Respiratory function rehabilitation in individuals with Covid-19: swimming exercise

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Authors’ Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim

Understanding the impact of swimming exercises on post-Covid-19 respiratory function is crucial for optimizing recovery strategies in affected individuals. The aim of this study is to determine the effect of 8-week swimming exercises on respiratory function parameters in adult individuals who have had Covid-19 disease.

Material and Methods

Sixteen male students, aged 19-21, voluntarily participated in the study. Eight participants were assigned to the experimental group (EG), and eight to the control group (CG), all of whom were students of the Faculty of Sports Sciences at the University. The EG underwent an 8-week swimming exercise program conducted at the Bingöl Youth and Sports swimming pool (25 meters), three days a week. The CG was not involved in any exercise regimen. Pulmonary function tests (FVC, FEV1, FEV1/FVC, PEF) were conducted using a Cosmed Pony FXdel 2016 spirometer, one day before and one day after the exercise program for both EG and CG. Data analysis was performed using Independent Samples and Paired Samples T tests in SPSS 25, with a significance level set at p < 0.05.

Results

A statistically significant increase in respiratory FVC, FEV1, FEV1/FVC, and PEF function values was observed in the experimental group (EG) after the exercise intervention (p < 0.05). This increase was observed when comparing these values to their pre-exercise measurements. In contrast, there was no statistically significant difference in respiratory function results before and after exercise in the control group (CG) (p > 0.05).

Conclusions

The findings of this study highlight the therapeutic potential of an 8-week swimming exercise program in significantly enhancing respiratory function among adult individuals who have previously contracted Covid-19. These results offer valuable insights for the development of post-Covid-19 rehabilitation protocols, emphasizing the importance of regular exercise, such as swimming, in the recovery process.

Keywords: Covid-19, respiratory functions, adults, swimming exercises

Introduction

The coronavirus 2019 (COVID-19) disease has been declared a pandemic by the World Health Organization in 2020 and has directly or indirectly affected all countries in the world, including Turkey, and individuals living in these countries, at the socially and individually [1]. The coronavirus (Covid-19) pandemic has caused great changes with its shocking effect on health, economic, psychological, social life and education, due to its easy transmission through droplets and contact [2]. One of the causes of high mortality and morbidity seen all over the world is Coronavirus [3]. The global and social burden it creates due to the increasing number of cases is increasing rapidly. Mortality and morbidity rates of the disease can differ in every segment, even within the same country. It is known that Covid-19 especially damages respiratory functions [4, 5]. This virus, which mainly causes respiratory tract infection, has changed from person to person or in the same person over time, leading to the emergence of a complex and heterogeneous disease [6]. The respiratory system is accepted as the main indicator of a person’s aerobic capacity. In addition the respiratory system is one of the important pillars both in daily life and in determining the work and performance capacity, has an important place in terms of health [7].

When the studies are examined, it has been observed that the improvement and protection of respiratory functions have positive effects on the quality of life of individuals [8, 9]. There are several types of breathing exercises that can improve ventilation and gas exchange in Covid-19 patients. The most commonly applied exercise types are diaphragmatic breathing, pursed lip breathing, segmental breathing, and respiratory exercises with incentivespirometry [10]. On the other hand, according to the results obtained from the literature review, it is accepted that the forced vital capacity (FVC) and accordingly the forced
expiratory volume in the first second (FEV1) and the maximum voluntary ventilation (MVV) value increase as a result of 12-15 weeks of moderate intensity swimming exercises, especially in aerobic style [11, 12]. Moreover since swimming is performed in a horizontal position, the heart and circulatory system work more comfortably [13], so the circulatory system of swimmers works more regularly compared to athletes dealing with other branches [14]. In the literature, aerobic exercise is the leading principle in the treatment methods that prevent pulmonary diseases in healthy people and improve lung functions in children and adults with chronic obstructive pulmonary disease [15, 16, 17, 18]. This sport branch maximizes the heart and lung capacity and improves endurance [19, 20].

Since our body will use more oxygen during physical activity, the respiratory system carries more oxygen to the body accordingly. A regularly working respiratory system is needed in order to balance the excess carbon dioxide and metabolic heat resulting from the use of more oxygen by the tissues [21]. The regular and adequate functioning of the respiratory system mechanically depends on the working capacity of the respiratory muscles. During exercise, the respiratory muscles are activated, especially the muscles that raise the rib cage to help with inspiration. Thanks to the power and effect of these respiratory muscles, respiratory air flow can reach its highest level [22]. This information shows that the strength of the respiratory muscles is an important factor in terms of respiration. Therefore, it is thought that the acute and chronic changes that may occur in this system, which can improve ventilation and gas exchange with swimming exercise in people who have had covid-19, and that the changes arising from their combined effect and exercise program in this direction will reveal a new and important perspective in terms of improving respiratory functions. The aim of our study is to determine the effects of swimming exercise on respiratory functions in adults who have had covid-19.

**Materials and Methods**

**Participants**

16 male students voluntarily participated in the study, 8 of which were in the experimental group and 8 in the control group, who were students of the Faculty of Sports Sciences of Bingöl University.

**Ethics approval and consent to participate**

The research protocol was approved by Bingöl University, Health Sciences Scientific Research and Publication Ethics Committee on 15.06.2023 with the decision of the ethics committee numbered 23/14.

**Research Design**

All participants completed and approved the voluntary consent form declaring that they volunteered for the study. The purpose of the study and its importance were explained to the subjects and their motivation and desire levels were tried to be increased. It was applied to the experimental group students participating in the study 3 days a week for 12 weeks in the Bingöl Youth and Sports swimming pool (25 meters). The control group was not included in the 12-week swimming exercise program. One day before and one day after the program, pulmonary function tests [FVC (L), FEV1 (L), FEV1 / FVC (%), PEF (lt/sec)] were applied to both the experimental and control groups by means of a spirometer (CosmedPony FXdel 2016).

**Training Plan**

The participating athletes were taken to the adaptation session after their first measurements. Two microstructures were applied to the athletes 3 days a week, in which the training time in the pool was at least 80 minutes after a 15-minute warm-up on land. Intensities of adaptation this trainings were applied as 50-60% and 4 techniques (free-back-frog-butterfly) were distributed equally in addition the average swimming distance was not less than 5 km. After the adaptation training, the main phase training, which will last for 12 weeks, was started. 15 minutes of land warming was applied in microstructures 1-4 of the main phase. Then, pool trainings, which were not less than 90 minutes and the intensity was 60-70%, were applied. In this section, the trainings that are not less than 4 km and in which 4 techniques are distributed equally were applied. In the 5-8 micro periods of the trainings, the training time was increased to 90-120 minutes and the training intensity to 70-80%. In this section where 4 techniques were equally distributed, the average swimming distance was applied as 3.5 km. In the last phase of the trainings (9-12 microstructures), the training duration was 90-120 minutes and the training intensity was 80-90%. In the last section, where the 4 techniques were applied equally, the average distance swim was 3 km. Finally, after the 12th week, the parameters were measured and recorded for the last time.

**Statistical analysis**

The obtained data were made using the SPSS 22.0 package program. Independent Samples Test and Paired Samples T test were applied and analyzed. The data showed a normal distribution. In the results, arithmetic mean (X) and standard deviation (SD) values were recorded as indicative statistics. P< 0.05 was taken as the significance level.

**Results**

Comparison of the demographic characteristics of the subjects in the experimental and control groups is given in Table 1. There was no statistically significant difference between the groups (p>0.05).
Table 1. Comparison of the demographic characteristics of the experimental and control groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>20.25±0.7</td>
<td>19.75±0.6</td>
<td>0.179</td>
</tr>
<tr>
<td>H (cm)</td>
<td>179.25±5.75</td>
<td>178.33±3.69</td>
<td>0.595</td>
</tr>
<tr>
<td>BW (kg)</td>
<td>75.55±9.08</td>
<td>73.10±11.35</td>
<td>0.798</td>
</tr>
<tr>
<td>BMI kg/m2</td>
<td>23.30±2.23</td>
<td>22.79±2.48</td>
<td>0.676</td>
</tr>
<tr>
<td>BMR (kg)</td>
<td>36.58±2.79</td>
<td>35.96±2.91</td>
<td>0.668</td>
</tr>
<tr>
<td>BFR (kg)</td>
<td>17.03±5.25</td>
<td>16.43±5.90</td>
<td>0.799</td>
</tr>
</tbody>
</table>

*P<0.05; H: Height; BW: Body Weight; BMI: Body Mass Index; BMR: Body Muscle Ratio; BFR: Body Fat Ratio

Table 2. Comparison of the initial pulmonary function results of the experimental and control groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC (L)</td>
<td>2.94±1.14</td>
<td>3.20±0.96</td>
<td>0.627</td>
</tr>
<tr>
<td>FEV1 (L)</td>
<td>1.88±0.75</td>
<td>2.01±0.74</td>
<td>0.746</td>
</tr>
<tr>
<td>FEV1 / FVC (%)</td>
<td>49.75±9.40</td>
<td>50.87±8.37</td>
<td>0.804</td>
</tr>
<tr>
<td>PEF (L/s)</td>
<td>2.90±1.24</td>
<td>3.07±0.83</td>
<td>0.519</td>
</tr>
</tbody>
</table>

*P<0.05; FVC: Forced Vital Capacity; FEV1: Forced Expiratory Volume 1 Second; PEF: Peak Expiratory Flow Rate

Table 3. Comparison of respiratory function values of the experimental group before and after exercise

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pretest</th>
<th>Posttest</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC (L)</td>
<td>2.94±1.14</td>
<td>3.23±1.25</td>
<td>0.000*</td>
</tr>
<tr>
<td>FEV1 (L)</td>
<td>1.88±0.75</td>
<td>2.08±0.85</td>
<td>0.006*</td>
</tr>
<tr>
<td>FEV1 / FVC (%)</td>
<td>49.75±9.40</td>
<td>51.30±9.64</td>
<td>0.001*</td>
</tr>
<tr>
<td>PEF (L/s)</td>
<td>2.90±1.24</td>
<td>3.41±1.61</td>
<td>0.003*</td>
</tr>
</tbody>
</table>

*P<0.05; FVC: Forced Vital Capacity; FEV1: Forced Expiratory Volume 1 Second; PEF: Peak Expiratory Flow Rate

Table 4. Comparison of respiratory function values of the control group before and after exercise

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pretest</th>
<th>Posttest</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC (L)</td>
<td>3.20±0.96</td>
<td>3.21±0.95</td>
<td>0.086</td>
</tr>
<tr>
<td>FEV1 (L)</td>
<td>2.01±0.74</td>
<td>2.00±0.74</td>
<td>0.104</td>
</tr>
<tr>
<td>FEV1 / FVC (%)</td>
<td>50.87±8.37</td>
<td>50.68±8.42</td>
<td>0.197</td>
</tr>
<tr>
<td>PEF (L/s)</td>
<td>3.07±0.83</td>
<td>3.10±0.54</td>
<td>0.210</td>
</tr>
</tbody>
</table>

*P<0.05; FVC: Forced Vital Capacity; FEV1: Forced Expiratory Volume 1 Second; PEF: Peak Expiratory Flow Rate

The comparison of the initial respiratory function results of the subjects in the experimental and control groups is given in Table 2. There was no statistically significant difference between the groups (p>0.05).

The comparison of the respiratory function results of the participants in the experimental group before and after exercise is given in Table 3. A statistically significant difference was found in the respiratory FVC, FEV1, FEV1 / FVC, PEF function values of the participants in the experimental group after exercise compared to the values before exercise (p<0.05).

The comparison of the respiratory function results of the subjects in the control group before and after exercise is given in Table 4. There was no statistically significant difference in the respiratory function values of the participants in the control group after exercise (p>0.05).

The comparison of the respiratory function values of the experimental and control groups after exercise is given in Table 5. There was no statistically significant difference between the groups in all post-exercise respiratory function values (p>0.05).

The comparison of the respiratory function difference values of the experimental and control groups after exercise is given in Table 6. A statistically significant difference was found in favor of the experimental group in all post-exercise respiratory function difference values (p<0.05).
Discussion

It is known that aerobic exercises such as swimming, jogging, running, skipping, dancing, bicycling in healthy individuals provide a better respiratory function capacity [15, 23, 24, 25, 26]. In addition, there are studies in the literature showing that aerobic exercise practices in children and adults with chronic obstructive pulmonary disease improve lung functions [27, 28].

Since the body is in a horizontal position during swimming, air will enter the upper part of the lung, it is reported that the vital capacity develops more compared to other sports branches [29]. As a result of moderate swimming exercises lasting between 12-15 weeks, FVC increases, and it has been reported that there is an increase in forced expiratory volume in the FEV1 and maximum voluntary ventilation (MVV) values due to this increase [11].

This study it was carried out to determine the effect of 8-week swimming exercises on respiratory function parameters in adult individuals who have had Covid-19 disease. It was carried out to determine the effect of 8-week swimming exercises on respiratory function parameters in adult individuals who have had Covid-19 disease. When the respiratory function results of the subjects participating in the study were examined before and after swimming exercises, there was a statistically significant increase in respiratory FVC, FEV1, FEV1 / FVC, PEF function values after exercise in EG compared to the values before exercise (p<0.05); When the respiratory function results before and after exercise in CG were examined, no statistically significant difference was found between the values (p>0.05).

In studies conducted in the literature, the increase in pulmonary function parameters. It is caused by an increase in the rate and depth of breathing, oxygen consumption, and diffusion capacity during exercise. It is also reported that exercise leads to changes in aerobic enzyme activity and oxidative capacity of respiratory muscles, resulting in the development of respiratory muscle function [30, 31].

Conclusions

Structured, supervised, intensity-adjusted swimming exercise training, with appropriate frequency and duration, demonstrates a significant potential for improving respiratory functions in adults who have recovered from Covid-19. Future research in this domain should focus on investigating the long-term effects of swimming exercises, exploring variations in exercise intensity and duration, and assessing the potential advantages of integrating swimming with other therapeutic modalities. These studies hold promise for developing a comprehensive approach to respiratory rehabilitation in post-Covid-19 patients, contributing to the ongoing refinement of recovery strategies for individuals affected by this virus.

Conflict of interest

The authors declare no conflict of interest
References


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