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Research Article/
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A Comparison Of Respiratory Function Parameters Of The Individuals Recovered From Mild Covid-19 And Their Non-Infected Counterparts

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ABSTRACT

Purpose: The COVID-19 epidemic particularly affects the immune and respiratory systems, leading to critical care and fatalities. Even if COVID-19 patients test negative after recovery, they may continue to experience post-COVID-19 effects, mainly in relation to the respiratory system. This study aims to compare the body composition and selected respiratory parameters between adults who have recovered from the disease with mild symptoms and individuals who have not been infected. Material and Methods: A total of 60 sedentary adults (12 males who previously tested positive and 24 who tested negative; 15 females who previously tested positive and 9 who tested negative) voluntarily participated in the study. The groups were categorized as positive (COVID-19 recovered within the past 6 months) and negative (non-infected). Measurements were taken for body composition and respiratory parameters, including vital capacity, forced vital capacity, forced expiratory volume in one second, forced expiratory flow between 25% and 75% of vital capacity, tiffeneau index, and peak expiratory flow rate. Results: According to the results of the independent sample t-test, there was no statistically significant difference in spirometric values between sedentary adults who had COVID-19 six months prior and their non-infected counterparts (p>0.05). Conclusion: Based on the study results, it is believed that the respiratory functions of individuals who recovered from COVID-19 with mild symptoms may have returned to normal after 6 months.

Key words: Pulmonary Function, Post Covicd-19 Syndrome, Sedentary Lifestyle.

HAFİF COVID-19 GEÇİREN BİREYLERİN SOLUNUM FONKSİYON PARAMETRELERİNİN, ENFEKTE OLMAMIŞ KONTROL GRUBU İLE KARŞILAŞTIRILMASI

ÖZ

Amaç: COVID-19 salgını özellikle bağışıklık ve solunum sistemlerini etkileyerek kritik bakım ve ölümlere yol açmaktadır. COVID-19 hastaları iyileştikten sonra testleri negatif çıksa bile, özellikle solunum sistemiyle ilgili olmak üzere COVID-19 sonrası etkiler yaşamaya devam edebilirler. Bu çalışma, hastalığı hafif semptomlarla atlatan yetişkinler ile enfekte olmamış bireyler arasında vücut kompozisyonu ve seçilmiş solunum parametrelerini karşılaştırmayı amaçlamaktadır. Materyal-Metot: Çalışmaya 60 yetişkin sedanter (pozitif n=12 ve negatif n=24 erkek; pozitif n=15 ve negatif n=9 kadın) gönüllü olarak katılmıştır. Gruplar pozitif (COVID-19 son 6 ay içinde iyileşmiş) ve negatif (enfekte olmamış) olarak kategorize edilmiştir. Vital kapasite, zorlu vital kapasite, bir saniyedeki zorlu ekspiratuar hacim, vital kapasitenin %25 ila %75'i arasındaki zorlu ekspiratuar akış, tiffeneau indeksi ve pik ekspiratuar akış hızı dahil olmak üzere vücut kompozisyonu ve solunum parametreleri için ölçümler yapılmıştır. Bulgular: Bağımsız örneklemler t-testi sonuçlarına göre, altı ay önce COVID-19 olan sedanter yetişkinler ile hiç enfekte olmayan yetişkinlerin spirometrik değerleri arasında istatistiksel olarak anlamlı bir fark bulunmamıştır (p>0,05). Sonuç: Çalışma sonucunda, COVID-19 hastalığını hafif şekilde atlatan hastaların solunum fonksiyonlarının 6 ay sonra normale döndüğü düşünülmektedir.

Anahtar Kelimeler: Akciğer Fonkisyon Testi, Post Covid-19 Sendromu, Sedanter Yaşam Tarzı.

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INTRODUCTION

The entire world has been confronted with the coronavirus (COVID-19) epidemic, originating in China and lasting for over a year, which can be regarded as the most significant tragedy in recent times. While this pandemic caused symptoms in certain individuals, others did not experience any symptoms. (Gandhi, Lynch, & Del Rio, 2020). According to the World Health Organization (WHO) classification, symptomatic cases have common symptoms (fever, dry cough, fatigue), less common symptoms (aches and pains, sore throat, diarrhea, conjunctivitis, headache, loss of taste or smell, skin rash or hand or color change on fingers or toes), or serious symptoms (respiratory distress or shortness of breath, chest pain or pressure in the chest, loss of speech or movement) (Gandhi et al., 2020; WHO). The most severe symptom is severe acute respiratory distress syndrome, which can lead to rapid death (Wang et al., 2020). There are also asymptomatic cases that do not have any COVID-19 symptoms, such as fever, gastrointestinal or respiratory symptoms, or a significant anomaly on a chest radiograph, despite being positive based on a positive viral nucleic acid test result (Lai et al., 2020). However, COVID-19 is mainly a respiratory tract illness, and the main concerns for the chronic phase are the development of a pulmonary interstitial illness and/or a permanent cardiovascular involvement (Clavario et al., 2020). There are worries about possible long-term breathing problems and reduced ability to function in individuals who are recuperating from COVID-19. It is also becoming more acknowledged that 30-60% of people experience lingering symptoms like fatigue and shortness of breath even after recovering from the initial illness. This condition is referred to as long-COVID or post-COVID syndrome (Max Thomas, Oliver J. Price, & James H. Hull, 2021). Persistent post-COVID syndrome, also called prolonged COVID-19, is a pathological entity that involves persistent physical, medical, and cognitive complications following COVID-19, including pulmonary, cardiac, and vascular fibrosis as well as immunosuppression (Oronsky et al., 2021). On the other hand, while a study has found severe mid-term consequences of COVID-19 in a population that is not intensive care patients, it highlights the lack of data related to the effects of long-term functional COVID-19 on clinically less complicated patients.

This study demonstrates the need for further data collection on the long-term effects of COVID-19 in clinically less complicated patients (Clavario et al., 2020). However, given the assumption that rehabilitation efforts are predominantly focused on post-intensive care patients, it has remained unclear how to assess the large number of patients with potential long-term consequences of COVID-19 (Clavario et al., 2020).

According to the results of a study that conducted a comprehensive health assessment of patients three months after recovering from COVID-19, it was found that a significant number of patients still experienced various serious health issues. Although the condition of the lung tissue improved significantly in patients who survived COVID-19, even after an average of three months, there were still residual abnormalities that affected lung function. Patients referred for further evaluation due to their mild COVID-19 symptoms actually reported more serious problems compared to those who were discharged after experiencing moderate to critical symptoms. These problems included limited physical abilities, fatigue, and a reduced quality of life. Despite no major abnormalities in lung function or radiological findings being present in the referred patients with mild symptoms after three months, the study was unable to explain their continued poor health conditions (van den Borst et al., 2021).

Based on recent studies, it has been noted that health issues resulting from COVID-19 can continue for a period of three months after the initial infection. As a result, it is crucial to examine possible adverse effects in patients with less severe instances of the disease. The objective of this study is to compare the lung functionality of individuals who had a mild COVID-19 infection six months ago to that of individuals who were not infected.

MATERIALS AND METHOD

Subjects

60 sedentary individuals in the age range of 20–50 (positive n = 12 and negative n = 24 males; positive n = 15 and negative n = 9 females) participated in the study voluntarily. The groups

were named as positive (those with positive RT-PCR test results from 6 months ago) and negative (those who have never felt the need to give an RT-PCR test or have never had positive RT-PCR test results). The volunteers included in the positive group depending on the RT-PCR (reverse transcriptase polymerase chain reaction) (Zitek, 2020) test were selected among the individuals who survived the disease mildly. The criteria for the positive group to be considered mild patients are having only common symptoms and feeling that the effects of these symptoms disappeared within the first week, not requiring hospitalization, and undergoing the disease process by resting at home.

The current analysis is part of a study that was approved by the Erciyes University Ethics Committee for the Social Sciences and Humanities (Date: September 26, 2021, Decision Number: 295).

Data Collection

Of the volunteers, body weight, age, BMI (body mass index), body composition, waist-hip ratio, resting heart rate, oxygen saturation, and, among the respiratory parameters, vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in one second (FEV1), average forced expiratory flow during the mid (25-75%) portion of the FVC (FEF25-75), tiffeneau index (FVC/FEV1), and peak expiratory flow rate (PEF) measurements were taken (Cosmed Spiropalm). Body composition measurements were carried out by the Tanita BC 418 MA body fat analyzer. Spirometric measurements were performed by Spiropalm Spirometer. In addition, the cigarette and alcohol use of the individuals were questioned.

FVC and FEV1, which generally provide information about the restraint in the large airways, were used among the spirometer tests. A decrease in FEV1/FVC rate indicates obstruction, and FEV1 reveals the severity of the obstruction (Jing, Huang, Cui, Xu, & Shen, 2009). The estimation of FEV1/FVC enables the detection of obstructive or restrictive ventilatory deficiencies. An FEV1/FVC <70 % in which FEV1 is decreased more than FVC means an obstructive defect such as chronic obstructive pulmonary disease (COPD) or asthma. An FEV1/FVC > 70% in which FVC is decreased more so than FEV1 seems to be associated with restrictive defects like interstitial lung diseases and chest wall deformations (Ranu, Wilde, & Madden, 2011). From the FVC maneuver, a set of indices such as peak expiratory flow, flows at 25%, 50%, and 75% of the exhaled FVC, and the forced expiratory flow at 25–75% of the FVC (FEF25–75%) are obtained (Quanjer, Weiner, Pretto, Brazzale, & Boros, 2014). FEF25–75 is the average flow rate at 50% of the forced vital capacity maneuver. It provides information about obstruction in medium- and small-diameter bronchi (Marseglia et al., 2007).

PEF is a very sensitive and accurate index for airway obstruction. This simple test, measured by a peak flowmeter, is very useful in the diagnosis, management, and follow-up of bronchial asthma and in predicting the status of ventilator lung function (Mrindha, Amin, & Kabir, 2011).

Statistical Analysis

Statistical analyses were performed using SPSS 25.0 for Windows software. The normal distribution of the data was tested using the Shapiro-Wilk test. An independent sample t-test was used to compare the arithmetic mean scores of different groups. A significance level of $p < 0.05$ was applied.

RESULTS

No statistically significant difference was found between the groups of female participants with COVID-19 (n = 15) and their non-infected counterparts (n = 9) in terms of age (year), BMI, waist-hip ratio (%), fat (%), fat mass (kg), FFM (fat free mass-kg), TBW (kg), resting pulse (beat/minute), and SpO2 (%) variables ($p > 0.05$) (Table 1).

No statistically significant difference was found between the groups of male participants with COVID-19 (n = 12) and their non-infected counterparts (n = 24) in terms of age (year), BMI, waist-hip ratio (%), fat (%), fat mass (kg), FFM (fat free mass-kg), TBW (kg), resting pulse (beat/minute), and SpO2 (%) variables ($p > 0.05$) (Table 1).

Table 1. Physical Characteristics of the Participants

Variable	COVID-19	Gender					
		Women			Men		
		x̄ ±SD	t	p	x̄ ±SD	t	p
n	Positive	15			12		
	Negative	9			24		
Age (year)	Positive	36.8±8.64	-0.502	0.621	33.58±11.39	-0.070	0.945
	Negative	37.78±7.96			33.83±6.51		
BMI (height/kg^2)	Positive	28.20±7.95	2.050	0.344	27.20±3.29	0.328	0.745
	Negative	28.25±4.95			26.75±4.12		
WHR	Positive	0.89±0.11	0.879	0.389	0.95±0.10	0.255	0.800
	Negative	0.85±0.06			0.94±0.05		
FAT (%)	Positive	35.07±8.54	0.114	0.910	20.36±5.01	-0.352	0.727
	Negative	34.67±7.68			21.0±5.17		
Fat Mass (kg)	Positive	28.89±12.96	0.680	0.504	17.85±5.95	0.003	0.997
	Negative	25.52±9.26			17.85±7.75		
FFM (kg)	Positive	48.78±11.75	0.751	0.461	68.0±4.92	1.515	0.139
	Negative	45.73±3.77			64.35±7.57		
TBW (kg)	Positive	37.43±5.34	2.050	0.052	49.78±3.60	1.514	0.139
	Negative	33.47±2.76			47.10±5.54		
HR (beat/min)	Positive	81.73±10.46	-0.634	0.533	85.50±12.12	0.702	0.488
	Negative	85.22±16.43			82.54±11.82		
SpO2 (%)	Positive	96.07±1.79	0.400	0.693	96.08±1.44	0.412	0.683
	Negative	95.78±1.56			95.88±1.42		

BMI: Body mass index, **WHR:** Waist-Hip Ratio, **FAT:** Body fat percentage, **FFM:** Fat-free mass, **TBW:** Total body water, **HR:** Heart Rate, **SpO2:** Peripheral oxygen saturation, **p>0.05**

No statistically significant difference was found between the groups of male participants with COVID-19 (n = 12) and their non-infected counterparts (n = 24) in terms of FVC (L), FEV1 (L), FEV1/FVC%, PEF (L/s), FEF25-75% (L/s), VC (L), FVC predict (%), FEV1 predict (%), and FEF25-75% predict (%) variables (p > 0.05) (Table 2).

Table 2. Respiratory Function Test Results of Men

Variable	n	Group	x̄±SD	t	p
FVC (L)	12	Positive	5.44±0.59	1.225	0.229
	24	Negative	5.21±0.48		
FEV1 (L)	12	Positive	4.35±0.59	0.407	0.528
	24	Negative	4.28±0.43		
FEV1/FVC%	12	Positive	80.92±4.30	-0.807	0.425
	24	Negative	82.28±4.98		
PEF (L/s)	12	Positive	6.79±2.59	-0.578	0.567
	24	Negative	7.33±2.65		
FEF25-75% (L/s)	12	Positive	3.90±0.93	-1.001	0.324
	24	Negative	4.17±0.73		
VC (L)	12	Positive	4.82±0.71	-0.022	0.982
	24	Negative	4.83±0.76		
FVC predict (%)	12	Positive	106.83±18.06	1.259	0.231
	24	Negative	99.73±7.06		
FEV1 predict (%)	12	Positive	97.83±15.53	-0.910	0.369
	24	Negative	101.75±10.17		
FVC predict (%)	12	Positive	89.50±17.17	-1.560	0.128
	24	Negative	98.41±15.66		

FVC: Forced vital capacity, **FEV 1:** Forced expiratory volume in one second, **FEV1/FVC:** ratio expressed as a percentage, **PEF:**Peak expiratory flow, **FEF25-75:** The average forced expiratory flow during the mid (25-75%) portion of the FVC, **VC:** Vital capacity, **p>0.05**

No statistically significant difference was found between the groups of female participants with COVID-19 (n = 15) and their non-infected counterparts (n = 9) in terms of FVC (L), FEV1 (L), FEV1/FVC%, PEF (L/s), FEF25-75% (L/s), VC (L), FVC predict (%), FEV1 predict (%), and FEF25-75% predict (%) variables (p > 0.05) (Table 3).

Table 3. Respiratory Function Test Results of Women

Variable	n	Group	x̄±SD	t	p
FVC (L)	15	Positive	3.51±0.61	0.373	0.713
	9	Negative	3.38±1.14		
FEV1 (L)	15	Positive	2.93±0.44	0.170	0.867
	9	Negative	2.85±1.05		
FEV1/FVC%	15	Positive	84.41±5.70	-0.048	0.962
	9	Negative	84.52±4.23		
PEF (L/s)	15	Positive	5.06±1.93	1.026	0.316
	9	Negative	4.23±1.84		
FEF25-75% (L/s)	15	Positive	2.90±0.54	1.943	0.065
	9	Negative	2.45±0.57		
VC (L)	15	Positive	3.49±0.73	0.986	0.335
	9	Negative	3.16±0.88		
FVC predict (%)	15	Positive	95.33±17.17	0.199	0.144
	9	Negative	93.66±23.84		
FEV1 predict (%)	15	Positive	95.26±11.77	0.180	0.858
	9	Negative	94.22±16.61		
FVC predict (%)	15	Positive	89.67±12.80	1.168	0.255
	9	Negative	84.00±8.77		

FVC: Forced vital capacity, **FEV 1:** Forced expiratory volume in one second, **FEV1/FVC:** ratio expressed as a percentage, **PEF:**Peak expiratory flow, **FEF25-75:** The average forced expiratory flow during the mid (25-75%) portion of the FVC, **VC:** Vital capacity, **p>0.05**

DISCUSSION

By contrasting the respiratory functions of those who had COVID-19 six months prior to the study's completion with those of those who had not, it was possible to identify the obstructive conditions that COVID-19 causes. No statistically significant difference was found between the spirometry values of the sedentary individuals who had COVID-19 six months ago and their non-infected counterparts. Similarly, in a study conducted on patients with COVID-19, no significant difference was observed between the groups with moderate and severe COVID-19 in terms of FEV1 predict, FVC predict, and FEV1/FVC% levels (Liao et al., 2020). In research like the previous study, a total of 81 COVID-19 patients were treated in the hospital. Three months later, there was no difference between the groups with severe COVID-19 and those who did not have severe COVID-19 in terms of the spirometry values of FVC, FEV1, and FEV1/FVC (Qin et al., 2021).

Respiratory function parameters were examined in individuals who recovered from mild COVID-19 compared to their non-infected colleagues. Studies have shown that patients who have recovered from COVID-19 may still experience lung damage and

impaired respiratory function even after being discharged (Hazarika et al., 2021; Lombardi et al., 2021; M. Thomas, O. J. Price, & J. H. Hull, 2021). Respiratory function tests revealed abnormalities in forced expiratory volume, forced vital capacity, and forced expiratory flow in those who survived COVID-19. A decreased diffusion capacity for carbon monoxide (DLCO) has also been found in these individuals. Additionally, chest CT scans have shown persistent abnormalities such as ground-glass opacities and fibrotic changes in a significant portion of those who recovered from COVID-19. The severity of respiratory failure during hospitalization has been found to be associated with the extent of respiratory impairment in recovered patients. Overall, these findings suggest that individuals who have recovered from mild COVID-19 may experience respiratory dysfunction and abnormalities in respiratory function compared to non-infected individuals.

Even if it is known that smoking can affect spirometry values (Enright, Connett, & Bailey, 2002; Padmavathy, 2008), smoking did not create any difference between the groups in our study. Among male participants, a total of 15 men (41.7%) smoked, as 3 (25%) of them had COVID-19 and 12 (50%) of them did not have COVID-19. Among the female participants, while 3 (20%) of them who had COVID-19 were smokers, there were no smokers among women who did not have COVID-19. Only a total of 3 female participants (12.5%) were smokers.

Contrary to our study, in a study investigating the clinical recovery process in COVID-19 patients, it was observed that while FEV1 of COVID-19 patients was below the normality value of FVC, FEV1/FVC was above the normality value. In addition, the FVC remained below the expected value six weeks after the individuals were discharged from the hospital (Fumagalli et al., 2021). Respiratory function tests were carried out 6 weeks after the treatment of individuals who were treated in the intensive care unit at the hospital and treated in the ward due to COVID-19. In these tests performed to compare the two groups, while there was no statistical difference in the FEV1 and FVC values, the FEV1% and FVC% values of the individuals treated in the intensive care unit were significantly lower (De Graaf et al., 2021). It is seen that there was a significant difference in respiratory function test results in the studies conducted on patients requiring hospitalization (Fumagalli et al., 2021) or intensive care treatment (De Graaf et al., 2021). However, no significant difference was found between the patients with mild COVID-19 and their non-infected counterparts in our study. It is known that some symptoms defined as post-COVID continue after COVID-19 (Max Thomas et al., 2021). Some of these symptoms are related to pulmonary function, which is the subject of our study. However, it is seen that the number of studies evaluating the respiratory function test results of the individuals who recovered from COVID-19 is quite limited (De Graaf et al., 2021; Fumagalli et al., 2021; Liao et al., 2020; Max Thomas et al., 2021). Therefore, when comparing the results with the respiratory function test results of healthy individuals, it was found that the obtained results in the current study were close to those of healthy individuals' (Al Ghobain et al., 2014; Ip et al., 2006; Memon, Sandila, & Ahmed, 2007). It was reported that the spirometry predicted reference values of women and men (according to Nhanes III reference values) with COVID-19 and their non-infected counterparts in our study were within normal limits (Hankinson, Odencrantz, & Fedan, 1999). And there was no statistically significant difference between the two groups in these predicted reference values.

On the other hand, in studies on individuals who have had COVID-19, a DLCO test is performed as well as lung volume and capacity measurements. It was observed that the DLCO values of the patients with serious COVID-19 status were close to the reference range, but in cases where the disease was very serious, the DLCO value was negatively affected (Méndez et al., 2021; Qin et al., 2021). In this study, since the participants had mild COVID-19, a test related to DLCO was not carried out.

It is known that increasing obesity is inversely related to respiratory function (Behrens, Matthews, Moore, Hollenbeck, & Leitzmann, 2014; Pouragha, Kazemi, Pouryaghoub, & Mehrdad, 2020), and body composition variables are associated with respiratory function (Ischaki et al., 2007; Park, Chung, Lee, & Shin, 2012; Pouragha et al., 2020). For example, lean body mass index had a significant relationship with FEV1 predictor (%) and FEV1/FVC ratio. However, there was no difference between the groups in terms of FEV1 predict (%) and FEV1/FVC values, and there was also no significant difference in body composition variables in this study. While Pouragha et al.

(2020) did not find a relationship between BMI and respiratory function, they found a direct relationship between fat-free mass and respiratory function tests (Pouragha et al., 2020). They found a correlation between bioelectrical impedance analysis (BIA) values and pulmonary function such as FEV1, FVC, and FEF25–75 that was higher than anthropometric measurements such as body weight, waist circumference, and waist-hip ratio. In the study by Park et al. (2012), BMI, fat percentage, muscle mass, FFM, and WHR (waist to hip ratio) values were found to have a significant relationship with respiratory function (Park et al., 2012). In our study, we did not find any significant difference between the groups in terms of body composition values, despite previous studies reporting that body composition does impact respiratory functions.

One of the reasons for our low number of participants is that individuals are hesitant to participate in the pulmonary function test because they have had COVID-19. Another limitation of our study is that the spirometry values of individuals before COVID-19 were unknown. Additionally, classifying the degree of COVID-19 based on patients' verbal statements and subjective reporting of symptoms is a limitation of the study.

CONCLUSION

In conclusion, according to the results of this study, we believe that the respiratory functions of the sedentary people who had mild COVID-19 returned to normal after 6 months. We suggest examining the same research questions with the athlete sample for future studies. Further studies could classify COVID-19 based on the doctor's report instead of the participants self-report. In addition, future studies could take necessary precautions (such as antibody testing) in case there were asymptomatic individuals in the comparison group, which included those who had not had COVID-19. It is also recommended that the respiratory functions of the individual who had COVID-19 at moderate and severe levels be analyzed. Finally, a larger sample size in further studies is recommended.

AUTHOR CONTRIBUTION

Idea/Concept: MÖ, MK, NS ; Design:MÖ, NS ; Data Collection and/ or Processing: BC, MÖ; Analysis and/or Interpretation: MK, BC; Writing the Article: MÖ, MK, NS; Critical Review: MÖ, MK, BC.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICAL STATEMENT

TThe current analysis is part of a study that was approved by the Erciyes University Ethics Committee for the Social Sciences and Humanities (Date: September 26, 2021, Decision Number: 295).

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