FACTA UNIVERSITATIS
Series: **Physical Education** Vol. 1, Nº 6, 1999, pp. 51 - 58

Professional Paper

THE INFLUENCE OF SPORTS EXPERIENCE LENGTH ON PULSE FREQUENCY IN STATE OF RESTING AND IN EXERCISE AT SPORTSMEN

UDC 796.03: 591.112.1

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Abstract. *The subject of research of this paper is the study of the influence of sports experience length on reaction of cardiovascular system observed through pulse frequency in state of resting, in exercise and in recovery at sportsmen. The goal of the research of this paper is to establish the importance of differences of the observed variables between two groups of tested persons. The first group of tested persons included 30 swimmers aged 11-12 years, with sports experience length 1-3 years, and the second group included 15 water-polo players aged 16-17 years, with sports experience length 4-11 years. For the requirements of this research, the sample of variables included the following ones: age, sports experience length, height in cm, corporal mass in kg, and the speed of swimming on 43 meters. The functional variable which was monitored is the pulse frequency: 1. in state of resting, 2. immediately after the exercise, 3. in the first minute after the end of exercise, 4. in the second minute after the end of exercise, 5. in the firth minute after the end of exercise. For all the variables that are the subject of this research, the basic descriptive statistical parameters were calculated: arithmetic mean value, standard deviation, coefficient of variation, minimal and maximal value. The statistical importance of differences of arithmetic mean values of the examined variables was determined by student's T- test. The coefficient of correlation in the whole applied system of variables will also be calculated. The results that we got show that the pulse frequency in state of resting is, on average, lower at sportsmen (water-polo players) who, on average, have longer sports experience (4 years) in comparison to the sportsmen (swimmers) with shorter sports experience (2 years). Body height and mass, at water-polo players, have the effect on higher pulsation after the exercise and also, on slower recovery, which is especially manifested in the second minute of recovery.*

Key words: *speed of swimming, sports experience length, pulse frequency, recovery of a sporsman.*

1. INTRODUCTION

It is known that at sportsmen, especially at sports of endurance type, the heart adjusts to great physical exercises (efforts) so that it behaves in a little bit different way in comparison to the heart of untrained persons (2).

Children who are untrained have a smaller heart. At children and youth, the size of heart, circulation of blood and breathing are constantly subject to changes due to the growth and training (3).

With the growth, the indicators of cardio-circulatory system are changed: artery pressure is increased, pulse is made less frequent, stroke and minute volume of heart are increased which improves efficiency of heart work, from the point of energetic needs (4).

Pulse, stroke and minute volume of heart at children and very small children (average results) (1):

Age	Pulse beat/min.	Stroke volume of heart	Minute volume of heart
Newborn infant	135	2.5	335
1	120	10.2	1220
6	95	20.6	1960
7	92	23.0	2120
8	90	25.0	2240
9	88	27.0	2370
10	86	29.2	2510
11	84	31.6	2650
12	82	33.4	2740
13	80	35.7	2850
14	78	38.5	3000
15	76	41.4	3250

2. THE SUBJECT OF RESEARCH

The subject of research of this paper is the research of the influence of sports experience length on reaction of cardiovascular system observed through pulse frequency in state of resting, in exercise and in recovery.

3. THE GOAL OF THE RESEARCH

The goal of the research of this paper is to establish the importance of differences between the examined samples of tested persons.

4. METHODS OF WORK

4.1 The sample of tested persons

The sample of tested persons is presented by two groups of selected sportsmen who go in water sports. The research included 30 tested persons, the swimmers aged 11 and 12 whose sports experience was from 1 to 3 years. The other group included 15 water-polo players, aged 16 and 17, whose sports experience was from 4 to 11 years. All the

tested persons were examined by doctors before the beginning of the research, and therefore, the healthy, functionally and physically capable ones were included in the research. All the tested persons are registered members of the Swimming and Water-polo club "Niš" from Niš .

The group of the tested persons who go in for swimming has 6 training seasons a week and the scope of swimming is about 20 kilometers in aerobic regime. 3% of the total weekly scope goes for speed.

The tested persons aged 16 – 17 have 6-9 training seasons a week and the scope of swimming, during the greater part of the season, is 15-18 km, but specific exercises and the game on two goals are not taken into consideration. The swimming intensity is mainly connected to the maximal consumption of oxygen as well as to the speed – strength exercise.

4.2 The sample of variables

For the needs of this research, the sample of variables included the following variables: age, sports experience, height in cm and corporal mass in kg, speed of swimming on 43 m. The functional variable which was monitored is the pulse frequency: 1. in state of resting, 2. immediately after the exercise, 3. in the first minute after the end of exercise, 4. in the second minute after the end of exercise, 5. in the fifth minute after the end of exercise.

For all the variables that are the subject of this research, the basic descriptive statistical parameters were calculated: arithmetic mean value, standard deviation, coefficient of variation, minimal and maximal value. The statistical importance of differences of arithmetic mean values of the examined variables was determined by student's T- test . The coefficient of correlation in the whole system of variables was also calculated.

5. RESEARCH RESULTS WITH DISCUSSION

The results of this research with discussion will be shown in charts, in logical sequence.

Chart 1. The basic statistical parameters of height and body mass of swimmers aged 11

Variables	SV	SD	Cv	MIN	MAX
Body height in cm	147.16	9.06	6.15	134.00	161.00
Body mass in kg	40.10	5.26	13.11	31.00	52.00

We can see from the chart 1. that the selected swimmers, whose average age is 11 years, have bigger average height and body mass in comparison to the average body height of citizens of Nis the same age (144.6 cm).

Chart 2. The basic statistical parameters of body height and mass of water-polo players aged 16,5

Variables	SV	SD	Cv	MIN	MAX
Body height in cm	181.60	3.08	1.69	175	185
Body mass in kg	75.20	8.42	11.19	58.00	94.00

The results shown in Chart 2 indicate that water-polo players aged 16,5 have significantly bigger body height in comparison to the average body height of the citizens of Nis of the same average age. Water-polo requires high, strong sportsmen with bigger body mass.

The results shown in Charts 1 and 2 give the basic insight in anthropo-metric status of the tested persons (height and weight) whose pulse frequency is examined in different phases: in state of resting, in exercise and recovery.

Chart 3. The basic statistical parameters of sports experience and pulse frequency in state of resting at the swimmers aged 11

Variables	SV	SD	Cv	MIN	MAX
Sports experience	2.66	0.47	17.66	2.00	3.00
Pulse frequency in state of resting	108.23	7.69	7.10	96.00	126.00

Chart 4. The basic statistical parameters of sports experience and pulse frequency in the state of resting at water-polo players aged 16,5

Variable	SV	SD	Cv	MIN	MAX
Sports experience	4.86	2.06	42.38	2.00	11.00
Pulse frequency in state of resting	99.33	8.50	8.55	84.00	114.00

By the analysis of this research results, which are shown in Charts 3 and 4, it can be concluded that sports experience at water-polo players is longer in comparison to swimmers experience, which can be explained also by the average age which is higher at water-polo players than at swimmers.

It can also be noticed that pulse frequency at state of resting is high at sportsmen, in spite of the fact that is was measured in a sitting position. Higher pulse values at state of resting can be explained by the pre-start "fever" which had greater influence on swimmers, in addition to their age and less experience. Higher pulse frequency at swimmers in comparison to water-polo players can be explained in this way, too. Coefficient of variation indicates that the group of swimmers is more homogeneous (Cv – 7.10) than the group of water-polo players (Cv – 8.55), observed through average values of pulse frequency per minute.

Chart 5. Statistical importance of differences of arithmetic mean values of sports experience and pulse frequency in state of resting at swimmers and water-polo players

Variables	Swimmers		Water-polo players		T	P
	SV	SD	SV	CD		
Sports exper. in years	2.66	0.47	4.86	2.06	–4.32	<0.01
Pulse at state of rest/min.	108.23	7.69	99.33	8.50	3.04	<0.05

In Chart 5, the results that we got indicate that swimmers have, in statistical sense, significantly less sports experience, on average, in comparison to water-polo players. Before the start of swimming, the pulse frequency in state of resting is, in statistical sense, significantly higher at swimmers in comparison to the pulse frequency in state of resting at water-polo players. This can be explained, beside the age and swimming

experience, also by the influence of training exercises (loads) on pulse frequency in state of resting.

Chart 6. Basic statistical parameters of swimming speed, pulse frequency in exercise, in the first, second and fifth minute of swimmers' recovery

Variables	SV	SD	Cv	MIN	MAX
Swimming speed in sec.	30.50	3.10	10.16	23.00	36.00
Pulse frequency in exercise / min	184.76	5.25	2.84	173.00	196.00
Pulse freq. in 1st minute of recovery / min	126.60	8.25	6.51	114.00	138.00
Pulse freq. in 2nd minute of recovery / min	113.73	8.84	7.77	96.00	126.00
Pulse freq. in 5th minute of recovery / min	97.13	11.07	11.39	78.00	116.00

The results shown in Chart 6 indicate that swimmers had lower pulse frequency in the fifth minute of recovery in comparison to the pulse frequency in state of resting before the start. This can be explained by the fact that in the fifth minute after the swimming, there was the stabilization of nervous system, so that the relation-ship of sympaticus and parasympaticus in this phase was in favor of parasymaticus (n. vagus).

The behavior of pulse frequency in exercise and in recovery indicates that water-polo players, after they had swam the same distance, responded, on average, by lower pulse frequency than the swimmers did. This can be explained by longer sports experience, maturity of nervous system (they are older, on average) and bigger adaptation of cardiovascular system to exercise (effort). The speed of recovery is bigger at water-polo players than at swimmers. This can especially be seen at pulse frequency in the fifth minute of recovery (97.13 / min) which is lower than the pulse frequency in state of resting of water-polo players.

Chart 7. Basic statistical parameters of swimming speed, pulse frequency in exercise, in the first, second and fifth minute of recovery of water-polo players

Variables	SV	SD	Cv	MIN	MAX
Swimming speed in sec.	24.53	1.35	5.50	22.00	26.00
Pulse frequency in exercise / min	179.86	7.61	4.23	168.00	198.00
Pulse freq. in 1st minute of recovery / min	103.06	8.57	8.84	90.00	120.00
Pulse freq. in 2nd minute of recovery / min	99.86	6.39	6.39	88.00	108.00
Pulse freq. in 5th minute of recovery / min	87.73	4.83	5.50	78.00	96.00

Chart 8. Statistical importance of differences of arithmetic mean values of swimming speed, pulse frequency in exercise and in the first, second and fifth minute of recovery of swimmers and water-polo players

Variables	Swimmers		Water-polo players		T	P
	SV	SD	SV	SD		
Swimming speed in sec.	30.50	3.10	24.53	1.35	7.45	<0.001
Pulse frequency in exercise / min	184.76	5.25	179.86	7.61	1.57	>0.05
Pulse freq. in 1st minute of recovery / min	126.60	8.25	103.06	8.57	6.20	<0.001
Pulse freq. in 2nd minute of recovery / min	113.73	8.84	99.86	6.39	5.07	<0.001
Pulse freq. in 5th minute of recovery / min	97.13	11.07	87.73	4.83	3.40	<0.05

By the analyses of the results shown in the Chart 8, we can come to the conclusion that the swimming speed (at a certain distance) of water-polo players - 24.53sec. is, statistically, significantly faster than the swimming speed of swimmers – 30.50 sec. This can be explained by the influence of training process and constitution (bigger mass and height of a body) as well as by the age since water-polo players are older.

Pulse frequency immediately after the end of swimming is numerically higher at swimmers – 184.76 in comparison to water-polo players – 179.86. This difference is not statistically significant.

Pulse frequency in the first, second and fifth minute of recovery is, statistically, very significantly lower at water-polo players than at swimmers. This can be explained by longer sports experience, older age as well as by better training of cardiovascular system of water-polo players, which finally results in faster recovery of this system at water-polo players.

Chart 9. Linear correlation of variables: age (STAR), sports experience (SSTA), pulse in state of resting (PUMI), body height (AVIS), body mass (AMAS), pulse after exercise (PULO), swimming speed (BRLP), pulse in the first minute of recovery (PU1M), pulse in the second minute of recovery (PU2M0), pulse in the fifth minute of recovery (PU5M) at swimmers

Variables	1	2	3	4	5	6	7	8	9	10
1. STAR	1.00									
2. SSTA	.20	1.00								
3. PUMI	–.67	–.29	1.00							
4. AVIS	.53	–.03	–.76	1.00						
5. AMAS	.01	.08	–.25	.55	1.00					
6. PULO	.22	–.24	–.55	.42	–.09	1.00				
7. BRPL	-.66	.00	.75	–.49	–.27	–.41	1.00			
8. PU1M	.48	–.10	.06	–.03	.06	–.10	–.12	1.00		
9. PU2M	.56	.57	–.19	.05	.19	–.35	–.21	.54	1.00	
10. PU5M	.25	.34	.20	–.16	.10	–.46	.02	.41	.29	1.00

Chart 9 shows the results of linear correlation of the examined variables at swimmers. We got the results which indicate that there is a great negative and significant correlation between pulse frequency in state of resting and the years of age. Namely, along with the years of age, pulse frequency slows down. A significant and positive correlation is shown by body height with the years of age (which is logical, too because height increases along with the years of age up to the mature age).

Sports experience shows significant and positive correlation with pulse frequency in the second minute of recovery (.57). Pulse frequency in state of resting shows high, significant and negative correlation with body height (–.76), significant and negative correlation with pulse frequency in exercise (–.55), high, significant and positive correlation with swimming speed (.75). Body height shows positive and significant correlation with body mass, which is understandable since with body height, body mass increases, too. Pulse frequency in the first minute of recovery shows significant and positive correlation with pulse frequency in the second minute of recovery.

Chart 10. Linear correlation of variables: age (STAR), sports experience (SSTA), pulse in state of resting (PUMI), body height (AVIS), body mass (AMAS), pulse after exercise (PULO), swimming speed (BRLP), pulse in the first minute of recovery (PU1M), pulse in the second minute of recovery (PU2M), pulse in the fifth minute of recovery (PU5M) at water-polo players

Variables	1	2	3	4	5	6	7	8	9	10
1. STAR	1.00									
2. SSTA	.00	1.00								
3. PUMI	.15	−.13	1.00							
4. AVIS	.09	.14	−.12	1.00						
5. AMAS	−.20	.10	−.00	.78	1.00					
6. PULO	−.07	.01	−.13	.66	.57	1.00				
7. BRPL	−.11	−.02	.33	−.55	−.30	−.57	1.00			
8. PU1M	−.28	−.07	.16	.09	.16	−.03	−.26	1.00		
9. PU2M	−.30	−.01	.33	.22	.39	.20	−.38	.74	1.00	
10. PU5M	−.15	−.00	.35	−.10	−.16	.08	−.09	.22	.54	1.00

The results that we got are shown in Chart 10 and they show that body height highly and positively correlates with body mass (.78) and pulse frequency in exercise (.66) at water-polo players. There is negative, high and significant correlation between body height and swimming speed (−.55). Body mass of water-polo players shows significant and positive correlation with body height (.78), pulse frequency in exercise (.57) and pulse frequency in the second minute of recovery (.39). Pulse frequency in exercise shows significant and high negative correlation with swimming speed on a certain distance. Swimming speed on a certain distance at water-polo players shows significant and negative correlation with pulse frequency in the second minute of recovery. Pulse frequency in the first minute of recovery shows high positive and significant correlation with pulse frequency in the second minute of recovery (.74). Pulse frequency in the second minute of recovery correlates highly and positively with pulse frequency in the fifth minute of recovery.

6. CONCLUSION

On the basis of the research results which included the sample of 30 swimmers, 11 years old on average, and 15 water-polo players, 16 years old on average, the following can be concluded:

Pulse frequency in state of resting is, on average, lower at sportsmen (water-polo players) who, on average, have longer sports experience (4 years) in comparison to the sportsmen (swimmers) with shorter sports experience (2 years). This is the result of the influence of sports experience length, intensity and length of sports training and the age, too. The sportsmen with longer sports experience swam 43 meters long line, in statistical sense, significantly faster than the sportsmen with shorter sports experience. Cardiovascular system responded with lower pulse frequency at the end of exercise at sportsmen with longer sports experience, but that was not statistically significant. The sportsmen with longer sports experience have, in statistical sense, significantly faster

recovery in the first, second and fifth minute after the exercise than the sportsmen with shorter sports experience in the first, second and fifth minute of recovery.

Body height and mass have the effect on higher pulsation after the exercise and also, on slower recovery, which is especially manifested in the second minute of recovery. However, pulse frequency after the exercise correlates negatively with swimming speed, and therefore it is concluded that better swimming capability is present at those water-polo swimmers who realize the same speed at a certain distance with lower pulse.

Water-polo players with bigger mass and height should rest during the game so that they could realize 100% of their capability always when they are in water.

The results which we got in this way can be used in swimming and water-polo schools at the dosage of exercise or as a starting base for some new researches.

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UTICAJ SPORTSKOG STAŽA NA FREKVENCIJU PULSA U MIRU I PRI OPTEREĆENJU

Tomislav Okičić

Predmet istraživanja ovog rada je ispitivanje uticaja dužine sportskog staža na reakciju kardiovaskularnog sistema sagledavanu kroz frekvenciju pulsa u miru, opterećenju i oporavku kod sportista. U ovom radu cilj je bio da se utvrdi značajnost razlika posmatranih varijabli između dve grupe ispitanika. Prvu grupu ispitanika je činilo 30 plivača starih 11-12 godina sa sportskim stažom 1-3 godine, a drugu 15 vaterpolista starih 16 -17godina i sportskim stažom 4-11 godina. Za potrebe ovog istraživanja uzorak varijabli su sačinjavale sledeće varijable: starost, sportski staž, visina u cm i masa tela u kg, brzina plivanja na 43m. Od funkcionalnih varijabli praćena je frekvencija pulsa: 1. u miru, 2. neposredno po opterećenju, 3. u prvom minutu po prekidu opterećenja, 4. u drugom minutu po prekidu opterećenja, 5. u petom minutu po prekidu opterećenja. Za sve varijable koje su predmet ovog istraživanja izračunati su osnovni deskriptivni statistički parametri: Aritmetička sredina, standardna devijacija, koeficijent varijacije, minimalna i maksimalna vrednost. Statistička značajnost razlika aritmetičkih sredina ispitivanih varijabli određena je studentovim T-testom. Izračunat je i koeficijent korelacije u celom primenjenom sistemu varijabli. Dobijeni rezultati pokazuju da je frekvencija pulsa u miru u proseku niža kod sportista (vaterpolista) koji u proseku imaju duži sportski staž (4 godine) u odnosu na sportiste (plivače) kraćeg sportskog staža (2 godine). Visina i masa tela kod vaterpolista utiču na veću pulsaciju nakon opterećenja kao i na sporiji oporavak koji se naročito ogleda u drugom minutu oporavka.

Ključne reči*: brzina plivanja, sportski staž, frekvencija pulsa, oporavak sportiste*