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ASSESSMENT OF HEMODYNAMICS IN STUDENTS PRACTICING SWIMMING

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ABSTRACT
Optimizing one's physical activity regime with the means of swimming is a good way to prevent and reduce various health problems. This type of physical activity has multilateral influence on the human body. In swimming, the achievement is measured accurately (in seconds) and it implies various appropriate possibilities for determining the level of training, control and real evaluation in its practitioners. The aim of this scientific study is to assess the impact of swimming through the field indicators used for the management of the training process. Methods: Assessment of the function of the cardiovascular system and the change in physical exertion. The results indicate an improvement in the function of the cardiovascular system. Conclusions: Systematic swimming activities, at an intensity tailored to the capabilities of its practitioners, improves physical capabilities and aerobic performance, which is a characteristic of the whole organism.

Key words: swimming, students, training process, physical capabilities, cardiovascular system

NTRODUCTION

"Modern lifestyle is marked by paradoxical contradiction – in the improved living conditions, the factors that negatively affect the harmonious development of human are increasing". The excessive mental overload is a reality fact and so is the reduced physical activity as well as the acceleration in the physical development and the reparations in terms of the physical capacity and overall fitness of the individual. At the same time, the requirements for high working capacity, especially for young people, are constantly increasing (1). Physical education (PE), as a general phenomenon, on one hand must be developed according to modern changes in the learning process of higher education institutions, on the other, to take into account new trends in the development of the different types of sports and the interests of students. The teaching process in the subject Physical Education and Sport in the higher education system is carried out through programs that meet the requirements and individual characteristics of the practicing students. In recent times, the issue of the quality of the educating process, the innovative learning methods and the constantly decreasing students' motivation for active participation in the learning process, has been repeatedly discussed at all levels. Sports educators in universities are constantly looking for incentives that would motivate young people to participate consciously and actively in sport activities. Young people should also be given the necessary knowledge to make them rethink the importance of an active lifestyle for their health, their personal development, and their full preparation for life. The volume of regulated Physical Education work, as well as the nature of the course of this activity, is such that the actual opportunities of the students are too limited to achieve the goal and tasks that lie ahead of the educational process (2). Particular attention needs to be paid to the preparation and motivation of young people in this field. Hristova in her study (3) highlights that the specific environment of sports classes poses big challenges for the participants. Active physical activity requires motivated attitude and willful effort from the participants.

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The latter requires individualization of the learning process, and the intensity of work must take into account the capabilities of the learners.

The above mentioned constantly provokes the researchers in the field of Physical Education and sport to look for various innovative methods and means for influencing the increase of students' motivation for physical activities. An in depth study of the process of Physical Education is inconceivable without the use of objective and modern methods. They give the opportunity to compare the same or different objects, indicators, and data.

Swimming is a necessity, skill and sport with a multifaceted influence on the human body, useful and desirable above all, because of the opportunity to achieve a diverse and harmonious physical development and strengthening of health, equally necessary for all people of all ages (4). It is very different from other sports, especially with the unusual environment in which it takes place. Undoubtable is its importance as an effective way for expanding the adaptive capabilities of the body.

The training process in swimming is a complex, managed and dynamic system. Clarity is needed both in the individual personal characteristics and in the specifics of sport swimming as well as the impact of the aquatic environment. Without knowledge of these guidelines, swimming sports activity cannot be properly placed and regulated. Under the influence of systemic physical activity, by applying regular workouts and directed exercises in the water with the means of swimming, cardiac and respiratory activity become more effective and economical.

The pulse rate is considered as the main indicator of how much load the given physical activity is. Depending on how intense physical activity is, the heart changes its pace of work. When we want to work out for maintaining good health, the workload should increase the pulse rate above 50% of its maximum. The easiest way to determine the maximum heart rate is by subtracting the age from 220. **Hrmax = 220-age**. This is the value, at which maximum oxygen consumption (VO2 max) is achieved. This method is not accurate, but it gives us indicative information on which basis we can determine the intensity of physical exertion. The intensity of work must take into account the capabilities of the participants.

When swimming, overcoming water resistance requires serious efforts from almost all muscle groups, but at the same time, the cardiovascular system and the heat release of the body are seriously relieved. This allows the swimmer to perform much more mechanical work in volume than in other sports practiced in air environment (5). The so-called aerobic loads include more than 50% of the muscle mass of the body. Thus, aerobic working capacity is a characteristic of the whole organism (6). To determine the workload, the pulse rate is measured, which is a good terrain indicator and orients us in the choice of moderate intensity of each load (should not exceed 150 beats per minute). At physical loads of low intensity, the pulse (HR) should be between 40-55% of the maximum, while at loads of medium (moderate) intensity should be between 55-70% (7).

METHODS

Our study's hypothesis was that swimming classes for university students improve those indicators and stimulate active lifestyle. The indicators, which were evaluated, are heart rate, distance passed and average speed during activity. We tracked the data for two academic years. Swimming is a preferred sport by a large number of students (24.58%), evenly distributed by both sexes (3).We selected students who participated in the swimming classes for the experimental group and students who chose to practice another sport for the control group.

The aim of the experiment was to track the results and relevant variables and to compare them by using different methods and means such as research of literary sources, targeted observation, testing and statistical methods.

The main task was to study the impact of swimming through the field indicators for management of the training process (pulse rate in rest and cardiorespiratory endurance). The data from the conducted sports-pedagogical testing were processed by variance analysis, which allows revealing the average levels and variability of the studied indicators.

The experiment involved 101 students from Sofia University, enlisted into control and experimental groups divided into subgroups by gender. All participants were in the age range

19-25 years. The sports activities in the selected sport of the students in the Control Group (CG1 and CG2) were held once a week with a duration of 90 minutes. Those of the Experimental Group (EG1 and EG2) were held twice a week in a 25 meters pool, lasting 90 minutes. Each swimming class of the Experimental Groups contained 30 minutes theoretical part and 60 minutes practical exercises (swimming) involving controlled physical exertion of moderate intensity (PR up to 150 beets/min). The difference between the two groups was in the application of different methodologies (according to the type of sport), as well as the number of weekly activities and the presence of a theoretical part in the methodology applied in the EG. For assessing the level of fitness, the functional indicators (pulse rate at rest and cardiorespiratory endurance) were taken.

RESULTS AND DISCUSSION

Our study's results are presented in the following tables and graphics, including individual values in the beggining and in the end of the experiment (**Table 1**). For analyzing the data, we applied Variance analysis and Student's *t*-test

Table 1. *Functional indicators*

Experimental Group 1										
№	**name**	**n**	**min**	**max**	**R**	**X**	**S**	**V**	**As**	**Ex**
1.	Puls in rest - beggining	20	60	88	28	73.4	7.0	9.6%	-0.298	0.044
2.	Puls in rest - end	20	58	80	22	67.6	5.5	8.1%	0.113	-0.047
3.	YMCA step test - beggining	20	94	120	26	102.4	6.3	6.2%	1.147	1.811
4.	YMCA step test - end	20	88	100	12	93.0	4.2	4.5%	0.816	-0.820
Control Group 1										
№	**name**	**n**	**min**	**max**	**R**	**X**	**S**	**V**	**As**	**Ex**
1.	Puls in rest - beggining	25	64	92	28	77.3	6.2	8.0%	0.294	0.563
2.	Puls in rest - end	25	62	84	22	73.9	5.3	7.1%	0.180	-0.047
3.	YMCA step test - beggining	25	88	165	77	113.4	21.5	19.0%	0.780	-0.259
4.	YMCA step test - end	25	84	140	56	103.1	14.8	14.4%	0.621	-0.293
Experimental Group 2										
№	**name**	**n**	**min**	**max**	**R**	**X**	**S**	**V**	**As**	**Ex**
1.	Puls in rest - beggining	24	60.0	78.0	18.0	68.5	5.3	7.8%	0.184	-0.991
2.	Puls in rest - end	24	60.0	70.0	10.0	64.9	3.6	5.5%	0.222	-1.168
3.	YMCA step test - beggining	24	94.0	140.0	46.0	110.3	12.2	11.0%	0.686	-0.202
4.	YMCA step test - end	24	88.0	112.0	24.0	97.5	8.0	8.2%	0.577	-0.945
Control Group 2										
№	**name**	n	min	max	R	X	S	V	As	Ex
1.	Puls in rest - beggining	32	62.0	90.0	28.0	74.7	6.7	9.0%	0.275	-0.024
2.	Puls in rest - end	32	60.0	80.0	20.0	71.6	5.5	7.7%	0.018	-0.671
3.	YMCA step test - beggining	32	80.0	160.0	80.0	105.7	16.5	15.6%	1.129	2.485
4.	YMCA step test - end	32	78.0	140.0	62.0	98.8	12.8	13.0%	0.962	2.131

The first indicator "heart rate" is one of the most commonly used indicators in sports practice for managing the intensity of the workout. This is an integral indicator of the body's function at rest and during physical exertion. The pulse rate at physical exertion is determined by the energy needs, the function of the respiratory system, the oxygen capacity of the blood and the degree of oxygen absorption by muscle cells. In addition, the pulse rate is directly related to the minute volume of the heart, therefore it depends on its stress volume. The second indicator of hemodynamics "YMCA step-test" using an evaluation scale **(Table 2)** enables us to track the adaptation of the cardiovascular system to physical exertion and the functional state of the studied person.

Table 2. *YMCA step test evaluation*

evaluation	**age (18-25 years)**	
	men	women
excellent	70-80	72-85
very good	81-90	86-99
good	91-100	100-108
average	101-106	109-117
below average	107-116	118-126
bad	117-129	127-140
very bad	130-164	141-155

In the haemodynamics indicators we tracked **(Table 3, Figurr 1)** at CG1 and EG1, it was evident that the groups were homogeneous (EG1 beggining V=9,6, end V=8,1; CG1 beggining V=8, end V=7,1). The difference in the average levels of these indicators is statistically reliable. The exception is the "heart rate in rest" test in the beggining, where the result is statistically insignificant. According to the number of persons surveyed and the risk of error 0.05 in CG1, the theoretical value of the Student's *t*-test is 2.06. In EG1, the same value is 2.09. The results of the comparative analysis show a high guarantee probability (P > 95%).

Table 3. *Statistical confidence between mean levels of haemodynamics indicator test for men in CG1 and EG1*

puls in rest	**beggining**		**end**		**d**	**t**	**α**	**P(t)**
group	**X beggining**	**S beggining**	**X end**	**S end**				
Experimental (EG1)	73.4	7.0	67.6	5.5	-5.8	-7.71	0.000	100.0%
Control (CG1)	77.3	6.2	73.9	5.3	-3.4	-6.91	0.000	100.0%
difference	-3.9		-6.3		-2.4			
t	-1.97		-3.92		-2.82			
α	0.055		0.000		0.007			
P(t)	94.5%		100.0%		99.3%			

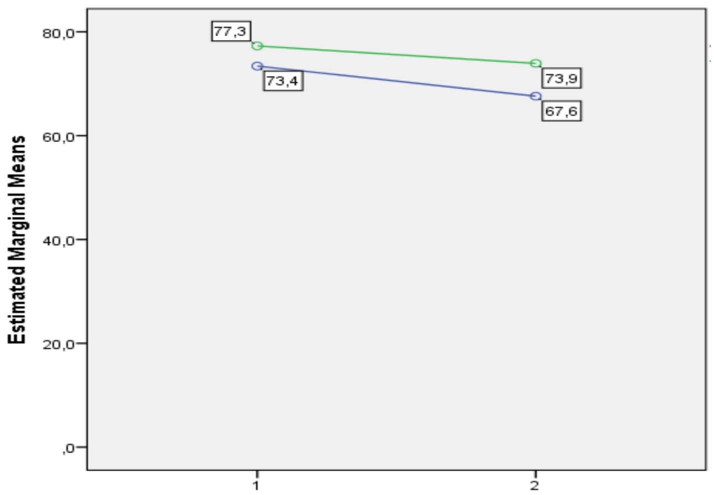

Figure 1. Diagram of men's mean values in EG1 and CG1 for the indicator "Pulse rate at rest"

Table 4. *Statistical confidence between mean levels of haemodynamics test indicator for women from EG2 and CG2*

puls in rest	**beggining**		**end**		**d**	**t**	**α**	**P(t)**
group	**X beggining**	**S beggining**	**X end**	**S end**				
Experimental (EG1)	68.5	5.3	64.9	3.6	-3.6	-7.446	0.000	100.0%
Control (CG1)	74.7	6.7	71.6	5.5	-3.1	-7.266	0.000	100.0%
difference	-6.2		-6.6		-0.5			
t	-3.722		-5.438		-0.707			
α	0.025		0.000		0.483			
P(t)	100.0%		100.0%		51.7 %			

For the indicators of hemodynamics for the women **(Table 4, Figure 2)** in CG2 and EG2, it is evident that the groups were homogeneous - EG2 beggining V= 7.8, end V = 5.51, CG2 beggining V = 9.0, end V=7.7. The difference in the average levels of these indicators is statistically reliable. According to the number of persons surveyed and the risk of error 0.05 in CG2, the theoretical value of the Student's *t*-test is 2.04. In EG2, the same value is 2.07. The results of the comparative analysis show a high guarantee probability (P > 95%).

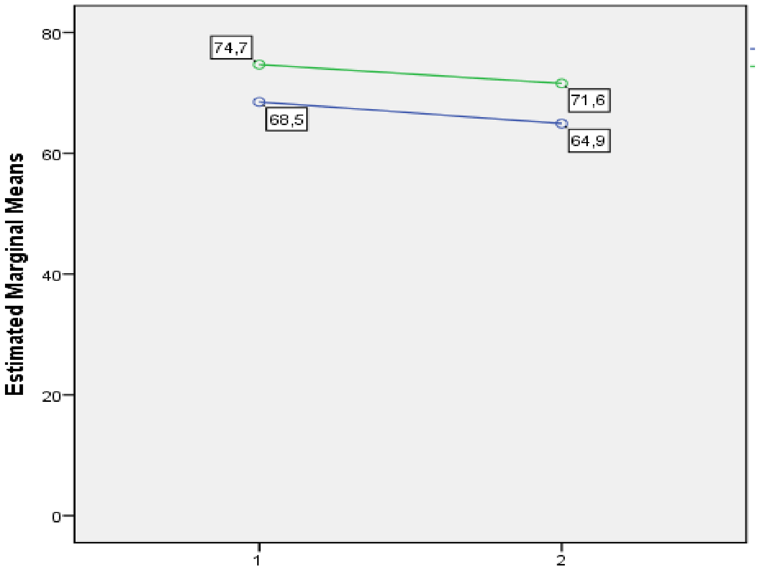

Figure 2. Diagram of women's mean values in EG1 and CG1 for the indicator "Pulse rate in rest"

The YMCA step-test in the male experimental group was homogeneous, the control group was approximately homogeneous (EG1 beggining V=6.2, end V=4.5; CG1 beggining V=19, end V=14.4). The difference in the mean levels of these indicators is statistically reliable **(Table 5, Figure 3).** The mean difference in the beggining and in the end between the groups can be assumed to be of a random nature (α>0,005). The results of the comparative analysis show a high guarantee probability (P > 95%). We observe statistical guarantee P(t) = 100 % in both the dependent and independent sample. The results are in one direction in both groups and a decrease in pulse rate values is noted.

Table 5. *Statistical confidence between mean levels of haemodynamics indicator test for men in CG1 and EG1*

YMCA step test	beggining		end		d	t	α	P(t)
group	X beggining	S beggining	X end	S end				
Experimental (EG1)	102.4	6.3	93.0	4.2	-9.4	-10.78	0.000	100.0%
Control (CG1)	113.4	21.5	103.1	14.8	-10.2	-6.33	0.000	100.0%
difference	-11.0		-10.1		0.8			
t	-2.42		-3.25		0.46			
α	0.022		0.003		0.650			
P(t)	97.8%		99.7%		35.0%			

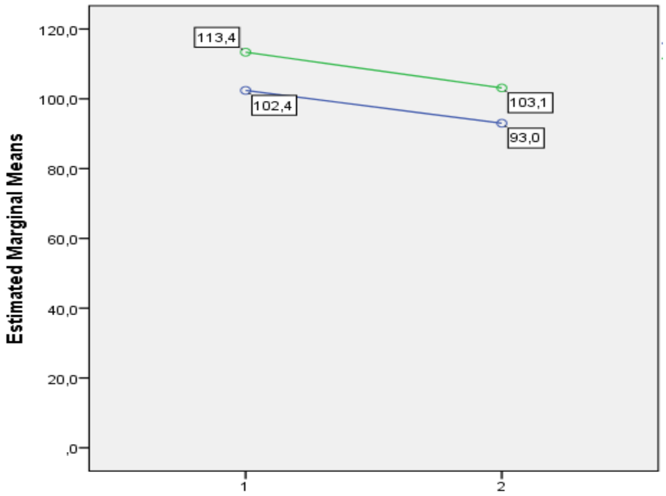

Figure 3. Diagram of men's mean values in EG1 and CG1 for YMCA step test indicator

In the YMCA step-test **(Table 6, Figure 4)**, the female experimental group showed uniformity (EG2 beggining V= 11.0, end V= 8.2), and in the female control group the result showed approximate uniformity (CG2 beggining V=15.6, end V=13.0). The difference in the mean levels of these indicators in the sample was statistically reliable, while the difference between the two groups was random (α>0,005). The results of the comparative analysis in the dependent samples show a high guarantee probability (P = 100%). In the independent sample of both groups (CG2 and EG2), we observed statistical guarantee input P(t)=74.0% and output P(t) = 74.0%, which shows us that there is no statistically reliable difference in the results. The results here are relatively in one direction in both groups and a decrease in pulse rate values is noted.

Table 6. *Statistical confidence between mean levels of haemodynamics test indicator for women from EG2 and CG2*

YMCA step test	beggining		end		d	t	α	P(t)
group	X beggining	S beggining	X end	S end				
Experimental (EG1)	110.3	12.2	97.5	8.0	-12.8	- 10.296	0.000	100.0%
Control (CG1)	105.7	16.5	98.8	12.8	-6.9	-7.765	0.000	100.0%
difference	4.6		-1.3		-5.8			
t	1.139		-0.419		-3.908			
α	0.260		0.677		0.000			
P(t)	74.0%		32.3%		100.0%			

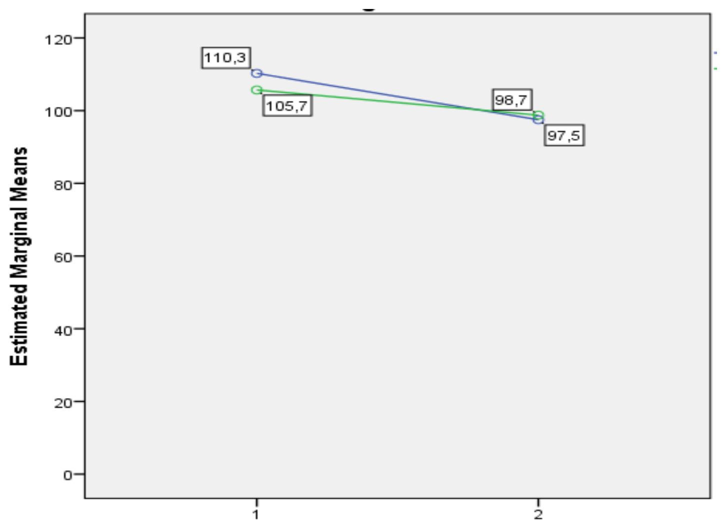

Figure 4. Diagram of women's mean values in EG1 and CG1 for YMCA step test indicator

CONCLUSION

Our survey made it possible to identify objectively specific trends and features formulated as follows: swimming activities in sports classes improve the indicators we studied and stimulated active lifestyle. The changes in the two-year study period in both groups show trends that can be formulated as follows:

- At the end of the experiment, the functional state of the students improves in both groups.
- For the two years study period, favorable changes occurred in both groups, but only in the experimental group, they are consequential.

In the initial testing, the arithmetic mean values between EG and CG were small and in most cases statistically insignificant. The difference in PR at rest indicator between the two male groups increased at the end of the experiment to 6.3 beats/min (P<0,001), which is due to the reduced values of this parameter in EG, as opposed to CG, in which PR slows down significantly less. It is established that in CG1, after the YMCA step test, the result in the beginning is 113.4, which according to Table 2 is within the limit of a "below average" rating. The result in the end of the experiment showed an improvement of 9.7 beats/min (average rating). This shows us that sports activities once a week are not enough to improve the functional state of the body. The same indicators 'result in the male EG1 after the YMCA step-test is 102.4, which according to Table 2 is within the limit of the "average" rating. In the end, it shows an improvement of 9.4 beats/min, which takes a "good" rating. In this group, swimming activities were held twice a week. In the female EG2 PR in rest at the beginning is 68.5, and in the end decreases by 3.6 beats/min. After the YMCA step-test, the result in the beggining is 110.3 (which scores average), in the edn decreases by 12.8 beats/min (very good rating). In the female CG2 PM at rest at the entrance is 74.7, in the end decreases by 3.1 beats/min. After the YMCA step-test, the result in the beginning is 105.7 (good rating), in the end decreased by 6.9 beats/min (again a good rating). The smaller changes in PR at rest of CG1 and CG2 may be associated with the less physical activity of which participants were subjected during the study period, but we assume that sports classes, although too insufficient, have a positive impact on the "economization" of cardiac activity. The creation of conditions and opportunities for expanding the number of students to participate in sports activities, with a view of improving their physical capacity, proper alternation of mental work and active recreation should be a main goal in the preparation of curricula in each faculty. In this sense, swimming, as a dominant type of activity for its practitioners, makes its specific requirements to them. At the same time, systematic participation in this activity will contribute to a certain evolving effect.

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