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MUSCULAR ENDURANCE AND STRENGTH IN BOYS AGED FROM 11 TO 13 YEARS

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Abstract

The psychophysical development of humans is genetically determined and influenced by a number of external factors. Nowadays, impacts on the physical development and physical ability of young men are caused by such phenomena as acceleration and civilizational or urban changes. Monitoring of changes in development and the influence of different factors seems to be justified as it is related to the understanding of processes and the introduction of preventive measures in the field of health and physical fitness for future generations. New concepts for testing human physical abilities seem to focus on utilitarian targets related to health needs and daily human activities.

The study was performed on a group of 211 boys from an urban area, including 75 at the age of 11, 74 at the age of 12 and 62 at the age of 13. The study examined the strength of abdominal and trunk muscles (sits-up from a lying position), shoulder girdle and lower extremity muscles (overhang on a bar), and explosive strength of upper limbs (forward and backward medicine ball throw). Boys at the age of 11 years achieved the shortest distances, and boys at the age of 13 the longest distances in forward medicine ball throws. The results of the attained distances in backward medicine ball throws were also better in older boys compared to younger ones. The results of the muscle endurance tests were different. In both attempts, boys at the age of 12 attained better results than their younger and older colleagues. The development of strength abilities in boys between the age of 11 and 13 years has stable progress, while the observed differences in muscle endurance in boys at the age of 13 require further monitoring and further examination of their impact in terms of quality and quantity in boys of prepubertal age.

The ***Key words:*** *motor skills, strength skills, muscle endurance, puberty*

Introduction

Human physical development is a complex process leading to the achievement of full maturity as a morphological and functional entity (biological maturity). Motor development as a multidimensional process is disclosed in particular motor skills, which are determined genetically, and by a number of external factors, which affect its course in a significant way [19]. The most dynamic changes in human development occur during the first and second decades of life [16].

Nowadays, such phenomena as acceleration and civilizational or urban changes have an effect on the development of young men and their physical fitness. Monitoring of developmental changes in a young man seem to be justified in terms of understanding the developmental processes and implementation of preventive activities in the scope of health and physical fitness for future generations. The concept of *Health-Related Fitness* is focused on health and comprises five areas of physical fitness, including morphological, musculoskeletal, motor, and cardiopulmonary capabilities, as well as metabolic fitness. New concepts of human physical fitness tests seem to focus on utilitarian goals related to health needs and daily human activity [11] (…) *Physical fitness testing is currently based on fundamental reorientation and certainly has implications for a change in assumptions with regard to all fundamental intentions of physical education. Gradually, moving away from issues focused on motor and sport successes and in*

general on temporary exercises, the objectives of the study moved towards health indicators and full capabilities.

It is assumed that motor abilities are connected within the biological development of human beings, covering growth processes related to biological development and the impact of environmental conditions [2, 3, 4, 5]. One of two criteria in the physical and motor development of a young man is qualitative change, which concerns the development and improvement of body posture. The qualitative determinants of proper body posture, alongside a well-developed nervous system and osteoarticular system, are adequate strength, length and flexibility of postural muscles [9].

Both the prepubertal and pubertal periods are significant for the development of human physical ability [16]. Physically, in this phase of puberty a dynamic development occurs of the somatic and motor features. The puberty phase in boys usually starts between 11 and 13 years [16, 18]. During that period, intensive development affects teenage motor changes [13] (the so-called crisis of motor skills) and is commonly referred to as the second critical apogee of body posture defects. Continuous research and cross-motor development of the younger generation requires constant monitoring due to the above-mentioned preventive goals and civilizational changes (life style, organization and forms of spending free time). Knowledge concerning levels of physical fitness is a key guideline for teachers in programming movement activities (compensation for deficits, training and improvement of overall motor skills).

The objective of the study was an assessment of the level of development of selected motor skills in boys during puberty. For the purpose of the study the following research questions were formulated: 1) What are the differences in strength abilities in boys aged between 11 and 13 years living in the same urban area? 2) Are there differences in muscle endurance in boys aged between 11 and 13 years?

Material and methods

The study was conducted in 2009 in a gym belonging to Primary School No. 5 in Opole. Overall, 211 boys from this urban area were enrolled in the study, including 75 boys at the age of 11 years (4th grade), 74 boys at the age of 12 years (5th grade) and 62 boys at the age of 13 years (6th grade). All participants systematically participated in physical education classes for three hours per week (45 minutes at a time). The Local Bioethics Committee of the Medical Chamber in Opole approved the study. The somatic features of the sample of boys are presented in Table 1.

Tab. 1 Characteristics of the sample. Values are presented as means (M) and standard deviation (DS)

Students - boys aged [years]	*n*	Height (cm)		Weight (kg)		BMI (Kg/height^2)	
		M	*SD*	*M*	*SD*	*M*	*SD*
11	75	152	6.3	49.5	6.0	16.22	1.54
12	74	157	6.3	56.8	7.7	18.05	2.04
13	62	169	6.8	59.5	6.3	17.58	1.44

In accordance with the methodology, selected trials from the European Physical Fitness Test were used to measure physical fitness [6]. During the test, assessment was made of the muscle endurance of: the abdomen and trunk (sits-up from a lying position), shoulder girdle and upper extremity muscles (overhang on a bar), as well as strength abilities, allowing the explosive strength of the upper limbs to be assessed [4, 17]. The collected data was analysed using the STATISTICA 10 (StatSoft) software. A one-way ANOVA was used to compare the selected motor skills of boys in the phase of puberty at three levels of age (11, 12 and 13 years). It was based on the assumption of normal distribution of the variables.

Results

The arithmetic mean and standard deviation for three age samples are shown in Tables 2 and 3. The differences between three age groups are presented in Figures 1, 2, 3 and 4.

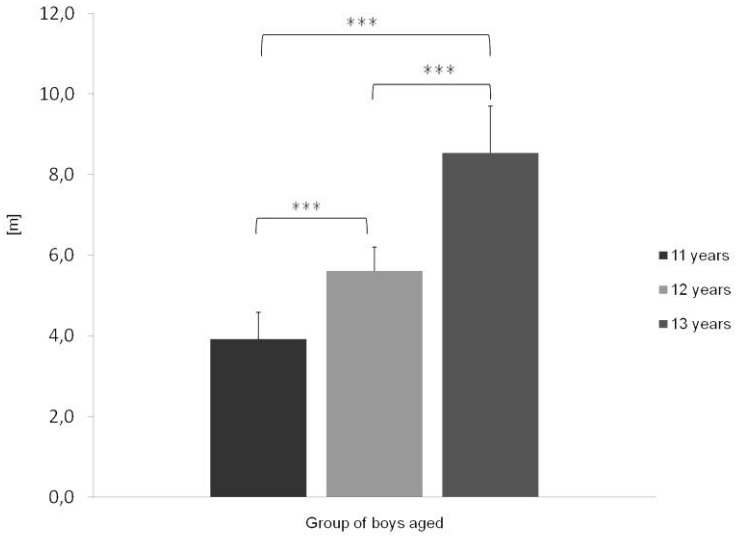
Tab. 2. Measurement results of explosive strength in upper limbs and shoulder girdle in pupils aged 11, 12 and 13 years

Students – boys aged [years]	*n*	Strength and explosive power			
		Medicine ball throw [m]			
		Throw the ball forwards		Throw the ball backwards	
		M	*SD*	*M*	*SD*
11	75	3.93	0.66	4.32	0.65
12	74	5.60	0.59	6.26	0.77
13	62	8.54	1.16	9.00	1.08

Tab. 3. Measurement results of muscle strength of shoulder girdle and abdomen in pupils aged 11, 12 and 13 years

Students – boys aged [years]	*n*	Functional strength			
		Overhang on a bar [s]		Maximum number of sitting positions from a resting position on the back in 30 seconds [number of repetitions]	
		M	*SD*	*M*	*SD*
11	75	27.00	16.14	26.11	2.80
12	74	46.43	20.61	28.30	3.10
13	62	26.34	17.99	27.15	2.90

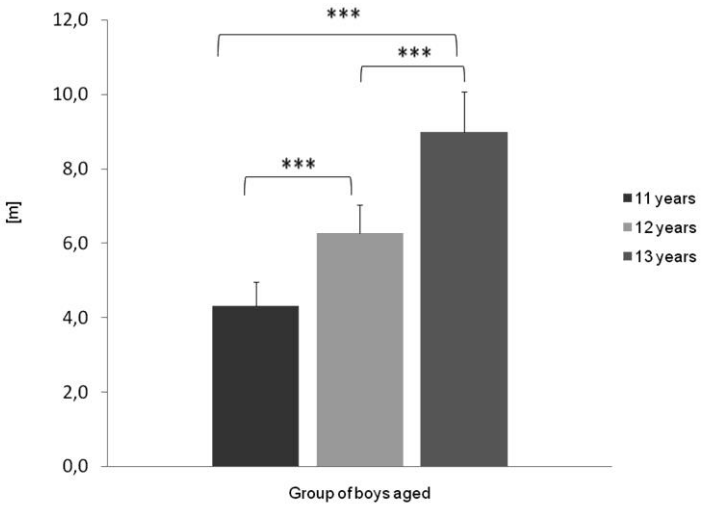
Fig. 1. Explosive strength of upper extremities and shoulders during a trial of forward medicine ball throws.



*** p<0.0001

The results of the forward medicine ball throw distances differentiate students aged 11, 12 and 13 at a high level of statistical significance (p < .000). Boys at the age of 11 achieved the shortest distances, which are shorter by approximately 1.67 [m] in comparison to boys at age 12, and 4.61 [m] shorter that those of boys at the age of 13. The difference in the average length of forward medicine ball throws between students at age of 12 and 13 was 2.94 [m] to the disadvantage of the younger pupils.

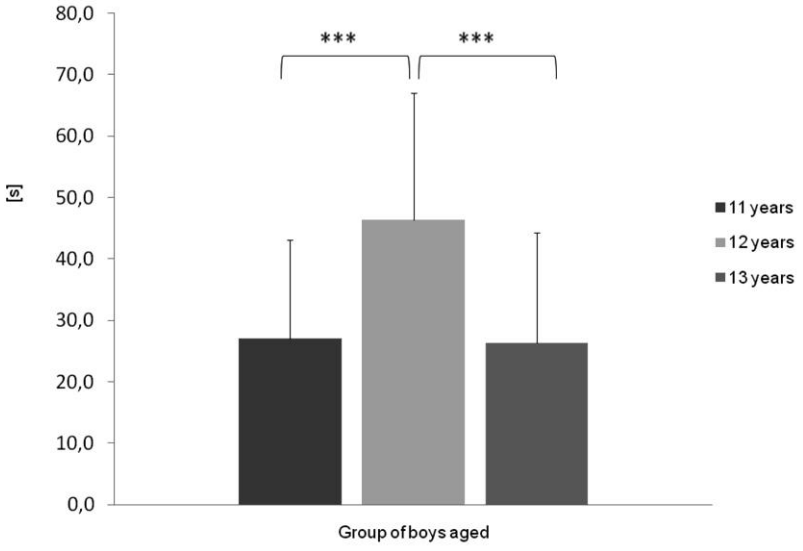
Fig. 2. Explosive strength of upper extremities and shoulders during a trial of backward medicine ball throws.



*** p<0.0001

The distance results in backward medicine ball throws as well as forward medicine ball throws are differentiated at a high level of statistical significance between the mean distances achieved by students at the age of 11, 12 and 13 years old (p < .000). In this attempt, the oldest boys again achieved the longest throw distances, which were approximately 2.74 [m] further than throws performed by boys of 12 years old, and about 4.68 [m] further than those of boys at the age of 11. Students at the age of 11 threw the ball with the shortest distances, and the difference in comparison to boys at the age of 12 was shorter by approximately 1.94 [m].

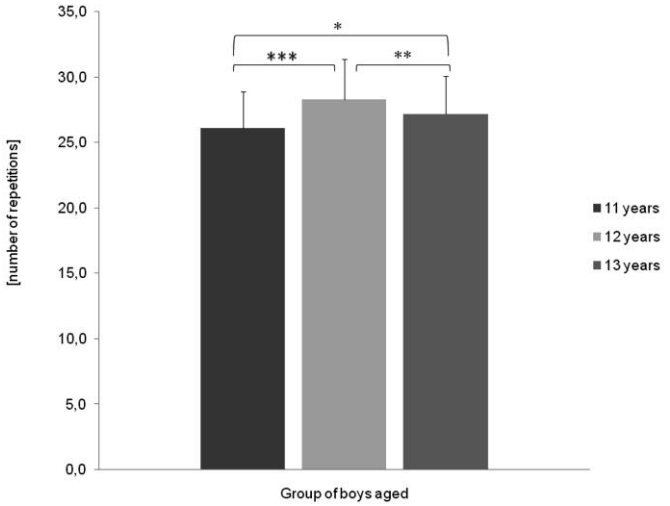
Fig. 3. Strength endurance of arm and shoulder muscles in groups of test students.



*** p<0.0001

The best results in trials on the muscle strength of the upper extremities and shoulders were attained by boys at the age of 12 and these results have a statistically high significance difference level in comparison to the results for the younger and older boys. In comparison to boys at the age of 11, the difference amounted to 19.42 [s], and in comparison to boys at the age of 13 years old the difference was 20.09 [s], Whereas the youngest boys achieved a slightly longer trial time of 0.66 [s] in comparison to the oldest boys, the difference is not statistically significant.

Fig. 4. Abdominal muscle strength measurements in three age groups of students.



*** $p<0.0001$; ** $p<0.02$; * $p<0.04$

The measures of the abdominal crunch tests (forward trunk bend from back lying position) clearly differentiate the strength of the three age groups of students. Boys aged 12 performed more bends in a limited period of time than their younger and older colleagues. Within 30 seconds, the oldest boys performed 1 bend more than their colleagues from the youngest group.

Discussion

The results of the study concerned three age groups of boys from the same urban area and from the same school community (a residential area and one of the largest schools in the city). The evaluation of selected motor skills in boys aged between 11 and 13 was related to strength skills (explosive strength) and muscle endurance (shoulder girdle and abdominal muscles). The study indicates that boys in the initial phase of puberty differ significantly in terms of their motor abilities.

The difference between the age samples of students in both trials of medicine ball throws (reflecting the explosive strength of upper extremities, shoulder girdle and trunk muscles) were significant at a very high level of P-value. Much better outcomes were obtained by the oldest pupils when compared with younger boys. Boys at the age of 13 were able to perform approximately 34% longer forward throws than their colleagues at age of 12, and as much as 54% longer throws than students at the age of 11. The difference in the length of forward throws between the youngest students and those at the age of 12 years old varied by 30%. A similar trend was observed during forward medicine ball throws overhead. During the trial, boys at the age of 12 attained approximately 30% greater distances than their colleagues at the age of 11,

which differed by 52% from the boys of 13. The difference in distance of backward throw lengths between the youngest students and those aged 12 varied by approximately 30%.

A similar trend was shown in a previous study from 2013 in a population of children aged from 10 to 12 from the town of Bochnia [8]. Also, among children of Polish emigrants living in London, boys aged 12 definitely prevail in obtaining longer distances in throwing medicine ball than the youngest ones. The present results are consistent with research by Pietraszewska [12]. She examined the development of children aged between 7 and 14 living in the countryside over a decade (1991-2000). The results suggest that after a slight slowdown, the increase in explosive strength development in boys aged between 9 and 11 is followed by its dynamic growth in boys at the age of 13 and 14. Asienkiewicz and Waddych's study indicates that there is a relationship between morphological features and selected motor abilities, combined with living environment [3].

Boys at the age of 12 achieved the longest time in the muscle strength of upper limbs and shoulders (overhang on a bar), as compared to boys at the age of 11 (established at around 42%), and to peers at the age of 13 (by approximately 43%). A curious phenomenon in the presented results is the longer overhang time achieved by the youngest participants in the tests, when compared to the oldest students (although the difference is not significant statistically). Archacka examined the impact of a complex spa treatment programme on physical fitness in children and adolescents who are overweight or obese. The group of boys at the age of 11 achieved the best outcomes in overhangs with bent arms, in comparison to boys at the age of 12 and 13 [1]. Moreover, better results were achieved by boys from the older age group than by boys at the age of 12. The present study is consistent with Pietraszewska's research and suggests that boys at that age seems to be characterized by greater regularity in the development of motor skills. The increase lasts till the age of 12. However, a slight regression in the process may appear at puberty [13]. Sunil Dutt performed research on a sample of 797 boys aged between 8 and 12. She found that better results of arm and shoulder muscle endurance were achieved by boys aged between 13 and 18, in comparison to boys aged 8 to 12 [5]. However, Górniak's study of a sample of children attending rural school revealed that boys at the age of 13 and 14 demonstrate the greatest capacity for functional strength [7]. In this case, living environment and ways of spending free time could have an effect on the differences.

The results of the abdominal muscle endurance (trunk bends lying back) test again clearly differentiate the age groups of boys. Boys at the age of 12 performed more bends in a limited period of time than their younger and older peers. Archecka found similar results [1]. However, Kazimierska and Spieszny [8] suggest that abdominal muscle strength increases with advancing age. Worth noting are the results of tests on a large population of boys at the age of 10 to 13, which covered characteristics of anthropometric features and physical abilities in Brazilian boys who had started sports training (football) [10]. The results of these studies indicate that older boys are more physically adept than younger boys in almost all trials. One exception was the test of agility: boys aged 11 attained better results than boys aged 12 and 13. Dominant strength of the upper part of the body can be observed in boys aged from 8 to 18, when compared to the strength of the abdominal muscle, hips and lower extremities [5]. Furthermore. the study performed across a population of 400 children aged 5 to 14 years (including a group of 200 boys) indicated that the strength and endurance of muscles constantly increases from 8 to 14 years, with fluctuations at the age of 11 to 13 [14].

Conclusions

The results of the study on the development of selected motor skills in boys in the phase of puberty suggests the following conclusions:

1) The progression of arm strength is significantly related to age. Boys aged 13 showed the best explosive strength of their upper limbs and shoulders in comparison to boys aged 12 and 11 years old. This can be useful information for the execution of the target and tasks of physical education (and elective courses) and pre-selection for sport.

2) Boys of 12 years old demonstrate significantly better stomach muscles and muscle capacity of the shoulder and arm girdle as compared to boys aged 11 and 13 years old. Boys aged 13 years scored significantly worse in muscle strength of shoulders and arms than boys aged 11 years. The results for boys aged 13 suggests a significant decrease in the ability of muscle strength. This indicates the importance of continuously monitoring the development of physical fitness and implementing appropriate compensatory programmes or prevention during adolescence.

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