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Development Characteristics of Fundamental Motor Skills of Children Aged 7-10 Years in Nanning

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Abstract

Objective: To study the development characteristics of fundamental motor skills of children aged 7 to 10 years in Nanning, Guangxi Zhuang Autonomous Region, and to provide reference for promoting the healthy development of children's sports. **Methods:** A total of 1040 children aged 7 to 10 years were selected from three primary schools in Nanning by random cluster sampling method. Two-way ANOVA was used to compare differences in basic motor skill scores among children of different genders and ages. **Results:** There was no significant interaction effect of gender multiply by age on the development of fundamental motor skills in children aged 7 to 10 ($P>0.05$). There was a significant main effect of age ($P<0.001$) on the total score of fundamental motor skills, total locomotor, ball skills and 13 sub-items, which showed an upward trend with age. Except for run and slide, the other 11 sub-items showed significant gender main effects ($P<0.05$). **Conclusion:** The development level of fundamental motor skills of children aged 7 to 10 years showed an upward trend with age. The effect size of age on the development of children's fundamental motor skills reached a medium and high level, while the effect size of gender on the development of children's fundamental motor skills was only low to medium level.

Keywords:

Nanning city of Guangxi Zhuang Autonomous Region, 7 to 10 years old children, gross motor, developmental characteristics



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Introduction

Children's fundamental motor skills belong to the category of human motor development. Human motor development is a complex process that spans the whole life cycle. It is an integral part of individual development and constitutes the overall development of an individual along with cognitive, emotional, social and physical development^[1]. Children's fundamental motor skills are the basic motor behavior patterns that can be observed during childhood, including the most basic walking, running, jumping and throwing^[1]. A good level of basic motor skill development can not only improve children's physical health^[2], and reduce children's static prescreen behavior^[3], prevention of obesity^[4], children's sensory and perceptual abilities^[5], coordination ability^[6], physical activity ability^[7], social interaction skills^[8] have a positive effect.

In the model of human motor development, primary school is the period when children have the greatest development potential and proficiency^[9] if the gaps in the development of children's fundamental motor skills during this critical period are not identified and remedied, it may lead to defects and deficiencies in fundamental motor skills and other areas of development^[10]. However, the current research on the development of fundamental motor skills of primary school students in Nanning, Guangxi Zhuang Autonomous Region is mostly based on the research results of the physical dimension of physical health, and there is a lack of research on the process, characteristics and age rules of children's fundamental motor skills development. Although there is a correlation between the two, there are essential differences. Based on this, this study aims to analyze the development characteristics of fundamental motor skills of children aged 7-10 years, so as to provide a reference for promoting the development of children's fundamental motor skills.

Methods

Participant

From September to November 2021, using the random cluster sampling method, a total of 1061 children aged 7-10 years were selected from eight primary schools in Nanning City to participate in the study, including 576 boys and 485 girls. The age groups were: 7-8 years old group, 8-9 years old group and 9-10 years old group. The inclusion criteria were: 1) normal physical development and no organic disease; 2) able to cooperate in completing the basic motor skills test; 3) both the subject children and their guardians signed and submitted informed consent.

Population & Sample

During the test, some of the test scores of 21 subjects were invalid due to personal reasons, and 1040 valid samples were finally retained, with an effective rate of 98% (Table 1).

Table 1 Basic information of research subjects (N=1040)

Group (age)	male	female	Total
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7~8	173	145	318
8~9	196	168	364
9~10	196	162	358
Total	565	475	1040

Instrument and Procedure

The Test of Gross Motor Development-3 (TGMD-3), newly revised by Dr. Ulrich, University of Michigan, USA, was used to test children's mobility and operant motor skills^[11], the scale has been proved to have good reliability and validity by many domestic scholars^[12-13]It can be used as a tool to assess the development of fundamental motor skills in Chinese children aged 3-12 years. The mobility skills included 6 movements including Run, Gallop, Hop, Skip, Horizontal Jump, Sliding. And the operational skills included 7 movements including Two-hand strike, One-hand strike, Dribble, Catch, Kick, Underhand throw, Overhand throw, with 13 movements in total.

All the testers learned TGMD-3 test manual and watched related test videos. Before the formal test, the tester correctly demonstrated the actions, and the subjects practiced once before the test. Video cameras were used to record the whole process of the test, and scores were made according to the results of the video. Each action has 3 to 5 different scoring criteria, formal test twice, meet a standard to get 1 point. The score of mobile motor skills ranged from 0 to 46, and the score of operant motor skills ranged from 0 to 54. The total score of all movements ranged from 0 to 100. The higher the score, the higher the level of fundamental motor skills^[11].Basic motor skill mastery scoring rules commonly used internationally were used^[14]1) Mastery refers to the correct performance of all criteria in two tests;2) Proficient, meaning that only one standard was not performed correctly in two tests;3) Unskilled, which means that two or more criteria were not performed correctly in two tests.

Data Analysis

SPSS26.0 was used for statistical analysis of the test data. All parameters were in line with normal distribution. The mean \pm standard deviation ($M \pm SD$) was used for descriptive statistics of the test scores of fundamental motor skills. A two-way ANOVA of 2 (gender: male/female) \times 3 (age: 7-8 years / 8-9 years / 9-10 years) was used to compare the differences in the scores of fundamental motor skills among children of different genders and ages. Bonferroni post hoc test was used to identify specific significant differences among age groups. The effect size of the experiment can reflect the effect size of the independent variable, and the effect size (η_p^2)The larger the effect size, the greater the influence of the independent variable on the dependent variable. The partial eta squared values of 0.01, 0.06 and 0.14 (η_p^2) represent small, medium and large effect sizes, respectively ^[15]. The significance criterion is $\alpha=0.05$.



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Result

1 Overall development of children's fundamental motor skills

Two-way ANOVA of 2 (gender: male/female) × 3 (age: 7-8 years / 8-9 years / 9-10 years) was used to compare the total scores of mobile motor skills, operant motor skills and fundamental motor skills among children of different genders and ages. The results showed that the total scores of mobile motor skills, operant motor skills and fundamental motor skills increased with age. There was no gender × age interaction effect in the three total scores ($P > 0.05, \eta_p^2 = 0.00$). As shown in figure 1.

There was no significant gender main effect on the total score of mobility motor skills ($P > 0.05, \eta_p^2 = 0.00$). The score of mobility motor skills of boys aged 7-8 years was higher than that of girls, and the score of mobility motor skills of girls aged 8-9 years was higher than that of boys. The total score of operant motor skills ($P < 0.001, \eta_p^2 = 0.13$) and the total score of fundamental motor skills ($P < 0.001, \eta_p^2 = 0.06$) showed a very significant gender main effect, and boys were higher than girls in the three age groups. The effect size of gender on the total score of operant motor skills and the total score of fundamental motor skills reached a medium level.

The total score of mobile motor skills ($P < 0.001, \eta_p^2 = 0.15$) and the total score of operant motor skills ($P < 0.001, \eta_p^2 = 0.16$) and the total score of fundamental motor skills ($P < 0.001, \eta_p^2 = 0.24$) showed a very significant main effect of age, and age had a large effect size on the total scores of the three tests. Bonferroni post hoc test found that the three total scores showed a linear upward trend, and the 7-8 years old group was significantly smaller than the 8-9 years old group and the 9-10 years old group. The scores in the 8-9 years old group were significantly lower than those in the 9-10 years old group.

In order to further understand the overall development of fundamental motor skills of children aged 7-10 years, the percentage of proficiency in each subitem of fundamental motor skills of 1040 children was measured. As shown in Figure 2, the proportion of children achieving proficiency in each individual basic motor skill ranged from 0.4% to 34.1%. The proportion of children reaching the proficiency level ranged from 7.1% to 52.1%; The proportion of children in the unskilled grade ranged from 16% to 92.5%. From the statistical results, it can be seen that the proportion of children in the unskilled level of single fundamental motor skills is high, the mastery level of each movement is uneven, and the overall situation of children's fundamental motor skills is at a low level. For 7-10 years old children, the most easy movement to master is dribble, and the proportion of proficient and skilled children accounted for 84%. The two most difficult movements to master were two-hand strike and one-hand strike, with 92.5% and 80.7% of the children being unskilled, respectively.

The fundamental motor skills of children of all ages were as follows: children aged 7-8 years had a good command of four movements: catch, dribble, side and run, and the proportions of proficient and skilled were 81.1%, 78%, 68.5%

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and 62.4%, respectively. Two-handed swinging to hit the fixed ball and one-handed swinging to hit the rebound ball were the two most difficult movements for children aged 7-8 years, and the proportion of proficient was less than 1%, while the proportion of unskilled in the remaining seven movements was more than 50%. Compared with the 7-8 year old group, the 8-9 year old group showed significant improvement in the movements of side sliding, running, underhand throwing and overhand throw, with the proportion of proficient and proficient children being 88.4%, 76.9%, 49.2% and 35.5%, respectively. Compared with the 8-9 years old group, the children aged 9-10 years improved significantly in the five movements of running, underhand throwing, fixed kick, one-foot jump and one-hand swing hitting the rebound ball, and the proportion of proficient and skilled children were 86.6%, 67%, 64.5%, 54.2% and 28.8%, respectively.

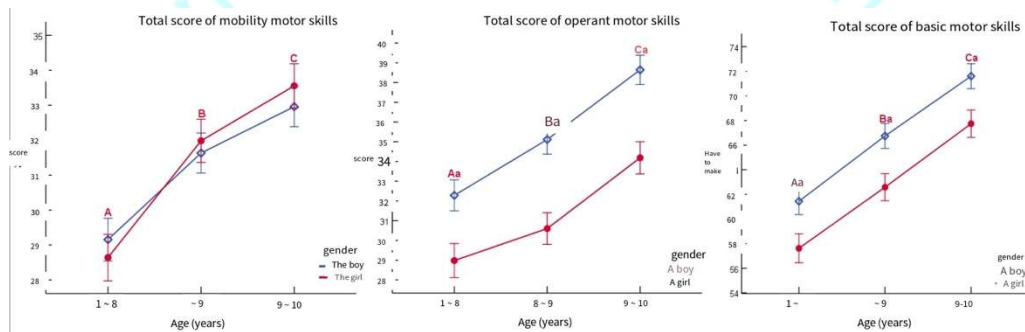


Figure 1 Total scores of mobile motor skills, operant motor skills and fundamental motor skills of children aged 7-10 years with different genders and ages (Different uppercase letters "A/B/C" indicate significant differences between age groups, and lowercase letters "A" indicate significant gender differences in the same age group)

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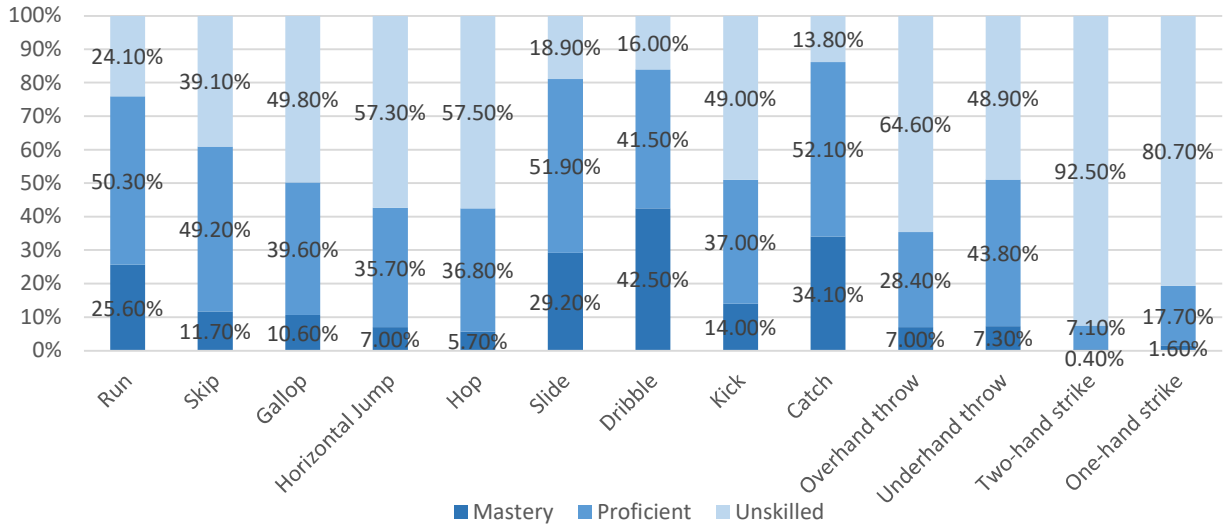


Figure 2. Percentages of fundamental motor skills development proficiency of children aged 7-10 years

2 Development of children's mobility motor skills

Two-way ANOVA of 2 (gender: male/female) × 3 (age: 7-8 years / 8-9 years / 9-10 years) was used to compare the differences between the scores of children's mobility motor skills of different genders and ages. The results showed that no interaction effect of gender × age was found in the six movements ($P > 0.05$). There were significant gender main effects in jumping, forward sliding, standing long jump and single hop, among which girls were more likely to jump and forward sliding than boys ($P < 0.001$), and boys were more likely to stand long jump and single hop than girls ($P < 0.05$). The main effect of age was significant for all the 6 activities ($P < 0.001$). With the increase of age, the scores of running, jumping, forward sliding, standing long jump, single jump and side sliding of children aged 7-10 years increased significantly. Bonferroni's post hoc test showed that only standing long jump showed significant differences among the three age groups, single jump did not show significant differences between 7-8 years old and 8-9 years old, and the other four movements did not show significant differences between 8-9 years old and 9-10 years old. As shown in Table 2, from the level of effect size, gender and age had a low level and a medium to high level of explanation for the score of the mobility motor skills sub-item, respectively.



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Project	Gender	Age			Total	Gender		Age		post hoc test
		7~<8	8~<9	9~<10		P	η_p^2	P	η_p^2	
Run*	Male	5.70±1.52	6.47±1.47	6.60±1.23	6.28±1.46					
	Female	5.84±1.42	6.29±1.34	6.31±1.08	6.16±1.30	0.202	0.00	<	0.05	⑦< ⑧⑨
	Total	5.76±1.48	6.39±1.41	6.47±1.17	6.23±1.39					
Skip△	Male	3.16±1.24	3.46±1.40	3.57±1.39	3.41±1.36					
	Female	3.28±1.40	3.95±1.42	4.20±1.19	3.83±1.39	<	0.02	<	0.04	⑦< ⑧⑨
	Total	3.21±1.31	3.69±1.43	3.86±1.34	3.60±1.39	0.001		0.001		
Gallop*	Male	4.60±1.83	5.08±1.76	5.26±1.61	4.99±1.75					
	Female	4.93±1.78	5.45±1.64	5.48±1.62	5.30±1.70	<	0.01	<	0.02	⑦< ⑧⑨
	Total	4.75±1.81	5.25±1.71	5.35±1.61	5.13±1.73	0.001		0.001		
Horizontal Jump*	Male	4.79±1.59	5.18±1.34	5.52±1.43	5.18±1.48					
	Female	4.56±1.49	5.04±1.42	5.34±1.50	4.99±1.50	<	0.00	<	0.04	⑦< ⑧⑨
	Total	4.68±1.55	5.12±1.38	5.44±1.46	5.09±1.49	0.05		0.001		
Hop*	Male	4.84±1.60	4.90±1.68	5.38±1.58	5.05±1.64					
	Female	4.21±1.41	4.62±1.67	5.20±1.71	4.69±1.66	<	0.01	<	0.04	⑦< ⑧⑨
	Total	4.55±1.55	4.77±1.68	5.30±1.64	4.89±1.66	0.001		0.001		
slide*	Male	6.07±1.34	6.54±1.28	6.63±1.24	6.43±1.31					
	Female	5.83±1.51	6.63±1.24	7.02±1.16	6.52±1.39	0.323	0.00	<	0.07	⑦< ⑧⑨
	Total	5.96±1.42	6.58±1.26	6.81±1.22	6.47±1.35			0.001		

Table 2 Two-way ANOVA analysis of the effects of gender and age on the development level of mobility motor skills (* Full score is 8, △ full score is 6; ⑦, ⑧, and ⑨ represent ages 7 to < 8, 8 to < 9, and 9 to < 10, respectively.)

3 Development of operant motor skills in children

2 (sex) x 3 (age) two-factor variance analysis, compare the different gender and age of children score differences between the operational movement skills, the results found that seven action has not been found that the interaction effect of sex by age ($P > 0.05$), but seven are the significant gender and age of main effect ($P < 0.001$), the boys better than girls. With the increase of age, the scores of dribble, kicking the fixed ball, catching the ball with both hands, throwing the ball over the shoulder, throwing the ball with the hands, swinging the fixed ball with both hands and hitting the rebound ball with the swing of one hand all increased significantly. The post hoc test showed that there was no significant difference in the scores of place dribbling and foot kicking between the ages of 7-8 years and 8-9 years, and there was no significant difference in the scores of overhand throw between the ages of 7-8 years and 8-9 years, while there were significant differences in the scores of the other four skills in all three ages. As shown in Table 3, from the level of effect size,



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gender and age had a medium-low and medium-high level of explanation for the scores of the operant motor skills subitems, respectively.





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Project	Gender	Age				Gender		Age		post hoc test
		7~<8	8~<9	9~<10	Total	P	η_p^2	P	η_p^2	
Dribble Δ	Male	4.88±1.28	4.99±1.20	5.28±1.04	5.06±1.18	<	0.06	<	0.05	⑦<
	Female	4.05±1.50	4.31±1.44	4.84±1.26	4.41±1.44					⑨
	Total	4.50±1.44	4.68±1.36	5.08±1.16	4.76±1.34					0.001
Kick*	Male	5.24±1.43	5.48±1.60	6.19±1.50	5.66±1.56	<	0.05	<	0.04	⑦<
	Female	4.63±1.58	4.85±1.75	5.29±1.85	4.93±1.75					⑨
	Total	4.97±1.53	5.19±1.70	5.78±1.72	5.33±1.69					0.001
Catch Δ	Male	4.59±1.06	4.80±1.21	5.17±0.98	4.86±1.11	<	0.02	<	0.04	⑦<
	Female	4.19±1.44	4.52±1.27	4.88±1.22	4.54±1.33					⑧⑨
	Total	4.41±1.26	4.67±1.25	5.04±1.10	4.72±1.23					0.001
Overhand throw*	Male	4.35±1.76	5.11±1.58	5.23±1.69	4.92±1.71	<	0.06	<	0.03	⑦<
	Female	3.82±1.88	3.90±1.66	4.38±1.79	4.04±1.79					⑧⑨
	Total	4.11±1.84	4.55±1.72	4.85±1.78	4.52±1.80					0.001
Underhand throw*	Male	4.86±1.63	5.34±1.31	5.99±1.29	5.42±1.48	<	0.02	<	0.08	⑦<
	Female	4.53±1.78	5.05±1.34	5.51±1.21	5.05±1.50					⑧⑨
	Total	4.71±1.71	5.21±1.33	5.77±1.27	5.25±1.50					0.001
Two-hand strike#	Male	4.86±1.68	5.33±1.39	6.03±1.40	5.43±1.56	<	0.03	<	0.08	⑦<
	Female	4.65±1.31	4.72±1.17	5.41±1.36	4.93±1.33					⑧⑨
	Total	4.76±1.52	5.05±1.33	5.75±1.42	5.20±1.48					0.001
One-hand strike *	Male	3.50±1.59	4.05±1.42	4.76±1.41	4.13±1.55	<	0.05	<	0.07	⑦<
	Female	3.10±1.45	3.26±1.63	3.87±1.57	3.42±1.59					⑧⑨
	Total	3.32±1.54	3.68±1.57	4.35±1.55	3.80±1.61					0.001

Table 3 Two-way analysis of variance of gender and age on the level of operant motor skills development (# marks out of 10, * marks out of 8, Δ marks out of 6; ⑦, ⑧, and ⑨ represent ages 7 to < 8, 8 to < 9, and 9 to < 10, respectively.)

Discussion

The results of this study showed that there was a significant gender difference in the total score of fundamental motor skills of children aged 7-10 years, and boys were higher than girls in the three age groups. In mobility movement skills, although before hopping, slide, standing long jump and hop appeared significant



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gender main effect, but not into mobility movement skill score significant gender differences, and Ma jing, DiaoYuCui, Behan, Odelia experts at home and abroad on children mobility characteristic findings consistent with motor skill development^[16-19]. In the total score of operant movements, Yuan Xin, Bolger, Wu Hua, Chelsey and other scholars^[20-23] the results of this study were consistent with those of previous studies. Boys were significantly higher than girls in three age groups, and there were significant gender differences in seven movements. Boys were better than girls in operant motor skills.

Although there was no significant difference between boys and girls in terms of mobility motor skills, boys' performance was better than girls' at the early age of 7 to 8 years, and girls' performance was better than boys' after 8 to 9 years. Ma Liang found in his research on the development of children's motor ability that the score of 7-8 year-old boys was higher than that of girls in mobile motor skills^[16] And Guo Jiajun et al. found that the score of mobility motor skills of 8-9 year-old girls began to be higher than that of boys in their research on children's fundamental motor skills.^[24] Similar to the results of this study, it can be seen that 7-9 years old is a sensitive period for the development of girls' mobility skills. The reason is that the growth spurt period of girls is two to three years earlier than that of boys. Therefore, the growth rate of boys and girls will transition from the same development level to the growth rate of girls is higher than that of boys, and finally the growth rate of boys is higher than that of girls. However, although the physical growth level of boys and girls fluctuates before puberty, there is no significant difference on the whole. The larger difference may occur when girls enter puberty, which needs to be confirmed by later experimental studies.

Gender differences in the development of children's fundamental motor skills have always been the focus of research in the field of child motor development. Bardid^[25] in a test of fundamental motor skills in Belgian children, boys and girls scored similarly in mobile motor skills, while boys scored higher in operant motor skills; Spessato^[26] the Basic motor State study of Brazilian boys and girls also found no gender differences in mobility motor skills, while boys showed superior scores for operant motor skills and fundamental motor skills. In contrast, LeGear^[27] found greater mobility motor skills in girls and greater operant motor skills in boys; Hardy^[28] also found that girls had higher scores on fundamental motor skills tests than boys; And Robinson^[29] found that boys are better at mobile motor skills. Many studies on the development of fundamental motor skills in children show that boys perform better than girls in operant motor skills, but there is no consensus on the gender difference in the development of mobile motor skills. For the explanation of the sex difference, Barnett^[30] in a systematic review of children's fundamental motor skills, gender was strongly correlated with operant motor skills, but not with stability or mobility motor skills, which is consistent with the effect size of gender on the development of mobility motor skills. Because motor development in early childhood is mainly influenced by biological factors, physical characteristics, such as body composition, morphology, and function, are very



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similar between boys and girls. Therefore, the differences may be largely influenced by social and environmental factors. Children are constantly learning gender roles from parents, peers, teachers, and the surrounding environment from birth to participate in gender-conforming sports. Therefore, boys are more likely to participate in collective and competitive ball games in their daily activities, while girls are more likely to participate in cooperation and play activities, and have fewer opportunities to contact and develop operant motor skills.

There were significant age differences in the total score of fundamental motor skills, total score of mobility motor skills, total score of operant motor skills and 13 subitems of children aged 7-10 years, which showed an increasing trend with the increase of age, which was in line with the general law of children's motor development. The results showed that children aged 7-10 years had better command of the movements of dribble, catching the ball with both hands and sliding. Two-handed swinging to hit the fixed ball and one-handed swinging to hit the rebound ball were the most difficult movements for 7-10 years old children to master. Jumping on one foot, throwing the ball over the shoulder and throwing the ball under the hand were also more difficult for children aged 7-10 years. In the post-hoc test of age characteristics of 13 sub-items, it was also found that standing long jump, two-handed catch, underhand throw, two-handed swing hitting the fixed ball and one-handed swing hitting the rebound ball showed significant progress in the three age stages. However, there was no significant improvement in running, jumping, front sliding, side sliding and overhand throw between the 8-9 and 9-10 age groups. There was no significant improvement in jumping, dribble, and kicking a fixed ball between the 7-8 and 8-9 years old groups. Duncan^[31] analysis of fundamental motor skills proficiency of British children from 6 to 9 showed that there were significant age differences in the total scores of fundamental motor skills, mobility motor skills and operant motor skills, and the motor proficiency of the subjects was low. Behan^[18] study of children aged 5 to 12 in Ireland also found consistent results with Wu.^[22] There was no significant age difference in the total scores of fundamental motor skills, mobility motor skills and operant motor skills among Chinese children aged 7-10 years, but the overall scores showed an upward trend. With the increase of age, the motor proficiency of children will improve accordingly. However, the fundamental motor skills will not be acquired spontaneously with the development and maturity of children, which needs continuous learning, practice and reinforcement.^[1] In addition, there are differences in the amplitude and rate of motor development, which show wavy growth. Different fundamental motor skills show their own characteristics in different age groups^[32]. Therefore, it is necessary to seize the critical period of children's development of fundamental motor skills. If they are not proficient in these fundamental motor skills during this critical period, children may lack the necessary motor ability and confidence to participate in sports, thereby reducing their probability of forming a healthy lifestyle^[33].



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This study also found that children's two-handed swing to hit the fixed ball and one-handed swing to hit the rebound ball action test effect is not good, the score is low. Baseball and tennis are popular in foreign countries, and children have more time to contact the computer. However, the development of these two sports in China is not ideal, and children's less contact leads to low test results. Moreover, the test scale is imported from abroad, although the reliability and validity of the scale are good in China. However, due to cultural differences, the test effects of individual subitems need further study.

Conclusion

Based on the in-depth analysis of the fundamental motor skills proficiency and characteristics of children aged 7-10 years in Nanning city, it was found that the development level of fundamental motor skills of children increased with age, and there was a significant gender difference. However, the effect size of gender on the development of fundamental motor skills of children was only at a medium to low level. The effect size of age on the development of children's fundamental motor skills reached a medium-high level. In the actual teaching process, teachers should carry out different teaching according to the characteristics of children's motor development of different genders and ages.

This article research is only in view of the city primary school the cross-sectional study of children, rural children samples didn't join them, later research should expand the scope of research, analysis of urban and rural children development level differences, due to domestic haven't establish common norm children fundamental motor skills development, for the difference of the different parts of the children can't in-depth comparison, This is also a key issue that needs to be solved by researchers in the later period. For the backward development of operant motor skills in girls, further experimental research is needed to design interventions to promote their motor development.

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