



RELATIONS BETWEEN ANTHROPOMETRIC, FLEXIBILITY AND STRENGTH INDICATORS IN PRACTICING SWIMMING PRIMARY SCHOOL-AGED CHILDREN

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ABSTRACT

According to many researches morphological characteristics of the body play a significant role in swimming. Swimming is also a sport which is associated with strength, but flexibility can greatly help swimmers to improve their performance.

THE PURPOSE of the research is to study the relations between anthropometric, flexibility and strength indicators in practicing swimming primary-school aged children.

METHODS: For the purpose of the study anthropometric tests, tests for flexibility, and strength tests were applied. The study population consisted of 20 children aged 7-10 years, 10 boys and 10 girls with an average age of 8,3 years.

RESULTS: The results of the study were statistically processed, and a correlational analysis of the obtained results were made. We found that anthropometric indicators correlate with the age indicator and strength indicators. Flexibility indicators correlate with each other, but not with the other studied indicators.

CONCLUSIONS: We can conclude that the age and anthropometric indicators are related to the strength, but flexibility is independent for development motor quality at that age.

Keywords: anthropometric indicators, flexibility, strength, children, swimming.

INTRODUCTION

Swimming is defined as a sport of great importance for the human health. The water environment and its features - hydrostatic pressure, resistance, buoyancy, temperature and chemical composition have a beneficial physiological and morphological effect on the body. The sport of swimming can be practiced from an early age, creating potential opportunities for high working capacity, good health and harmonious physical development among adolescents (1). Systematic practice of swimming leads to optimization of body composition (2, 3), improved flexibility levels and increased sport performance (4).

Practicing swimming leads to improved muscle balance, as all muscle groups are activated,

thereby the tone of the muscles and the nervous system is balanced. Those muscles that are weakened and have reduced tone are activated and strengthened, and those that have increased tone and are spastic are balanced and their spasm is reduced (5).

Systematic swimming training increases the capillary network in the working muscles, improves metabolism, which leads to hypertrophy not only in the muscle tissue, but also in the underlying bones. Strengthening the skeletal system and developing muscles through systematic swimming can help form correct body posture (6). The chest expands due to increased ventilation of the lungs, which model the thorax from the inside out and symmetrically load both the upper limbs and the muscles of the back, abdomen and lower limbs (7). Swimming is a sport that also has a

corrective and preventive effect on those who exercise. The effect is primarily due to the nature and diversity of the movements and the specificity of the aquatic environment (8).

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Swimming has an extremely beneficial effect on physical development indicators related to lung capacity and physical performance indicators (9).

Early identification of anthropometric potential in swimmers is considered important for the recruitment and selection of adolescents for systematic training (10-13). Some researchers have concluded that the height and length of the upper body in swimmers are very important for speed swimming disciplines (14-16). However, a well-structured training process and the associated changes in body composition during the growth period are far more important than early selection before puberty (17).

An important aspect of initial swimming training is dealing with the fear of water and depth in order to progress in training and develop the various motor qualities and functional capabilities of the child's body. In this direction, various authors conduct their research and share that the use of aids in the water, as well as teaching by a specialist, are key to dealing with fear (18-20).

The purpose of the research is to study the relations between anthropometric, flexibility and strength indicators in practicing swimming primary-school aged children.

MATERIALS AND METHODS

The study involved 20 children with average age 8,3 years, included in primary swimming education groups. Boys and girls are equally represented by number. The sports-pedagogical experiment was carried out in two stages - when the child was enrolled in the swimming groups and after 6 months of systematic swimming trainings.

To realize the purpose of the research different tests were conducted. First group of tests aims to establish the level of anthropometric indicators - height, weight and BMI, second group of tests are focused on evaluating flexibility and strength – Standing forward bend, Standing left bend, Standing right bend, Sit-ups, Back extensions and Right-hand dynamometry and Left-hand dynamometry (**Table 1**).

Table 1. Studied indicators

N	Studied indicators	Direction of increase	Units of measurement	Accuracy of measurement
1.	Height	+	cm	1
2.	Weight	+	kg	1
3.	BMI	+	%	1
4.	Standing right bend	- / +	cm	1
5.	Standing left bend	- / +	cm	1
6.	Standing forward bend	- / +	cm	1
7.	Sit-ups	- / +	counts	1
8.	Back extensions	- / +	counts	1
9.	Right-hand dynamometry	+	kg	1
10.	Left-hand dynamometry	+	kg	1

To establish the strength of the dependence between the gender of the subjects and the used tests, the point-biserial correlation coefficient (r_b) was used. The studied indicators were subjected to a correlation analysis to establish the strength of the dependence between them. The Pearson correlation coefficient (r) was applied.

RESULTS

The values of the point-biserial correlation coefficient (r_b) show that there is no correlation between gender and the studied indicators, both in the first and second study (**Table 2**). This gives us reason to analyze the collected data without separating the indicators for boys and girls.

Table 2. Point-biserial coefficient (r_b) – gender of the respondents

Test - Gender	First testing	Value	Second testing	Value
The point-biserial correlation coefficient (r_b)	Height	,223	Height	,233
	Weight	,151	Weight	,073
	BMI	,048	BMI	,189
	Standing right bend	,240	Standing right bend	,298
	Standing left bend	,156	Standing left bend	,196
	Standing forward bend	,080	Standing forward bend	,125
	Sit-ups	,153	Sit-ups	,113
	Back extensions	,117	Back extensions	,122
	Right-hand dynamometry	,235	Right-hand dynamometry	,158
	Left-hand dynamometry	,163	Left-hand dynamometry	,118

Critical values of the correlation coefficient at $n=20$, for $r_{0.05}=0.300$; *St. significant correlation

For better visualization, a brief description of the tests is used, presented at **Table 3**.

Table 3. Short abbreviation of the used tests

Indicators	Short name
Height	T1
Weight	T2
BMI	T3
Standing right bend	T4
Standing left bend	T5
Standing forward bend	T6
Sit-ups	T7
Back extensions	T8
Right-hand dynamometry	T9
Left-hand dynamometry	T10

To establish the relationships between the investigated indicators at the beginning and at the end of the experiment, the Pearson correlation coefficient - r was applied. Where

moderate and significant correlations are present, they are marked with * at $p<0.05$ and ** at $p<0.001$. The interpretation scale is shown in **Table 4**.

Table 4. Scale for interpretation of correlational dependences

Pearson correlation coefficient values	No dependence
up to 0.3	Weak
from 0.3 to 0.5	Moderate
from 0.5 to 0.7	Significant
from 0.7 to 0.9	High
over 0.9	Very high
1	Functional

The strength of the correlational dependences between the studied variables is represented by coloring the statistically significant coefficients, with a moderate dependence from 0.3 to 0.5 colored in green, a significant dependences from 0.5 to 0.7 colored in yellow.

The correlation analysis of the results of the tests in the first study (Table 4) show that significant dependencies (in yellow) are observed only between the indicators Height and Weight ($r=,601$), BMI and Weight ($r=,572$) и Back Extensions and Standing left bend ($r=,605$).

Moderate dependencies (12 in number) are found between the indicators Height and BMI ($r=,307$), Standing left bend and Height ($r=,410$), Standing left bend and BMI ($r=,368$), Standing forward bend and Height ($r=,303$), Standing forward bend and Weight ($r=,380$),

Sit-ups and BMI ($r=,364$), Back extensions and Standing left bend ($r=,344$), Back extensions and Sit-ups ($r=,396$), Right-hand dynamometry with: Standing forward bend ($r=,300$); Sit-ups ($r=,433$); Back extensions ($r=,408$), Left-hand dynamometry and Right-hand dynamometry ($r=,407$) (**Table 5**).

Table 5. Correlational dependences between studied indicators in the beginning of the experiment

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
T1	1									
T2	,601**	1								
T3	-,307*	,572**	1							
T4	,410*	,067	-,368*	1						
T5	-,290	-,080	,196	,276	1					
T6	,303*	,380*	,171	-,066	-,142	1				
T7	,182	-,168	-,364*	,290	,259	,141	1			
T8	,044	-,029	-,099	,344*	,605**	,029	,396*	1		
T9	,145	,141	,021	,268	,107	,300*	,433*	,408*	1	
T10	-,051	-,012	,033	,190	-,019	,242	-,216	,119	,407*	1

In the second study, 13 moderate dependencies, colored in green, and 6 significant dependencies, colored in yellow, were identified (Table 6). The significant dependencies were found between the indicators Height and Weight ($r=,614$), Weight and BMI ($r=,532$), Standing forward bend with Height ($r=,577$) and Weight ($r=,589$), Back extensions and Sit-ups ($r=,557$) and Left-hand dynamometry and Height ($r=,578$).

The analysis of correlation dependences at the end of the study also revealed a greater number

of moderate dependencies compared to the first study (**Table 6**). These are BMI and Height ($r=,338$), Standing left bend with Height ($r=,485$) and BMI ($r=,468$), Standing left bend and Standing right bend ($r=,421$), Standing forward bend and Sit-ups ($r=,485$), Back extensions and BMI ($r=,303$), Left-hand dynamometry with: BMI ($r=,426$), Standing left bend ($r=,353$), Standing right bend ($r=,382$), Standing forward bend ($r=,407$), Right-hand dynamometry with: Standing forward bend ($r=,385$), Sit-ups ($r=,395$), Left-hand dynamometry ($r=,343$).

Table 6. Correlational dependences between studied indicators in the end of the experiment

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
T1	1									
T2	,614**	1								
T3	-,338*	,532**	1							
T4	,485*	,032	-,468*	1						
T5	-,226	-,127	,082	,421*	1					
T6	,577**	,589**	,092	,116	-,253	1				
T7	,157	-,037	-,196	,005	-,046	,485*	1			
T8	,254	-,008	-,303*	-,155	-,118	,297	,557**	1		
T9	,578**	,159	-,426*	,353*	-,382*	,407*	,224	,108	1	
T10	,128	,015	-,126	,192	,205	,385*	,395*	,264	,343*	1

DISCUSSION

The results of the study and the correlational analysis at the beginning of the experiment (**Table 5**) show that there are significant dependencies between the anthropometric indicators Height and Weight and Weight and BMI, which is understandable considering the intense period of body growth. Moderate dependencies are presented between flexibility indicators and anthropometric indicators: Standing forward bend with Height and Weight, as well as Standing left bend with Height and BMI. The indicators of strength correlate with each other as Back extension and Sit-ups, Right-hand dynamometry and Left-hand dynamometry, Right-hand dynamometry with Back extension and Sit-ups. The only indicator of strength that correlates moderately with an anthropometric indicator is Sit-ups with BMI. We can conclude that before carrying out systematic swimming training, statistically significant correlations are observed between anthropometric indicators, between indicators of spinal flexibility with height and weight, and between strength indicators.

At the end of the experiment (**Table 6**), more significant and moderate dependencies were found between the studied indicators compared to the beginning of the experiment. Significant dependencies were observed between the anthropometric indicators Height and Weight, Weight and BMI, between the flexibility indicator Standing forward bend with Height and Weight, between the strength indicators Back extension and Sit-ups and between the strength indicator Left-hand dynamometry with Height.

At the end of the study, moderate dependencies were observed between the anthropometric indicators Height and BMI, between the flexibility indicator Standing left bend with the anthropometric indicators Height and BMI, between the flexibility indicators Standing left bend and Standing right bend, between the flexibility indicator Standing forward bend and the strength indicator Sit-ups and between the flexibility indicators Standing left bend, Standing right bend and Standing forward bend with Left-hand dynamometry, between the anthropometric indicator BMI with the strength indicators Back extension and Left-hand dynamometry, between the strength indicators Right-hand dynamometry and Sit-ups.

We can conclude that at the end of the study new dependencies appear between the studied indicators compared to the first study. We also find a moderate dependency between flexibility indicators with those for trunk strength and upper limb strength, as well as anthropometric indicators with strength indicators, which we believe is due to the systematic application of swimming training.

CONCLUSIONS

At the observed age of 7-10 years gender is not a factor that influences the studied indicators. The correlation analysis shows that at the beginning of the study, 3 significant and 12 moderate correlations were observed between the studied indicators, while at the end of the study, 6 significant and 13 moderate correlations were found. This is evidence that systematic swimming lessons lead to the development of dependencies between anthropometric indicators, indicators of body flexibility and indicators of body and upper limb strength.

Anthropometric indicators are in a significant correlation with each other both at the beginning and at the end of the study, which is tied to the dynamics of growth and physiology at that age. At the end of the study, a significant correlation is reported between the indicator of spinal flexibility Standing forward bend with Height and Weight, as well as the strength indicators Back extension and Sit-ups with each other.

After 6 months of systematic training with novice swimmers, moderate correlations begin to appear between spinal flexibility indicators and strength indicators and between anthropometric indicators, as well as between strength indicators and anthropometric indicators, which confirms that with systematic swimming classes, both flexibility and strength develop in parallel and optimize body mass indicators.

The results of this study, based on only 6 months of swimming training in novice swimmers, give us a reason to assume that with long-term swimming training and in advanced swimmers, high and very high correlations could be found between anthropometric indicators and indicators of physical performance.

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