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STUDY OF THE CORRELATIONS AMONG THE PHYSICAL ABILITIES OF PRESCHOOL AGED BOYS AND GIRLS

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ABSTRACT
Physical abilities are an essential part of the individual physical fitness. It has been found that by purposeful impact on a given physical ability the other abilities are influenced to a certain extent too. The PURPOSE of this study was to establish the strength and character of the relationship among the basic physical abilities of 5-6 aged boys and girls. A total of 208 children – 113 boys and 95 girls, from two age groups – 3rd and 4th preparatory group for school were examined. The following research METHODS were used: theoretical analysis, sports-pedagogical testing, statistical methods, graph analysis. In order to establish the level of the studied physical abilities eleven motor tests were carried out. The RESULTS show that a big part of the registered correlations have low and statistically insignificant values. Some moderate and statistically significant correlations dominated in all age-sex groups were found. CONCLUSION: In the 5-6 years age period, a complex development of physical abilities is recommended, but with an emphasis on one or another ability, depending on its sensitive period.

Key words*:* components of physical fitness, relationships, 5-6-years-old children

INTRODUCTION

The basic physical abilities – strength, speed, endurance, flexibility and agility are essential components of the physical fitness of the individuals and make possible a person to perform different daily motor activities in all his life (1, 2). They are genetically determined but during the ontogenesis they change under the influence of a number of endogenous and exogenous factors such as external environmental conditions, education and training, lifestyle, etc. (3-5).

Physical abilities of preschool aged children are in constant, complex and heterochronical development and improvement, which is a prerequisite for the harmonious physical development of the child (6, 7). A number of studies show that there is a certain correlation between the functional and structural parameters of the organism, i.e. structural prerequisites play some role in the formation and development of better physical fitness. In this sense, they should not be overlooked when assessing a person's physical abilities (8-10). prerequisite for the recorded periodicity in the rate of development of physical abilities are the individual anatomical and physiological peculiarities of the child's organism (6).

Some periods of various growth intensity of the individual physical abilities are observed. The most pronounced complex natural increase of the physical abilities of boys and girls is registered in the 4th and 6th year, while in the 3rd and 7th year there is no growth in both sexes (7).

Many researchers proved the existence of a certain relationship in the development of physical abilities and a positive or negative transfer is observed between them (11, 12). This phenomenon is due to the similar nervous- muscular regulation in the performance of a given motor action, to the participation of the same muscle groups, to the

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similarity in the dynamics of muscle effort in different motor activities and their kinematic characteristics (8). Moreover, the role of physical load should be mentioned as it impacts the development and improvement of the physical abilities and ensures the interaction with the biological factors (13, 14). With increasing the age and the level of physical fitness, however, the effect of positive transfer from one ability to another gradually decreases. In some cases, the so-called "negative transmission" is observed AS the improvement of one ability leads to the decrease of another one. In addition, a close relationship is established between motor skills and habits and the level of physical abilities. Well-controlled and automated motor habits are a solid basis for an effective development and manifestation of the individual physical abilities and vice versa. In this regard, most authors (6, 8, 15 etc.) recommend complex development of the physical abilities during preschool age period, devoting more time to one ability or another, depending on the period of its development (whether it is sensitive or not). ***The purpose*** of this study was to establish the strength and character of the relationship among the basic physical abilities of 5-6 aged boys and girls.

MATERIALS AND METHODS

To achieve the goal of the study the following ***tasks*** were set to be solved: measurement of the anthropometric indicators of the children; measurement of the basic components of physical fitness of the children; establishment of the correlations between the tested physical abilities.

The subject of the study are the basic physical abilities of 5-6-year-old boys and girls: strength, speed, endurance, flexibility and agility.

The object of the study is the strength and character of the relationships between the physical abilities of 5-6-year-old boys and girls.

The following research methods were used to achieve the purpose set: Theoretical analysis of the informational resources, anthropometric measurements, sports-pedagogical testing, math-statistical methods – variation and correlation analysis, graph analysis.

PARTICIPANTS

The research was conducted with 113 boys and 95 girls (a total of 208 children) from two age groups – 3th and 4th preparatory group, attending and educating in two Sofia kindergartens and one school which were randomly selected. The ministry of education approved the conducting of the research. The parents of the children were asked to sign an informed consent for the participation of their children in the study. The children had to meet the following criteria: to be without chronic diseases, to attend the kindergarten regularly and to participate voluntarily.

ORGANIZATION OF THE RESEARCH

In order to solve the goals the research was organized and conducted on the territory of the kindergartens and the school.

To estimate the individual body structure characteristics anthropometric measurements were carried out.

The following anthropometric indicators were measured: body height, body weight and chest circumference using a commonly adopted methodology (16). To obtain current and cumulative information about the individual latent state and dynamics of the components of the physical fitness a test battery, developed by the author (17), was used. The following motor tests were included: hand grip of the right hand (static strength of the flexors of the wrist) (kg), Trunk strength dynamometry (static strength of the low back muscles) (kg), 40 m run (speed of movement) (sec), Standing broad jump (speed-strength of the lower extremities) (cm), Throwing a medical ball 1 kg with two hands above the head (speed-strength of the upper extremities) (cm), Throwing a medical ball 1 kg with two hands underneath (speed-strength of the upper extremities) (cm), Throwing a small dense ball 150 g as far as possible (speed-strength of the upper extremities) (cm), Throwing a small dense ball 150 g towards horizontal and vertical marker (coordination) (n), Maximum number of squats for 20 sec (strength endurance) (n), 200 m run (endurance) (sec), Sit and reach (flexibility) (cm). All data were recorded in individual protocols for each child.

DATA ANALYSIS

An experimental physical culture educational program was applied in pedagogical situations during the test period. IN order to eliminate its impact on the indicators and the relationships of our interest, we subjected to mathematical - statistical analysis only the results from the first testing procedures.

The variation and correlation analysis were applied using software package IBM SPSS STATISTICS v22 and MS Office 2018.

Ordinary correlation coefficients (pearson's coefficient – r) between any pair of physical abilities were calculated. For statistically significant were accepted those values of the coefficient – r – which are greater than or equal to the theoretically calculated (in our case r = 0.11). The statistical significance was selected at the level of $p < 0.05$.

RESULTS AND DISCUSSION

The anthropometric characteristics and their variations are presented in **Table 1**.

Table 1. *Anthropometric variables – 5-years-olds and 6-years-olds*

Anthropometric variables – 5-years-olds						
Variables	**Boys** (n=46)			**Girls** (n=41)		
	$\bar{x}$	S	V%	$\bar{x}$	S	V%
Body height (cm)	112,92	4,54	4,02	116,68	4,88	4,18
Body weight (kg)	20,12	3,17	15,76	19,51	2,22	11,38
Chest circ. (cm)	56,38	4,40	7,80	57,46	2,55	4,44
Anthropometric variables – 6-years-olds						
Variables	**Boys** (n=67)			**Girls** (n=54)		
	$\bar{x}$	S	V%	$\bar{x}$	S	V%
Body height (cm)	119,75	5,12	4,28	117,21	4,66	3,96
Body weight (kg)	23,22	3,18	13,70	23,18	4,30	18,55
Chest circ. (cm)	59,07	4,70	7,96	56,0	3,45	6,16

The age-sex groups can be determined as homogenous or semi homogenous according to the coefficient of variation (V%) of the basic anthropometric parameters. Compared to the data of the national scientific research (Bulgarian academy of sciences) no significant differences were registered between our participants and the Bulgarian children as a whole. So, their physical development is in normal limits for that age.

The results of the correlation analysis are presented in **Tables 2, 3, 4 and 5** separately for any sex-age group.

Their analysis shows that the values of a big part of the recorded correlations are low to moderate in strength and in most of the cases are statistically insignificant.

Table 2. *Correlation matrix of physical abilities of 5-year-old boys*

Tests	1. Hand grip - right hand (kg)	2. Trunk strength dynamometry (kg)	3. 40 m run (sec)	4. Standing broad jump (cm)	5. Throwing medical ball 1 kg above head (cm	6. Throwing medical ball 1 kg undemeath (cm)	7. Throwing small ball as far as possible (cm)	8. Towards horizontal and vertical mark(n)	9. Max squats for 20 sec (n)	10. 200 m run (sec)	11. Sit and reach (cm)
1. Hand grip - right hand (kg)	1										
2. Trunk strength dynamometry (kg)	,404**	1									
3. 40 m run (sec)	0,022	-0,118	1								
4. Standing broad jump (cm)	0,23	0,067	**-,509****	1							
5. Throwing medical ball 1 kg above head (cm)	**,547****	,391**	-0,16	,308*	1						
6. Throwing medical ball 1 kg underneath (cm)	0,286	,371*	-0,233	,356*	,426**	1					
7. Throwing small ball as far as possible(cm)	,339*	0,183	-0,175	,401**	,453**	0,178	1				
8. Towards horizontal and vertical mark(n)	0,063	0,067	-,418**	,331*	,313*	,381**	,328*	1			
9. Max squats for 20 sec (n)	0,175	0,185	-,403**	0,246	0,288	0,134	-0,02	,303*	1		
10. 200 m run (sec)	0,095	0,113	,442**	-0,189	-0,133	-0,191	-0,134	-0,156	-0,231	1	
11. Sit and reach (cm)	,416**	0,288	-0,083	0,182	,306*	-0,098	0,059	-0,023	0,197	0,253	1

Table 3. *Correlation matrix of physical abilities of 5-year-old girls*

Tests	1. Hand grip - right hand (kg)	2. Trunk strength dynamometry (kg)	3. 40 m run (sec)	4. Standing broad jump (cm)	5. Throwing medical ball 1 kg above head (cm	6. Throwing medical ball 1 kg underneath (cm)	7. Throwing small ball as far as possible (cm)	8. Towards horizontal and vertical mark(n)	9. Max squats for 20 sec (n)	10. 200 m run (sec)	11. Sit and reach (cm)
1. Hand grip - right hand (kg)	1										
2. Trunk strength dynamometry(kg)	,486**	1									
3. 40 m run (sec)	-0,127	-,471**	1								
4. Standing broad jump (cm)	,455**	**,703****	**-,517****	1							
5. Throwing medical ball 1 kg above head (cm)	,474**	**,603****	-,403**	**,572****	1						
6. Throwing medical ball 1 kg underneath (cm)	,499**	,484**	-,442**	**,534****	**,610****	1					
7. Throwing small ball as far as possible (cm)	,452**	0,282	-0,084	0,244	,408*	**,557****	1				
8. Towards horizontal and vertical mark (n)	0,247	0,245	-,336*	0,227	0,227	0,253	,383*	1			
9. Max squats for 20 sec (n)	0,286	,425**	-0,295	,398*	0,282	,452**	,362*	,322*	1		
10. 200 m run (sec)	-0,05	-0,199	0,23	-0,151	-0,15	-0,264	-,380*	0,118	-0,217	1	
11. Sit and reach (cm)	0,231	,467**	-0,284	,355*	,376*	0,259	0,051	-0,02	-0,121	-0,098	1

Table 4. *Correlation matrix of physical abilities of 6-year-old boys*

Tests	1. Hand grip - right hand (kg)	2. Trunk strength dynamometry (kg)	3. 40 m run (sec)	4. Standing broad jump (cm)	5. Throwing medical ball 1 kg above head (cm	6. Throwing medical ball 1 kg underneath (cm)	7. Throwing small ball as far as possible(cm)	8. Towards horizontal and vertical mark(n)	9. Max squats for 20 sec (n)	10. 200 m run (sec)	11. Sit and reach (cm)
1. Hand grip - right hand (kg)	1										
2. Trunk strength dynamometry (kg)	,458**	1									
3. 40 m run (sec)	-,349**	-,369**	1								
4. Standing broad jump (cm)	0,192	,351**	-,377**	1							
5. Throwing medical ball 1 kg above head (cm)	**,532****	,420**	-,293*	0,23	1						
6. Throwing medical ball 1 kg underneath (cm)	,487**	**,537****	-,398**	,386**	**,712****	1					
7. Throwing small ball as far as possible (cm)	,245*	,498**	-0,143	,379**	,365**	**,557****	1				
8. Towards horizontal and vertical mark (n)	,287*	0,212	0,018	,253*	,349**	,274*	,292*	1			
9. Max squats for 20 sec (n)	-0,105	0,13	-0,239	,337**	0,048	,269*	0,211	0,06	1		
10. 200 m run (sec)	-0,169	-0,134	,404**	-,265*	-0,171	-,271*	-0,13	-0,035	-0,229	1	
11. Sit and reach (cm)	0,14	0,192	-0,019	,251*	0,118	,247*	,389**	0,048	,241*	-0,059	1

Table 5. *Correlation matrix of physical abilities of 6-year-old girls*

Tests	1. Hand grip - right hand (kg)	2. Trunk strength dynamometry (kg)	3. 40 m run (sec)	4. Standing broad jump (cm)	5. Throwing medical ball 1 kg above head (cm	6. Throwing medical ball 1 kg underneath (cm)	7. Throwing small ball as far as possible(cm)	8. Towards horizontal and vertical mark(n)	9. Max squats for 20 sec (n)	10. 200 m run (sec)	11. Sit and reach (cm)
1. Hand grip - right hand (kg)	1										
2. Trunk strength dynamometry (kg)	,412**	1									
3. 40 m run (sec)	-,407**	-,357*	1								
4. Standing broad jump (cm)	,318*	0,086	-0,247	1							
5. Throwing medical ball 1 kg above head (cm)	,455**	,357*	-,313*	,457**	1						
6. Throwing medical ball 1 kg underneath (cm)	,342*	0,081	-0,202	,388**	**,539****	1					
7. Throwing small ball as far as possible (cm)	,355**	0,066	-,395**	0,265	**,538****	,422**	1				
8. Towards horizontal and vertical mark (n)	0,148	0,153	-,436**	0,131	0,22	0,052	0,258	1			
9. Max squats for 20 sec (n)	0,216	0,056	-,275*	0,205	0,001	-0,047	0,12	0,168	1		
10. 200 m run (sec)	-,385**	-0,243	,455**	**-,535****	-,466**	-,313*	**-,505****	-,369**	-,292*	1	
11. Sit and reach (cm)	0,268	0,19	-0,221	0,094	0,152	0,102	0,15	-0,056	-0,019	-0,141	1

In that regard, in our report we are going to discuss only those correlations which are statistically significant and moderate and significant in strength.

The direction and the strength of the established relationships between the investigated physical abilities does not allow us to outline any definite tendencies characteristic for both age-sex groups. In the experimental groups, some contradictory results have been obtained, but nevertheless here we are going to outline the most interesting general trends.

Table 6 shows the distribution of the correlation coefficients according to the degree of their significance for all age-sex groups.

Table 6. *Degree of significance of the correlation coefficients by age and gender*

Degree of significance	5-year-old boys	5-year-old girls	6-year-old boys	6-year-old girls
Moderate (n)	19	21	16	19
Significant (n)	2	7	4	4

From the table it is seen that the number of the moderate correlations is significantly higher in all age-sex groups in comparison with those of the significant correlation coefficients which number is not high (especially in 5-year-old boys). In that group it was recorded a significant correlation only between the static strength of the wrist flexors and the speed-strength of the upper extremities measured by the 'throwing a medical ball 1 kg above the head ' test, as well as between the speed- strength of the lower extremities and the speed of movement (**Table 2**).

In girls of the same age group, the number of the significant relationships are three times more. They are mainly between the different forms of

strength and vary in the range from r= .517 (between the speed-strength abilities of the lower extremities and speed) to r= .703 (between the speed of the lower extremities and the static low back strength). The significant and positive in direction correlations are mainly between the speed-strength of the upper and lower extremities and between them and the static strength of the low back (**Table 3**).

In 6-year-old boys, the significant correlation coefficients range from r= .532/ between the static wrist flexors strength and the upper extremities speed-strength up to /r = .712/ between throwing a medical ball, 1 kg above the head and underneath/. Here again, a trend for a stronger correlation between the tests measuring the upper extremities speed-strength abilities and between them and the static strength of the low back muscles is observed (**Table 4**).

In 6-year-old girls, the significant relationships varies from r = -.505 (between the results from the test "throwing a small dense ball 150 g as far as possible" and "200 m run"), as the character of the relationship have a negative sign, to r = .539 (between the results of the tests: "throwing a medical ball 1 kg with two hands above the head" and "throwing a medical ball 1 kg with two hands underneath"). Here there is a negative relationship between the endurance and the speed-strength of the lower extremities (**Table 5**).

It is obvious that statistically significant correlations in the moderate range are much more in number.

Here the relationship between the static strength of the wrist flexor and that of the low back muscles will be mentioned. It has a positive direction in both age-sex groups. In addition, the results of the static strength tests correlate also with the flexibility in 5-year-olds or when increasing the mobility in the hip joints, the strength of the muscles around them, as well as those of the back increase their strength too.

In 6-year-olds, a negative relationship is recorded between the static strength of the wrist flexors and the low back muscles on one hand and the speed of movement on the other.

In the same age group, the speed correlates negatively with the speed-strength abilities of the upper and lower extremities and the strength endurance of the lower extremities and it is in positive correlation with the endurance. Similar results were observed in 5-year-olds.

Analysing the results, we found that there is a statistically significant positive relationship between the speed and the strength of all the muscle groups studied (those of upper and lower extremities) in all the tests used. That means that the physiological impact (physical load) on them leads to their parallel and complex development and that the increase of any one of the strength forms results in the increasing of the other ones. That fact confirms the statement that the speed-strength development in that age period (6-7-years-old) have a complex character depending on the sensitive period of its natural growth and development.

Here it is important to mention the strong positive relationship between the results of the two tests measuring the speed-strength abilities of the upper extremities "throwing a medical ball 1 kg with two hands above the head and underneath". That means that they carry the same significant information which makes it possible to use only one of them in the cases of developing a test battery.

Coordination abilities in preschool age are in their initial period of formation and development. In our case, they depend to a moderate degree on the speed-strength of the upper and lower extremities in 5-year-old boys and on the speed in 5-year-old girls, as the direction is negative.

In 6-year-old boys and girls, no relationship between coordination and the other physical abilities was found. In such a case a differentiated approach in its development at that age is recommended.

In general flexibility depends very much on the strength and elasticity of muscle tissue. In the age-sex groups we studied it is well developed. In our case it is in a moderate and positive relationship with the static strength of the wrist flexors and low back muscles. In addition, a statistically significant correlation with the speed-strength of the upper extremities was also found, which confirms the statement that better mobility in a given joint is a prerequisite for better speed-

strength abilities of the muscles around this joint (18).

The endurance is an ability closely connected with the individual's health. In that connection instead of the fact that in preschool age the natural rate of its development is slower (it is not in a sensitive period) according to some authors it should be developed throughout the children life (19). In literature there are data about its relationship with the other physical abilities whose development reflects on its development too. In our case, a moderate and positive correlation was found only with the speed of running and the strength endurance of the lower extremities. So, we propose an appropriate physical exercises for the purposeful development of this ability to be included in the physical education classes at the kindergarten as well as at the school.

CONCLUSION

Based on the results of the correlation analysis revealing the existing relationship between the physical abilities of 5-6-year-old boys and girls, we can state the following conclusion:

A high number of the registered correlations have low values and are statistically insignificant. At the same time, moderate and significant correlations are also recorded, especially between the speed-strength abilities as in most of the cases the direction of the relationship is positive and statistically significant. Therefore, when a purposeful functional impact is applied on one or another motor ability, the other abilities are affected to a certain degree. In that sense, in the age period – from 5 to 6/7 years, the complex development of the physical abilities is recommended, but with an emphasis on one or another ability depending on the period of its development (sensitive period). Moreover, in some cases a differentiated approach should be applied when selecting the most appropriate methods and means.

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