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Features of the respiratory and cardiovascular system responses of girls 10–12 years of age on the swimming load

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Purpose: *study of the respiratory and cardiovascular system responses of girls aged 10–12 years on a dosed swimming load.*

Material & Methods: *the study involved 45 girls of 10–12 years old, engaged in the section of sports swimming. The method of spirography was measured: BH, RV, Pv of inhalation and exhalation, VC, MBV, MVL, RB, OC_2. Cardiovascular parameters were recorded: HR, BP, SV, MBV.*

Results: *the study showed that swimming the control 50 and 100-meter distances in the same age group is different due to the effect on the respiratory and circulatory systems, depending on the sport of swimming.*

Conclusions: *the results of the study showed that the greatest impact on the indices of the cardiorespiratory system of adolescents aged 10–11 years was observed while swimming the back crawl; and 12-year-old subjects performed larger loads "more economically". The dynamics of the studied functional systems of 12-year-olds showed that the greatest changes are observed when swimming 100 m breaststroke. In general, the load of 50 and 100 m distances is feasible for teenagers with all the sports swimming methods being studied.*

Keywords: *swimming, load, cardiovascular system, adolescents.*

Introduction

The age period from 10 to 12 years in girls is characterized by significant vegetative-endocrine changes in the body. At this age, the functional capabilities of the muscles and the cardiovascular system change [1; 3]. At the same time, at the age of 12, the extreme lability of the functions of respiration and blood circulation is noted, and the oxygen regimes of the body become less effective and economical [4; 6; 7]. We must not forget that, despite significant differences in the functional state of the apparatus of external respiration and circulation, young swimmers and their peers – not athletes, the body has not yet reached maturity and their age development and formation occurs in accordance with the same general biological laws. Therefore, the question of the impact of sports swimming on the body of young swimmers should be considered not only from the point of view of the influence on it of the specific features of the aquatic environment, but also taking into account the anatomical and physiological features.

Systematic training of adolescents in swimming favorably affects the development of external respiration apparatus, increases its functionality. In connection with the structural and functional changes of the heart that occur in the process of systematic training, adolescents are ahead of their peers who are not involved in sports for 1–2 years in terms of its development [6].

It is well known that, on the one hand, many factors are characteristic of swimming, which facilitate (compared to "ground" sports) the muscular work of young swimmers in the aquatic environment, on the other hand, swimming imposes extremely high demands on the apparatus of external respiration and blood circulation. Therefore, it is extremely important that the entire training system of young swimmers is built taking into account the age and anatomical and physiological characteristics of their body [5; 8].

Purpose of the study: study of the respiratory and cardiovascular system responses of girls aged 10–12 years on a dosed swimming load.

Material and Methods of the research

Studies of the reactions of the cardiovascular and respiratory systems of young swimmers to the dosed load are of undoubted interest [9; 12]. The characteristics of these effects on the developing organism of adolescents have practically not been studied.

As a metered load was taken swim for a 50-meter distance in different sports swimming methods. The study was conducted in the swimming pools of legal and polytechnic universities with the participation of 45 girls of 10–12 years old, who regularly attend the sports swimming section.

The method of spirography was measured: respiratory rate (RR), breathing volume (BV), reserve inspiratory and expiratory volume (Rv inspiration and Rv exhalation), vital capacity (VC), minute respiration volume (MRV), maximum lung ventilation (MLV), respiratory reserve (RR), oxygen consumption (OC_2). Blood pressure (BP) was measured by the method of N. S. Korotkov, the heart rate (HR) was recorded by the method of electrocardiography. According to Starr's formula [8] in the modification of N. S. Pugina and Ya. Yu. Bamash [2], the stroke (SV) and the minute volume of blood circulation (MVC) were calculated for adolescents. All indicators were recorded at rest and in the first 30 seconds after exercise.

Results of the research

At the first stage of the study, the reaction of the respiratory and cardiovascular systems to swimming 50-meter distances at an arbitrary speed was studied. The average time in the swims was: 87,6 s – for girls 10 years; 82,3 s – for 11-year-olds and 63,4 s – for 12-year-old athletes. The difference between 10 and 12 year old girls is significant (t=6,9).

As can be seen from Table 1, after the swimming load a greater degree of stress was experienced by the respiratory system of girls 10 and 11 years old. Thus, the MRV for 10 and 11-year-old swimmers increases to a greater extent than for 12-year-olds, while the VC in the 1st minute of recovery has changed slightly.

In subjects of all ages, the increase in BV after exercise occurred due to a decrease in Rv inhalation and mainly in exhalation Rv. The exhalation rate decreased the most in 10-year-olds, which indicates a large load on the respiratory muscles when swimming in a crawl on his chest.

MLV after exercise in girls 11–12 years old practically did not change, while in girls 10 years old it slightly decreased. This suggests that the capacity of the ventilatory function of the lungs of girls 11–12 years after the load remained high, while in the subjects of 10 years it was low. This is also confirmed by indicators of the dynamics of taxiway. It declined sharply in 10-year-olds. This is also indicated by the values of oxygen consumption. The lowest oxygen consumption was recorded in girls 11 years old, slightly higher rates were observed in 12-year-olds, and the highest oxygen consumption was recorded in athletes 10 years (Table 1).

Large consumption of O_2 in 10-year-old girls was provided by a high stress of the cardiovascular system. It should be noted that the largest increase in heart rate was recorded in swimmers 10 years. MVC increased in all 3 age groups due to the growth of both heart rate and SV. The largest increase in the MVC was also registered in girls 10 years of age and was achieved due to a greater heart rate, while the SV increased evenly in all age groups.

In 12-year-old athletes, blood pressure usually changed according to the normotonic type, whereas in subjects aged 10 and 11 years, both hyper- and dystonic types of reactions took place, which was reflected in the level of diastolytic pressure (Table 2).

Despite the fact that the tension of the cardiovascular and respiratory systems of girls 10 years old at the studied distance is the highest, there is reason to believe that this load is feasible for them, because after swimming the control distance MLV, which characterizes the functional ability of the respiratory apparatus, they have decreases slightly. At the same time, the RR of the subjects of this age decreased sharply. Apparently, a distance of 50 m imposes a requirement bordering on the limiting abilities of girls of 10 years.

Girls 11 years old had a greater voltage ventilation function than the cardiovascular. Despite a slight increase in swimming speed, the load for them is somewhat smaller than for 10-year-olds. The reserve capacity of 11-year-old athletes is somewhat larger, the MLV tends to increase and the RR is higher than that of 10-year-olds.

Dynamics of measurements of all indicators of girls 12 years old with a higher swimming speed is most adequate. This is evidenced by a change in heart rate and MVC.

Thus, the dynamics of the performance of the heart and respiration in most 10–12-year-old subjects is favorable, which gives grounds to consider the 50-meter distance to be adequate to the capabilities of their body.

The next stage of the study was to study the reaction of the respiratory and cardiovascular systems to swim the 100-meter distance at an arbitrary speed using the front crawl, back crawl by girls 10–12 years old and the breaststroke method by girls 11–12 years old.

An analysis of the research results showed that swimmers of the 100-meter distance of swimmers for 10 years did not have significant differences between the swimming methods of the crawl on the chest and back and ranged from 0,44 to 0,49 $m \cdot s^{-1}$. An analysis of the research results showed that swimmers of the 100-meter distance of swimmers for 10 years did not have significant differences between the swimming methods of the crawl on the chest and back and ranged from.

A higher CO_2 (19,2 $ml \cdot (min \cdot kg)^{-1}$ versus 16,4) was observed after swimming the crawl on the back. It was provided by an increase in MRV almost 5 times and MVC more than 3 times (Table 3, 4). With the way the crawl on the chest, the tension of the fan function was sharper (MRV increased 8.6 times), whereas the dynamics of the indicators of circulatory function when swimming by way of the crawl on the back, on the contrary, is more pronounced (MVC was 320% against 265).

When swimming with a front crawl, the respiratory type of compensation for deviations that occurred during exercise was more often observed; when swimming, the back crawl is a mixed type of compensation.

In subjects 11 years old, the difference in the speed of swimming distances by a crawl on the chest and on the back was not significant. The levels of functioning of the respiratory and cardiovascular systems did not have such significant differences as they had in girls 10 years. Mixed type of compensation prevailed in both ways. However, in subjects 11 years old, a higher oxygen demand in the first 30 seconds after the load was, like that of 10-year-olds, when swimming on a back crawl.

Despite the lower swimming speed, in the early recovery period after swimming the breaststroke method, CO_2 was noted more than in the first two methods. The higher values of MRV and MVC in the first 30 seconds after the swimming load using the breaststroke method also indicate that the effect on the body is the greatest.

In girls of 12 years, as in other age groups, after swimming with the breaststroke method, the degree of stress in the

Table 1

Dynamics of lung volumes and ventilation parameters of girls 10–12 years old at the swimming load, % of the rest level

Age	RR	BV	MRV	VC	Rv inspiration	Rv exhalation	MLV	RR	OC$_2$
10 years t	150,9± 4,95 2,24	249± 27,4 3,44	356± 71,2 2,23	92,9± 1,73 3,99	83,9± 35,5 2,28	54,7± 5,31 1,83	81± 13,8 5,23	18,1± 13,8 0,88	336± 13,6 8,27
11 years t	216± 24,4 3,9	232± 32,4 3,66	463± 55,2 6,17	105± 9,29 0,21	78± 10,4 1,71	77± 7,84 1,17	108± 4,31 0,40	37,4± 11,4 3,08	190± 12,9 4,34
12 years t	155,8± 13,2 2,58	206,4± 27,1 4,74	298± 38,0 3,34	95,5± 4,73 0,49	97,9± 5,43 0,21	72,5± 10,7 5,01	107± 12,9 0,25	50,5± 9,12 2,25	237,5± 42,5 3,04

Table 2

Dynamics of hemodynamic parameters of girls 10–12 years old at the swimming load, % of the rest level

Age	HR	Systolic pressure	Diastolic pressure	Pulse pressur	Systolic volume	Minute volume
10 t	200± 10,4 8,42	121,4± 2,12 5,90	103,5± 4,40 0,43	142± 4,40 3,68	113,5± 5,9 1,33	226± 8,4 6,80
11 t	167± 8,1 7,36	118± 2,92 2,89	101,3± 9,50 0,106	147,5± 22,5 2,09	114,5± 14,2 1,07	197± 23,0 1,32
12 t	171,7±9,10 4,13	107,7± 2,88 5,97	88,7± 1,21 1,34	174± 9,41 11,07	117,1± 3,03 3,16	206± 11,6 6,25

functions of respiration and circulation was higher than in the swimming methods for the crawl on the chest and on the back. Compared to 11-year-olds, the older responded to the 100-meter breaststroke swimming with a lower degree of adaptive changes in the indices of the respiratory and circulatory systems. In 12-year-olds with all methods of swimming a mixed type of compensation prevailed. Thus, swimming a 100-meter distance with the same or similar speed in the same age group differs in the strength of its effect on the respiratory and circulatory systems, depending on the method of swimming. In general, the load is feasible for students with all the swimming methods studied (MLV are not reduced, RR is above zero).

Conclusions / Discussion

The peculiarities of the reactions of the respiratory and cardiovascular systems of the subjects to swim the same distance revealed by us do not contradict the ideas of the development of the aerobic abilities of children and adolescents in modern literature [10; 11].

The results of the study confirmed the correctness of our conclusions that large loads per unit of body weight (both in power and in terms of CO_2) were observed in 10–11-year-old swimmers when swimming using the crawl on the back. More trained subjects with a swimming experience of 2–3 years

Table 3

Indicators of the respiratory function of girls 10–12 years after swimming a distance of 100 m in various ways, % of the rest level

Age	Way of swimming	Time, min	RR	BV	MRV	VC	MLV	RR	OC$_2$
10	Front crowl Back crowl	3.25,2 3.4,0	200± 29,5 223,5± 8,86	440± 37,2 212,4± 23,6	860,3± 114,8 476± 59,2	84,7± 83 89,7± 87	115± 3,06 126,6± 4,92	23,7± 7,62 28,3± 8,81	283,5± 13,7 340,3± 10,9
11	Front crowl Back crowl	2.52,8 3.14,0	202± 17,7 190,9± 5,05	213,8± 24,8 225,3± 9,01	431,6± 46,8 433,6± 22,8	81,6± 2,67 95,1± 1,08	103,7± 3,19 130,2± 4,3	33,4± 8,56 50± 4,81	214,1± 11,96 303± 10,5
12	Breaststroke Front crowl Back crowl	3.40,0 2.41,9 2.44,6	220,4± 9,32 202± 22,6 239,3± 4,91	186,7± 17,2 187,9± 20,1 174,4± 12,6	420,9± 24,5 377,6± 34,0 427,9± 45,6	85,6± 2,03 89,5± 3,15 90,6± 1,68	92,4± 7,92 108,2± 10,6 137,7± 4,61	21,5± 3,9 82,4± 17,7 4,46± 7,19	400,6± 4,4 177± 38,3 213,8± 7,15

Table 4

Indicators of the cardiovascular system of girls 10–12 years old after swimming a distance of 100 m in various ways, % of the resting level

Age	Way of swimming	Speed	HR	BPmin	BPmax	SV	MVC
10	Front crowl	0,49	210± 9,03	98,7± 1,36	127,4± 7,26	126,3± 6,55	265,1± 25,1
	Back crowl	0,44	218,2± 5,15	97,4± 2,96	146,9± 6,32	146,9± 3,17	320,7± 8,86
11	Front crowl	0,58	192,1± 7,08	93,7± 13,6	126,5± 10,4	132± 7,12	246,4± 23,9
	Back crowl	0,51	214,4± 5,69	97± 2,22	148,8± 4,79	145,8± 16,3	309,6± 16,2
12	Breaststroke	0,45	218,5± 2,71	95,5± 1,48	149± 4,6	146,8± 3,95	319,9± 9,42
	Front crowl	0,62	195± 60,4	89,7± 2,53	130,3± 4,25	131,8± 8,09	254± 18,5
	Back crowl	0,61	219,5± 9,14	97± 1,1	147,3± 3,97	140± 4,33	307,6± 18,3

perform larger loads "more economically" (from the point of view of CO_2 and the level of functioning of the respiratory and circulatory system).

Thus, the dynamics of indicators of the cardiorespiratory system is favorable, which gives reason to consider 50 meter and 100 meter distances to be adequate to the body's capabilities of 10–12 year old adolescents.

Prospects for further research are to study the reactions of the cardiorespiratory system to the swimming load of young swimmers 10–12 years old.

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