stationary Dribble, Catch, Kick, Overhand Throw and Underhand Roll. (Ulrich, 2000)

Results

First, descriptive statistics were performed for the scores of participants, followed by the preliminary screening of indicators according to the Pearson coefficient, discrimination and difficulty coefficient, and finally all indicators were entered into the stepwise regression equation to obtain the formula with a higher degree of fitting. A consistency test was then conducted to observe the effectiveness of screened indicators.

Descriptive statistics for TGMD-2

The scores achieved by participants are shown in Table 3 and Table 4.

Table 3. *Locomotion score*

	Number	Run	Horizontal Jump	Hop	Leap	Gallop	Slide
Boys	90	4.74±1.32	6.82±1.48	6.00±3.60	5.38±1.05	5.06±1.06	6.76±1.83
Girls	50	4.59±0.66	6.42±1.49	5.40±3.45	4.68±1.31	4.86±2.06	6.38±2.22
Total	140	4.69±1.14	6.69±1.49	5.79±3.55	5.13±1.19	4.99±2.12	6.64±1.97

Table 4. *Object Control score*

	Number	Stationary Dribble	Kick	Catch	Striking a Stationary Ball	Overhand Throw	Underhand Roll
Boys	90	4.40±2.77	6.30±1.37	3.64±1.85	6.19±2.93	4.66±2.53	4.75±2.75
Girls	50	3.16±2.77	5.20±1.86	3.64±1.30	5.14±2.56	4.02±2.43	3.72±2.09
Total	140	3.97±2.82	5.92±1.64	3.64±1.68	5.83±2.84	4.44±2.51	4.39±2.19

Preliminary discrimination of simple indicators

- Analysis of age and gender difference in motor skill scores

Multivariate analysis of variance was used to analyse age and gender differences in motor skill scores to observe whether there are interaction effects (Table 5).

Table 5. *Age and gender differences*

Skill	Gender (sig)	Age (sig)	Gender* Age (sig)
Run	0.173	0.000	0.421
Horizontal Jump	0.630	0.016	0.084
Hop	0.755	0.000	0.681
Leap	0.001	0.178	0.278
Gallop	0.708	0.043	**0.022**
Slide	0.388	0.000	0.695
Stationary Dribble	0.181	0.000	0.069
Kick	0.000	0.000	0.266
Catch	0.478	0.005	0.267

Striking a Stationary Ball	0.089	0.000	0.523
Overhand Throw	0.520	0.001	0.080
Underhand Roll	0.180	0.001	0.835
Total	0.038	0.000	0.468

According to Table 5, the interaction between gender and age was greater than 0.05 in all items, except the forward Slide item where gender and age had an interaction. The age factor had no effect on the Leap, but its effect on other items was significant, indicating that the level of scores was related to increasing age, therefore the development level of children aged 3-6 varies with age in most test items. The gender factor had an effect only on the Leap and Kick.

Therefore, taking into account age factors, preliminary screening can only help to eliminate Leap; as for the rest of the project, subsequent filter action involving gender differences in jumping and playing action or gender interaction with age in the Slide movement may consider standard test evaluation. Given the simple and feasible requirements of the test indicators in the research objective, these indicators may need to be avoided in subsequent screening.

- Correlation analysis

The Pearson coefficient was adopted to conduct a bivariate analysis of the correlation between the scores of each item and total score (Table 6).

Table 6. *Pearson correlation between the scores of different movements and total score*

Skill	Pearson
Run	0.417
Horizontal Jump	0.483
Hop	*0.773*
Leap	0.253
Gallop	0.464
Slide	*0.559*
Stationary Dribble	*0.630*
Kick	*0.638*
Catch	0.478
Striking a Stationary Ball	*0.606*
Overhand Throw	*0.599*
Underhand Roll	*0.512*

Data in Table 6 show that the single score index associated with the total score is significant, the correlation coefficient is greater than 0.5, and moderately related action items include Hop, Kick, Stationary Dribble, Slide, Striking a Stationary Ball, Underhand Roll and Overhand Throw. The project grading correlation coefficient is 0.77, which is close to highly correlated.

- Discrimination

D was used to reflect movement discrimination at each age [D = (average score of high group - average score of low group)/full score of movements], where the top 27% and the bottom 27% of all tested children were selected for the high group and low group, and the discrimination D > 0.4 was the best (Table 7).

Table 7. *Skill discrimination*

Skill	D
Run	0.40
Horizontal Jump	0.53
Hop	*0.88*
Leap	0.42
Gallop	*0.60*
Slide	0.49
Stationary Dribble	*0.86*
Kick	0.48
Catch	0.51
Striking a Stationary Ball	*0.69*
Overhand Throw	*0.77*
Underhand Roll	*0.67*

Note: D indicates discrimination.

All data in Table 7 show that the degree of discrimination of 0.4 and above in children aged 3-6 years is good, with 0.6 above the level of projects for Hop, Stationary Dribble, Overhand Throw, Striking a Stationary Ball, Underhand Roll and Gallop, with more than 0.8 in the case of the first two (Hop and Stationary Dribble).

- Difficulty coefficient

The difficulty coefficient L reflects the difficulty of an action (L = average score of a single action/total score of a single action × 100%), being moderate when it ranges from 15% to 85% (Table 8).

Table 8. *Skill difficulty coefficient*

Skill	Total score	L
Run	8	83.50%
Horizontal Jump	8	59.40%
Hop	10	57.90%
Leap	6	85.50%
Gallop	8	62.40%
Slide	8	83.00%
Stationary Dribble	8	50.00%
Kick	8	74.00%
Catch	6	60.70%
Striking a Stationary Ball	10	58.20%
Overhand Throw	8	55.50%
Underhand Roll	8	54.90%

Note: L indicates the difficulty coefficient.

In general, if the purpose of a test is to effectively distinguish between different skill levels, the average difficulty of the project should be about 0.50. It can be seen from the above table data that the movements with moderate difficulty coefficient (close to 50%) are: Stationary Dribble, Underhand Roll, Overhand Throw, Hop and Striking a Stationary Ball, of which Stationary Dribble is 50%. To sum up, in the process of screening test indicators, we preliminarily excluded the movement items with a main gender effect, followed by the correlation coefficient between each movement and the total score, the degree of movement discrimination, and finally the difficulty coefficient of each movement. Five indicators with good performance in several aspects were selected by comprehensive factors: Hop, Stationary Dribble, Overhand Throw, Underhand Roll and Striking a Stationary Ball (Table 9).

Table 9. *Preliminary screening of indicators*

Skill	Age (sig)	Gender (sig)	Pearson	D	L
Hop	0.000	0.173	0.773	0.88	57.90%
Overhand Throw	0.001	0.520	0.599	0.77	55.50%
Stationary Dribble	0.000	0.181	0.630	0.86	50.00%
Underhand Roll	0.001	0.180	0.512	0.67	54.90%
Striking a Stationary Ball	0.000	0.089	0.606	0.69	58.20%

Establishing the total score prediction model and determining simple indicators

All test indicators were taken as independent variables, and the total score, as a dependent variable. The regression equation was obtained by means of stepwise regression analysis. The regression analysis results are shown in Table 10.

Table 10. *Model summary*

Model	R	R-Square	Adjusted R-Square	Std. Error of the Estimate
1	.773[a]	.597	.594	9.54430
2	.853[b]	.727	.723	7.88487
3	.897[c]	.804	.800	6.70427
4	.928[d]	.862	.857	5.65462
5	.944[e]	.890	.886	5.05105
6	.956[f]	.914	.911	4.47735
7	.966[g]	.933	.930	3.96826
8	.973[h]	.947	.943	3.56183
9	.979[i]	.958	.955	3.18708
10	.982[j]	.965	.962	2.91938
11	.984[k]	.969	.967	2.74111
12	.987[l]	.974	.972	2.50838

Note:
a. Predictors: (Constant), Hop
b. Predictors: (Constant), Hop, Striking a Stationary Ball
c. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble
d. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble, Gallop
e. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble, Gallop, Catch
f. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble, Gallop, Catch, Slide
g. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble, Gallop, Catch, Slide Overhand Throw
h. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble, Gallop, Catch, Slide, Overhand Throw, Kick
i. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble, Gallop, Catch, Slide, Overhand Throw, Kick, Horizontal Jump
j. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble, Gallop, Catch, Slide, Overhand Throw, Kick Horizontal Jump, Leap
k. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble, Gallop, Catch, Slide, Overhand Throw, Kick, Horizontal Jump, Leap, Run
l. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble, Gallop, Catch, Slide, Overhand Throw, Kick, Horizontal Jump, Leap, Run, Underhand Roll

As can be seen in Table 10, twelve models were established with the scores of all indicators as independent variables. The complex correlation coefficients (R) of the twelve models are all higher than 0.77, indicating that these independent variables or the combination of independent variables can explain the dependent variables to a large extent, which is relatively satisfactory. The goodness of fit (R2) of the twelve models is also relatively high, namely above 0.59, indicating that the goodness of fit adjusted to the sample data is relatively high, therefore the models are of significance for prediction. With the introduction of more variables, the complex correlation coefficient, goodness of fit and adjusted goodness of fit of the model increased gradually, but the range of growth decreased gradually.

Table 11. *Results of ANOVA*

	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	18608.067	1	18608.067	204.274	.000a
	Residual	12570.926	138	91.094		
	Total	31178.993	139			
2	Regression	22661.546	2	11330.773	182.251	.000b
	Residual	8517.447	137	62.171		
	Total	31178.993	139			
3	Regression	25066.170	3	8355.390	185.893	.000c
	Residual	6112.823	136	44.947		
	Total	31178.993	139			

Note:
a. Predictors: (Constant), Hop
b. Predictors: (Constant), Hop, Striking a Stationary Ball
c. Predictors: (Constant), Hop, Striking a Stationary Ball, Stationary Dribble
e. dependent variable: Total Score

As can be seen in Table 11, Sig values (P values) of the four models are all 0.000, therefore less than 0.05, suggesting that there is a linear relationship between the total score of the dependent variable and the independent variable or the combination of independent variables.

Table 12. *Total score – Regression equation parameters*

		Unstandardized Coefficients		Standardized Coefficients		
	Model	B	Std. Error	Beta	t	Sig.
1	(constant)	43.634	1.547		28.199	.000
	Hop	3.250	.227	.773	14.292	.000
2	(constant)	34.614	1.698		20.388	.000
	Hop	2.691	.200	.640	13.440	.000
	Striking a Stationary Ball	2.069	.256	.384	8.075	.000
3	(constant)	32.405	1.475		21.973	.000
	Hop	2.210	.182	.525	12.111	.000
	Striking a Stationary Ball	1.800	.221	.334	8.143	.000
	Stationary Dribble	1.647	.225	.311	7.314	.000

Note: a. dependent variable: Total Score

As can be seen in Table 12, the regression coefficients corresponding to each variable in the three equations are highly significant when the significance level is 0.05. The formulas of the three established regression models are as follows:

Model 1: TGMD-2 total score = 43.634 + 3.250* Hop score

Model 2: TGMD-2 total score = 34.614 + 2.691* Hop score + 2.069* Striking a Stationary Ball score

Model 3: TGMD-2 total score = 32.405 + 2.210* Hop score + 1.800* Striking a Stationary Ball score + 1.647* Stationary Dribble score

Total score prediction and total score for the consistency test

To verify the effect of the prediction equation, the TGMD-2 test was conducted on another (reserved) sample. The intra-class correlation coefficient (ICC) was used to test the consistency between the total score predicted by the model and the total score obtained from the actual test. The ICC test can analyse the consistency of multiple quantitative or categorical data. Single measures are mainly for raw data, while average measures are mainly for calculated data. The adopted ICC model indicates mixed/random bidirectional absolute consistency (considering errors for the calculated data). The results are shown in Table 13, Table 14 and Table 15.

Table 13. *ICC Model 1*

Mixed/Random bidirectional absolute consistency	ICC	95% CI (LL)	95% CI (UL)
single measurement ICC (A, 1)	0.676	0.494	0.801
average measurement ICC (A, K)	0.806	0.662	0.890

Note: A indicates absolute consistency, 1 indicates single measurement, K indicates average measurement.

Table 14. *ICC Model 2*

Mixed/Random bidirectional absolute consistency	ICC	95% CI (LL)	95% CI (UL)
single measurement ICC (A, 1)	0.314	0.078	0.527
average measurement ICC (A, K)	0.478	0.145	0.690

Note: A indicates absolute consistency, 1 indicates single measurement, K indicates average measurement.

Table 15. *ICC Model 3*

Mixed/Random bidirectional absolute consistency	ICC	95% CI (LL)	95% CI (UL)
single measurement ICC (A, 1)	0.503	0.286	0.676
average measurement ICC (A, K)	0.669	0.445	0.807

Note: A indicates absolute consistency, 1 indicates single measurement, K indicates average measurement.

By comparing the ICC of the average measurement in the above tables, the intra-class correlation coefficient of Model 1 is the highest (0.806), indicating that the total score predicted by Model 1 has a strong consistency with the actual total score, followed by Model 3.

Conclusion

This paper studies and analyses the TGMD-2 results and draws the following conclusions:

Hop is mainly recommended for the selected movements, and the alternative or reference indices are Striking a Stationary Ball and Stationary Dribble. There is no significant gender difference between children aged 3-6 years for these three movements where the difficulty is moderate, the degree of discrimination is good, and the total score can be predicted well. The screened indicators can be used for large-scale preschool quality monitoring, which is simple and easy to achieve. According to the actual situation, one or two of the three indicators can be selected for testing.

Children's gross motor development ability improves with age. In this study, except the forward Jump, their motor development level improves significantly with age from 3 to 6 years.

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