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Research Article

Effects of Swimming Fatique on Lung Functions

Mustafa Özdal[1] and Bilal Coşkun[2]*

[1]Department of Physical Education and Sport, Gaziantep University Performance Laboratory, Faculty of Sport Sciences, Gaziantep University, Gaziantep, Turkey

[2]Department of Physical Education and Sport, Ministry of Education, Gaziantep University Performance Laboratory, Gaziantep, Turkey

***Corresponding Author:** Bilal Coşkun, Department of Physical Education and Sport, Ministry of Education, Gaziantep University Performance Laboratory, Gaziantep, Turkey.

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Abstract

In our study, it was aimed to examine the effect of fatigue created by swimming exercise on lung functions. For this purpose, lung functions of 16 male swimmers were measured at baseline levels and after swimming performance by means of a spirometer, after performing the 50m sprint in four different swimming styles (frontcrawl, backstroke, butterfly, breaststroke). When the data obtained were analyzed, it was seen that swimming performance caused a significant decrease in the FVC, FEV1, PEF, PIF, MVV and VC values after the four swimming styles ($p < 0.05$), with the highest decrease after the butterfly style performance ($p < 0.05$). As a result, it can be said that swimming exercise negatively affects lung functions by causing respiratory fatigue.

Keywords: *Respiratory; Exercise; Swimming*

Abbreviations

FVC: Forced Vital Capacity; FEV1: Forced Expiratory Flow in One Second; PEF: Peak Expiratory Flow; PIF: Peak İnspiratory Flow; MVV: Maximal Voluntay Ventilation; VC: Vital Capacity; TV: Tidal Volume; SD: Standard Deviation; CI: Confidence Interval; LB: Lower Bound; UB: Upper Bound

Introductıon

The respiratory system, which is of great importance in determining the daily life and work performance of the individual, is also important in terms of sportive performance capacity. The oxygen requirement of the tissues increases during exercise [1]. Therefore, the amount of oxygen coming into the body from the respiratory system should also increase. The respiratory system should work regularly and adequately for the increase in the oxygen demand of the tissues, the tolerance of the excess carbon dioxide and metabolic heat in the body [2-4]. As the water creates a pressure effect during the breathing of the individual, it makes it difficult to breathe during swimming [5]. Therefore, the energy required to cover a distance during swimming is much higher than in other physical activities [6,7].

Considering the effect of the respiratory system described above on swimming performance, it is important to predict the effects of four different swimming styles on lung functions and to know the effect of respiratory fatigue caused by swimming performance on lung functions.

Aim of the Study

The aim of our study is to determine the effects of fatigue that occurs with swimming styles on lung functions.

Methods

Our study was designed according to the cross-experiment design with repeated measurements. 16 male swimmers participated in the study as subjects (Age: 18.56 ± 0.73 years). Subjects were also not given a nutritional program and were informed about the study procedure the day before the study, and baseline lung functions were determined. The subjects came to the pool at 24-hour intervals and performed 50m sprint swimming in four days randomly (by drawing a practice card) with four different swimming styles (freestyle, backstroke, butterfly, breaststroke). Lung functions of the subjects were measured again immediately after each swimming practice.

50m sprint swimming performance measurement

The subjects completed the 25 meters in four different styles, 2 times in a 25-meter swimming pool [8].

Determining of the lung functions

Measurements were made with the M.E.C. Pocket Spiro USB-100 device. During the measurement, the subject was allowed to wear light clothing. Subjects were given and demonstrated a simple explanation of the measurement. It was stated to the subjects that maximal effort was necessary and otherwise the results would be meaningless. After the information about the subject was recorded on the spirometer, the subject was placed in a sitting position. A separate mouthpiece was used for each subject. The subject's nose was clogged with a plug and it was ensured that he took the mouthpiece between his lips so that there was no gap at the corners of the mouth. During the measurement of the subjects, the movement was repeated and the subject was also motivated by vocal expressions. At the time of measurement, the measurement was completed by first performing three normal inspirations and expirations, followed by a rapid and vigorous maximal inspiration, and then an expiration as fast as possible. With this measurement method, FVC (forced vital capacity), FEV1 (forced expiratory flow in one second), PEF (peak expiratory flow), PIF (peak inspiratory flow) values were obtained. After the forced vital capacity measurement, slow vital capacity measurement was also performed, and VC (vital capacity), TV (tidal volume) values were obtained. After performing normal inspiration and expiration three times in the same procedure, this time the measurement was completed by making a slow maximal inspiration and then a slow maximal expiration [9].

Statistical method

SPSS 22.0 program was used for statistical operations. Shapiro-Wilk test was used for normality test. Repeated Measures One Way ANOVA and LSD tests were performed to determine the effect of swimming performance. Values were presented as mean, standard deviation, standard error, 95% confidence interval and analyzed at 0.05 significance level.

Results

The findings obtained in the study are presented in table 1.

		Mean ± SD	Std. Eror	95% CI		p	Difference
				LB	UB		
FVC (l)	1.Baseline	4.74 ± 0.92	0.28	4.12	5.36	0.001	1-2, 1-4, 1-5 3-4 5-2, 5-4
	2.Frontcrawl	4.40 ± 1.02	0.31	3.71	5.08		
	3.Backcrawl	4.62 ± 0.97	0.29	3.96	5.27		
	4.Butterfly	4.35 ± 0.88	0.26	3.76	4.93		
	5.Breaststroke	4.58 ± 0.94	0.28	3.94	5.21		
FEV1 (l)	1.Baseline	4.08 ± 0.72	0.22	3.60	4.56	0.001	1-2, 1-3, 1-4, 1-5 3-2, 3-4, 3-5 5-4
	2.Frontcrawl	3.67 ± 0.77	0.23	3.16	4.19		
	3.Backcrawl	3.90 ± 0.75	0.22	3.40	4.40		
	4.Butterfly	3.60 ± 0.72	0.22	3.12	4.09		
	5.Breaststroke	3.81 ± 0.76	0.23	3.30	4.31		
FEV1/FVC (%)	1.Baseline	86.64 ± 8.71	2.63	80.79	92.49	0.644	-
	2.Frontcrawl	84.85 ± 13.20	3.98	75.99	93.72		
	3.Backcrawl	85.29 ± 10.89	3.28	77.98	92.61		
	4.Butterfly	83.26 ± 7.95	2.40	77.92	88.60		
	5.Breaststroke	83.63 ± 9.60	2.89	77.18	90.08		

PEF (lt/sec)	1.Baseline	6.81 ± 1.96	0.59	5.50	8.13	0.003	1-2, 1-4
	2.Frontcrawl	5.72 ± 1.80	0.54	4.51	6.92		2-4
	3.Backcrawl	6.37 ± 1.98	0.60	5.04	7.69		
	4.Butterfly	5.56 ± 1.84	0.55	4.32	6.79		3-2, 3-4
	5.Breaststroke	6.36 ± 1.83	0.55	5.17	7.62		5-4
PIF (lt/sec)	1.Baseline	5.65 ± 1.10	0.33	4.91	6.38	0.023	1-2, 1-3, 1-4, 1-5
	2.Frontcrawl	5.09 ± 1.56	0.47	4.04	6.14		2-4
	3.Backcrawl	5.46 ± 1.21	0.36	4.64	6.27		
	4.Butterfly	4.89 ± 1.46	0.44	3.91	5.86		3-2, 3-4
	5.Breaststroke	5.17 ± 1.64	0.49	4.06	6.27		5-4
VC (l)	1.Baseline	4.61 ± 0.89	0.27	4.02	5.21	0.004	1-2, 1-3, 1-4, 1-5
	2.Frontcrawl	3.60 ± 0.91	0.27	2.99	4.21		5-2, 5-4
	3.Backcrawl	3.95 ± 1.05	0.32	3.25	4.66		
	4.Butterfly	3.95 ± 0.96	0.29	3.30	4.60		
	5.Breaststroke	4.09 ± 1.06	0.32	3.38	4.80		
TV (l)	1.Baseline	1.06 ± 0.52	0.16	0.71	1.41	0.163	-
	2.Frontcrawl	1.16 ± 0.88	0.27	0.56	1.75		
	3.Backcrawl	1.50 ± 0.69	0.21	1.03	1.96		
	4.Butterfly	0.99 ± 0.82	0.25	0.44	1.54		
	5.Breaststroke	1.27 ± 0.71	0.21	0.80	1.75		

FVC: Forced Vital Capacity; FEV1: Forced Expiratory Flow in One Second; PEF: Peak Expiratory Flow; PIF: Peak İnspiratory Flow; MVV: Maximal Voluntay Ventilation; VC: Vital Capacity; TV: Tidal Volüme; SD: Standard Deviation; CI: Confidence İnterval; LB: Lower Bound; UB: Upper Bound; 1: Baseline; 2: After Frontcrawl, 3: After Backcrawl; 4: After Butterfly; 5: After Breaststroke.

Table 1: *Analysis of obtained data.*

Table 1 shows the changes in lung function parameters of the subjects between swimming performances. According to the results of one-way analysis of variance and LSD correction in repeated measurements, significant decreases were found in FVC, FEV1, PEF, PIF and VC parameters between the control application in which no swimming performance was exhibited and the free, backstroke, butterfly and breaststroke style swimming applications ($p < 0.05$). The highest rate of decrease was observed after butterfly style ($p < 0.05$). There was no significant difference between the treatments in TV and FEV1/FVC parameters ($p > 0.05$).

Discussion and Conclusion

In our study, changes were observed in lung functions due to fatigue after swimming performance. There was a significant decrease in lung functions, especially in butterfly style swimming, between the control application in which swimming performance was not exhibited and all swimming styles ($p < 0.05$). The results showed that there was a decrease in lung function values after swimming performance, especially butterfly style swimming performance affected respiration more.

In sports activities, the O_2 requirement of the muscles increases, and a harmony occurs in the physiology of the respiratory system, which will meet the increased O_2 need. The increase in respiratory functions according to the type of exercise; The development of respiratory muscles is an event depending on the flexibility of the bronchi and bronchioles with the ability of the lungs and rib cage to expand

[10]. Vital capacity and forced vital capacity are parameters that show lung functions, and it is interpreted as normal for each person to be 80% or more of the expected value according to age, height, gender and body weight [11]. A FEV1 value below 80% may indicate a problem with expiration. FVC measurement is used to identify problems in the diaphragm muscle. If the diaphragm muscle is weak, FVC values are below normal [12]. It is known that sports have a positive effect on VC and FVC values. During exercise, an increase in respiratory volume occurs in order to provide the O_2 needed for increased metabolism. As the exercises become continuous, respiratory muscles will develop [2].

Respiratory stress is the main reason for the results obtained in our study. Causes of acute respiratory stress include chlorine inhalation [13,14] and lactate increase [15]. Fatigue reduces the ability of respiratory muscles to contract by lowering the blood acid-base balance [16-22]. The 50-meter swimming performance can be considered as a short-term performance, but the inspiratory muscles may reveal metabolic fatigue even in short-term activities [22-25]. Decreased activation of proteins contracted by fatigue [26], insufficient blood amount in these muscles [27] and less oxygen than needed [28,29] reflects negatively on their capacities [30]. Apart from these, water pressure acutely affects the respiratory muscles and decreases respiratory functions [31].

In our study, the reason for the negative effects of the acute effects of swimming exercise on lung functions in all styles is thought to be the limitation of mechanical functions due to fatigue in the respiratory muscles. The main sources of fatigue are thought to be the natural resistance of exercise, water pressure, and horizontal position in swimming. The number of muscles used and contraction rates are considered as the reason for the difference between styles [32]. As a result, it can be said that swimming exercise acutely affects lung volume and capacities negatively, and especially the negative effect of butterfly swimming style is more.

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