YALOVA ÜNİVERSİTESİ SPOR BİLİMLERİ DERGİSİ
YALOVA UNIVERSITY JOURNAL OF SPORTS SCIENCES
CİLT:4 SAYI:1 YIL:2025
ISSN: 2822-664X
DOI: DOI: 10.70007/yalovaspor.1628639

Covid-19 Zamanla Sporcuların Solunum Fonksiyonlarını Etkiledi mi?

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DOI: 10.70007/yalovaspor.1628639 ORJINAL MAKALE

Özet

Çalışmanın amacı, Covid-19 geçiren sporcularda solunum fonksiyonlarının gelişiminin zaman içinde etkilenip etkilenmediğini belirlemektir. Bu retrospektif çalışmaya araştırma grubu olarak Covid-19 geçiren toplam 14 sporcu (8 judocu ve 6 kayakçı) ve kontrol grubu olarak Covid-19 geçirmeyen toplam 12 sporcu (8 judocu ve 4 kayakçı) dahil edildi. Veriler 2019 ve 2021 yıllarında alınan rutin performans ölçümlerinden toplandı. Sporcuların solunum fonksiyonları ve solunum kas kuvvetleri dijital spirometre (Pony FX Cosmed, İtalya) kullanılarak değerlendirildi. Veri analizi için dağılımı incelemek amacıyla Eğrilik ve Kurtosis değerleri ile Shapiro-Wilk test sonuçları dikkate alındı. Zaman içinde ve gruplar arasında değişiklikleri karşılaştırmak ve etkileşim etkilerini belirlemek için Karma Tasarımlı İki Yönlü ANOVA kullanıldı. Tüm istatistiksel analizler IBM SPSS 25.0 yazılımı kullanılarak gerçekleştirildi. İki farklı zaman noktasında yapılan testlerde solunum fonksiyon testi puanlarının ve solunum kası gücü puanlarının zamanla arttığı bulundu. Ancak Covid-19 bu iyileşmeyi istatistiksel olarak anlamlı şekilde etkilemedi. Çalışmanın bulguları Covid-19'un solunum parametrelerinin gelişimi üzerindeki uzun vadeli etkilerini gözlemlemek için bir kaynak görevi görebilir.

Anahtar kelimeler: Covid-19, Solunum, Gelişim, Performans

Did Covid-19 Affect Athletes Respiratory Functions Over Time?

Abstract

The aim of the study is to determine whether the development of respiratory functions over time was affected in athletes who had Covid-19. This retrospective study included a total of 14 athletes who had Covid-19 (8 judoka players and 6 skiers) as the research group, and a total of 12 athletes who did not have Covid-19 (8 judoka players and 4 skiers) as the control group. Data were collected from routine performance measurements taken in 2019 and 2021. Athletes' respiratory function and respiratory muscle strength were assessed using a digital spirometer (Pony FX Cosmed, Italy). For data analysis, Skewness and Kurtosis values, along with Shapiro-Wilk test results, were considered to examine the distribution. Mixed Design Two-Way ANOVA was used to compare changes over time and between groups, and to determine interaction effects. All statistical analyses were performed using IBM SPSS 25.0 software. It was found that respiratory function test scores and respiratory muscle strength scores increased over time in tests conducted at two different time points. However, Covid-19 did not statistically significantly affect this

improvement.The findings of the study may serve as a source for observing the long-term effects of Covid-19 on the development of respiratory parameters.
Keywords: Covid-19, Respiratory, Development, Performance

Introduction

On March 11, 2020, Turkey reported its first case of Covid-19, and on the same date, the World Health Organization declared this newly emerging virus a pandemic. The Covid-19 pandemic has broadly affected many individuals and specifically athletes, leading to a series of restrictions that could impact athletes' performance both short and long term from a pathophysiological perspective. These restrictions primarily affected training and eating habits, caused distressing physical conditions, and also influenced psychological behavior and overall health status (Demarie et al., 2020; Font et al., 2021). It has been stated that the reduction of physical activity disrupts proper glycemic control, changes body composition, leads to an increase in fat mass and a decrease in muscle mass, all of which have negative consequences on maximum oxygen uptake (VO2max) (Olsen et al., 2008; Mikus et al., 2012). In addition to the metabolic changes and psychological effects caused by inactivity in athletes, respiratory changes should also be considered. Many athletes have reported persistent symptoms such as chronic cough, tachycardia, and fatigue months after the initial Covid-19 infection. This situation has made it challenging to return to physical activity, especially in aerobic disciplines, due to the constant demand on the respiratory system for optimal sports performance (Wilson et al., 2020). Furthermore, maintaining a relatively stable but simultaneously adapted metabolism during exercise posed a significant challenge for respiratory and circulatory functions (Astrand, 1976). Considering the respiratory system, it is known that the lungs go through a growth and maturation phase during the first twenty years of life, reaching maximum lung function around the age of 20 in women and 25 in men. Lung function remains stable with minimal changes between the ages of 20 to 35 and then begins to decline (Knudson, 1981; Zeleznik, 2003). The long-term effects of the Covid-19 pandemic on athletes remain an area that has yet to be fully elucidated. While existing studies primarily focus on the acute phase of the disease, research examining changes in respiratory function over time is highly limited. This study aims to provide a more comprehensive understanding of the impact of the pandemic on athlete health by evaluating the long-term development of respiratory function in athletes who have recovered from Covid-19. The findings obtained will offer valuable insights into the structuring of training programs, the optimization of athletic performance, and a better understanding of post-Covid-19 recovery processes. In this regard, the study seeks to fill a critical gap in the literature and provide a novel perspective in the fields of sports sciences and health.

Lung volumes are dependent on body size, particularly height. The total lung capacity adjusted for age remains unchanged throughout life. Functional residual capacity and volume increase with age, leading to a decrease in vital capacityIn young athletes, the development of lung volumes and capacities over time is a desirable and expected condition. In light of this information from the literature, our aim is to investigate whether the respiratory function development of athletes who have had Covid-19 is affected over time.

Materials and Methods

For this study conducted on athletes who were employed as resident athletes in public facilities, retrospective respiratory test data were reviewed. To distinguish between athletes who had contracted Covid-19 (Covid- 19 group) and those who had not, weekly PCR tests conducted by the institution from 2021 backward were examined. Athletes who tested positive in 2020 and had respiratory function tests as part of routine performance tests in 2019 were designated as the experimental group. For athletes who had not contracted Covid-19 (control group), those who tested negative on PCR tests until the respiratory function test in 2021 were identified. These athletes, who had respiratory function tests conducted in 2019, were designated as the control group. All athletes in the COVID-19 group experienced symptoms such as cough, headache, and loss of smell. None of the athletes included in the study were severe cases, and none required hospitalization. To ensure that the respiratory function test results were not affected by the specificity of the training based on the athletes' disciplines, only athletes from the same disciplines were included. Athletes with similar heights, ages, and daily and weekly training durations were selected for the research group (Table 1). This approach aimed to control for factors that could affect respiration as much as possible. This led to a relatively small number of athletes being included in the study. Additionally, due to the limited number of female athletes in the same disciplines who had not contracted Covid-19, female athletes were not included in the study. The study was conducted solely on male athletes.

Table 1. *Demographic Characteristics of the Participants*

Variables	$\bar{x}$	***Sd***	***Min***	***Max***
Age (year)	17,00	2,05	15	22
Height (cm)	172,77	7,40	159	184
Weight (kg)	64,35	14,04	40	109

Sd: Standart Deviation; **Min:** Minimum; **Max:** Maximum

Table 2. Demographic Characteristics of the Participant Groups by Year

Covid-19	Variables	Age_2019 (year)	Height_2019 (cm)	Height _2022 (cm)
Control Group	Mean	17,25	173,17	177,42
	Sd	2,379	7,78	5,61
	Min	15	159	170
	Max	22	184	186
Covid-19 Group	Mean	16,79	172,43	175,29
	Sd	1,805	7,35	6,55
	Min	15	159	165
	Max	21	182	185
Total	Mean	17	172,77	176,27
	Sd	2,06	7,40	6,12
	Min	15	159	165
	Max	22	184	186

Sd: Standart Deviation; **Min:** Minimum; **Max:** Maximum

Assessment of Respiratory Function and Respiratory Muscle Strength

The respiratory function and respiratory muscle strength of the athletes were assessed using a digital spirometer (Pony FX Cosmed, Italy). The 2005 American Thoracic Society/European Respiratory Society (ATS/ERS) spirometry guidelines state that spirometer calibration should be performed daily, and recalibration is required after every four athletes (Miller, Hankinson, & Brusasco, 2005). The athletes included in the study arrived at the laboratory on different days but at the same time of day, without having engaged in strenuous exercise within the previous 24 hours and having refrained from consuming a substantial meal for at least two hours prior to testing. Prior to the tests, athletes were provided with information about the procedures. The tests were conducted in a comfortable sitting position. During the tests, the athletes' noses were clipped, and they were instructed to seal the mouthpiece of the spirometer with their lips, ensuring no air leakage from the sides.

The tests were performed by having the athletes execute respiratory maneuvers through the spirometer mouthpiece. Before the actual tests, several practice tests were conducted to help the athletes understand the procedure and adapt to the device. Each test was performed three times, and the best measurement score was used for statistical analysis. To evaluate the athletes' respiratory functions, forced vital capacity (FVC) maneuvers and maximal voluntary ventilation (MVV) tests were administered. During the FVC maneuver, the athlete was first asked to take a deep breath in, then exhale all the air from their lungs as quickly, forcefully, and completely as possible until they could no longer breathe out, followed by another deep breath in. The test results provided values for FVC, forced expiratory volume in one second (FEV1),

FEV1/FVC ratio, peak expiratory flow (PEF), and forced expiratory flow at 25-75% of the pulmonary volume (FEF_{25-75}). During the MVV test, the athlete was asked to breathe in and out deeply, rapidly, and forcefully for 12 seconds. At the end of the test, the athlete was asked to hold their breath for a few seconds to prevent respiratory alkalosis caused by the maneuver, and the MVV value was recorded. To assess the strength of the respiratory muscles, maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) tests were conducted. For the MIP test, the athlete was asked to completely exhale all the air from their lungs, then take a deep, rapid, and forceful breath in. For the MEP test, the athlete was asked to completely fill their lungs with air, then exhale rapidly and forcefully. The results were recorded, and each maneuver was repeated three times, with the best result used in the analysis.

Data Analysis

Data for the identified sub-problems within the research scope and the specified date range were recorded. In the analysis of the obtained data, Skewness and Kurtosis values and Shapiro-Wilk test results were considered to determine the distribution. A Two-Factor Mixed Design ANOVA was used to compare intergroup and time-dependent test means and to determine interaction effects. In the hypothesis stating that 'There is a significant difference in the mean scores of time-dependent respiratory parameters (FVC, FEV1, PEF, FVC25-75, MVV, and MEP) in athletes who have contracted COVID-19,' the respiratory parameters serve as the dependent variable, while repeated measurements define the within-subject factor.

All statistical analyses were performed using the IBM SPSS 25.0 software package. The sample size for the study was calculated using G Power 3.1 software based on data from a previous pilot study, with a power of 0.80 and a type I error rate of 0.05.

Result

In this section, tables and interpretations of the statistical procedures applied concerning the effect of Covid-19 on athletes' respiratory functions over time are provided.

Table 3.

Mean and Standard Deviation Values of FVC Measurement Results

Group	N	FVC				FEV1				PEF			
		2019		2021		2019		2021		2019		2021	
		$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*
Not Infected Covid	12	4,50	1,00	5,25	0,75	4,08	0,99	4,25	0,45	7,83	2,08	9,08	1,37
Infected Covid	14	4,93	0,99	5,64	0,74	4,21	0,80	4,64	0,74	8,57	1,55	8,93	1,63

Total	26	4,73	1,00	5,46	0,76	4,15	0,88	4,46	0,64	8,23	1,81	9,00	1,49

Group	N	FVC 25- 75				MVV				MEP			
		2019		2021		2019		2021		2019		2021	
		$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*
Not Infected Covid	12	4,50	1,08	4,67	1,07	147,83	35,69	167,00	23,18	136,42	35,88	172,17	36,99
Infected Covid	14	4,64	1,08	4,71	1,06	153,07	25,76	175,93	21,17	177,14	44,46	177,86	40,64
Total	26	4,58	1,06	4,69	1,05	150,65	30,21	171,81	22,14	158,35	44,98	175,23	38,33

FVC: Force vital capacity; **FEV1:** Forced expiratory volume; **PEF:** peak expiratory flow; **FVC** $_{25\text{-}75}$: Forced Expiratory Flow (FEF)25-75; **MVV:** Maximum Voluntary Ventilation; **MEP:** Maximum Expiratory Pressure

As seen in Table 3, an increase is observed in all parameters obtained for both groups, those who have had Covid and those who have not, in 2021 compared to 2019. Below is the table and interpretations of the two-way ANOVA results applied to the changes in parameters over time and by group, considering the means and standard deviations provided by years.

Table 4.

ANOVA Results for FVC Scores

Sources of Variance	SS	df	MS	F	p	η2
Between Groups	10,197	25				
Group (Covid Yes/Covid No)	1,09	1	1,09	1,593	0,219	0,062
Eror	9,107	24	0,379			
Within Groups	11,485	26				
Time	6,927	1	6,927	36,510	0,000*	0,603
Time*Group	0,004	1	0,004	0,022	0,884	0,001
Error	4,554	24	0,19			
Total	21,682	51				

SS: Sum of Squares; Df: Degree of Freedom; **MS**: Mean Squares; **η2**: Etasquares

The analysis provides us with the opportunity to separately comment on the common effects of group and measurement, as well as the fundamental effects of group and measurement.

As a fundamental effect of group: There appears to be no significant difference in the average total scores obtained from the FVC measurements in 2019 and 2021 between athletes who had and hadn't contracted Covid-19. $F_{(1,24)}=1.593$, $p>.05$, Partial $\eta^2=.062$. No effect of Covid-19 disease is observed on athletes' FVC values.

As a fundamental effect of measurement: It can be stated that there is a significant difference between the averages of FVC test scores taken at two different times for individuals included in the study without making a distinction based on groups. $F_{(1,24)}=36.510$, $p<.05$,

Partial η^2=.603. This can be interpreted as athletes' FVC scores increasing over time between the two different tests.

As the common effect of group and measurement: It is observed that there is no significant difference in FVC scores of athletes who have and haven't contracted Covid-19 over time, meaning that the common effects of contracting the disease and repeated measurement factors on FVC scores are not significant, $F_{(1,24)}$=022, p>.05, Partial η^2=.001. No effect of Covid-19 disease is observed on athletes' FVC development.

Graph 1. Changes in FVC measurement averages by group and time.

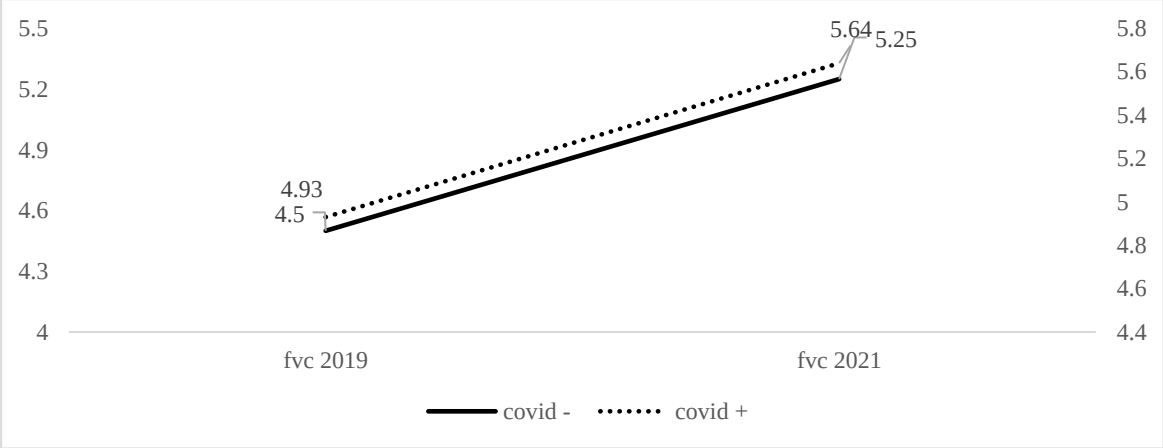


Table 5.

ANOVA Results for FEV1 Scores

Sources of Variance	SS	df	MS	F	p	η2
Between Groups	12,538	25				
Group (Covid Yes/Covid No)	0,443	1	0,443	0,879	0,358	0,035
Eror	12,095	24	0,504			
Within Groups	5,915	26				
Time	1,145	1	1,145	6,041	0,022*	0,201
Time*Group	0,222	1	0,222	1,170	0,290	0,046
Error	4,548	24	0,189			
Total	18,453	51				

SS: Sum of Squares; Df: Degree of Freedom; **MS:** Mean Squares; **η2**: Etasquares

As a fundamental effect of the group: It is observed that there is no significant difference in the average total scores obtained from the FEV1 measurements in 2019 and 2021 between athletes who had and hadn't contracted Covid-19. $F_{(1,24)}$=879, p>.05, Partial η^2=.035. No effect of Covid-19 disease is observed on athletes' FEV1 values.

As a fundamental effect of measurement: Without distinguishing between groups, it can be said that there is a significant difference in the averages of FEV1 test scores taken at two

different times for individuals included in the study. $F_{(1,24)}$=6.041, p<.05, Partial η^2=.201. This can be interpreted as athletes' FEV1 scores increasing over time between the two different tests.

As the common effect of group and measurement: It is observed that there is no significant difference in FEV1 scores of athletes who have and haven't contracted Covid-19 over time, meaning that the common effects of contracting the disease and repeated measurement factors on FEV1 scores are not significant, $F_{(1,24)}$=1.170, p>.05, Partial η^2=.046. No effect of Covid-19 disease is observed on athletes' FEV1 development.

Graph 2. Changes in FEV1 measurement averages by group and time.

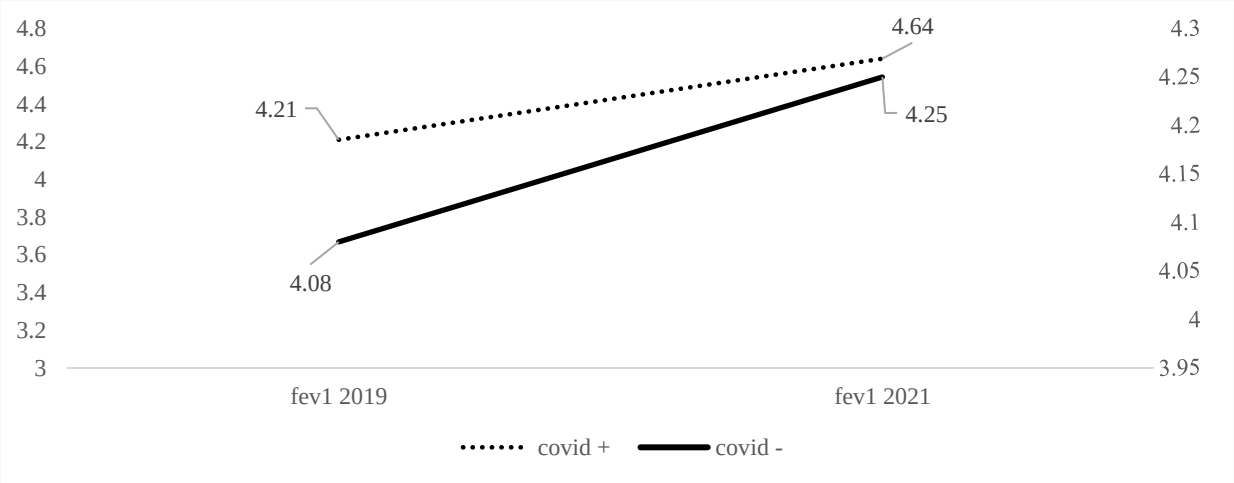


Table 6.

ANOVA Results for PEF Scores

Sources of Variance	**SS**	**df**	**MS**	**F**	**p**	**η2**
Between Groups	56,154	25				
Group (Covid Yes/Covid No)	0,55	1	0,55	0,237	0,631	0,01
Eror	55,604	24	2,317			
Within Groups	34,653	26				
Time	8,345	1	8,345	8,439	0,008*	0,26
Time*Group	2,576	1	2,576	2,605	0,12	0,098
Error	23,732	24	0,989			
Total	90,807	51				

SS: Sum of Squares; Df: Degree of Freedom; **MS**: Mean Squares; **η2**: Etasquares

As a fundamental effect of the group: It is observed that there is no significant difference in the average total scores obtained from the PEF measurements in 2019 and 2021 between athletes who had and hadn't contracted Covid-19. $F_{(1,24)}$=237, p>.05, Partial η^2=.01. No effect of Covid-19 disease is observed on athletes' PEF values.

As a fundamental effect of measurement: Without distinguishing between groups, it can be said that there is a significant difference in the averages of PEF test scores taken at two different times for individuals included in the study. $F_{(1,24)}$=8.439, p<.05, Partial η^2=.26. This suggests that athletes' PEF scores increase over time between the two different tests.

As the common effect of group and measurement: It is observed that there is no significant difference in PEF scores of athletes who have and haven't contracted Covid-19 over time, meaning that the common effects of contracting the disease and repeated measurement factors on PEF scores are not significant. $F_{(1,24)}$=2.605, p>.05, Partial η^2=.098. No effect of Covid-19 disease is observed on athletes' PEF development.

Graph 3. Changes in PEF measurement averages by group and time.

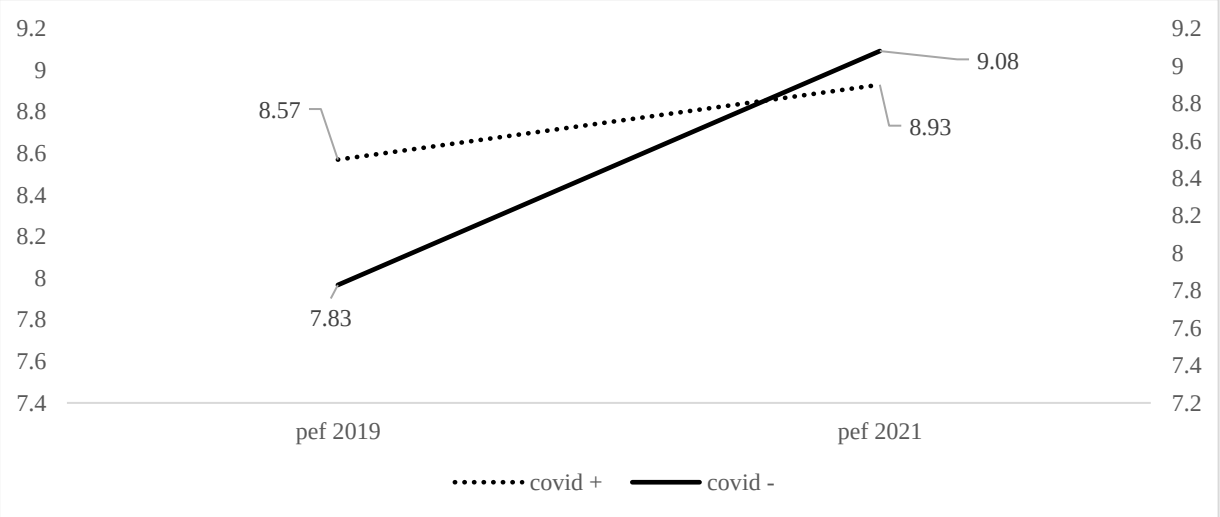


Table 7.

ANOVA Results for FVC $_{25\text{-}75}$ Scores

Sources of Variance	SS	df	MS	F	p	η2
Between Groups	25,279	25				
Group (Covid Yes/Covid No)	0,059	1	0,059	0,056	0,815	0,002
Eror	25,22	24	1,051			
Within Groups	5,51	26				
Time	0,183	1	0,183	0,830	0,371	0,033
Time*Group	0,029	1	0,029	0,133	0,719	0,006
Error	5,298	24	0,221			
Total	30,789	51				

SS: Sum of Squares; Df: Degree of Freedom; **MS**: Mean Squares; **η2**: Etasquares

As a fundamental effect of the group: It is observed that there is no significant difference in the average total scores obtained from the FVC 25-75 measurements in 2019 and 2021

between athletes who had and hadn't contracted Covid-19. $F_{(1,24)}$=.056, p>.05, Partial η^2=.002. This suggests that there is no effect of Covid-19 disease on athletes' FVC 25-75 values.

As a fundamental effect of measurement: Without distinguishing between groups, it is observed that there is no significant difference in the averages of FVC 25-75 test scores taken at two different times for individuals included in the study. $F_{(1,24)}$=.830, p>.05, Partial η^2=.033. This implies that athletes' FVC $_{25\text{-}75}$ scores are similar between the two different tests.

As the common effect of group and measurement: It is observed that there is no significant difference in FVC 25-75 scores of athletes who have and haven't contracted Covid-19 over time, meaning that the common effects of contracting the disease and repeated measurement factors on FVC 25-75 scores are not significant. $F_{(1,24)}$=0.133, p>.05, Partial η^2=.006. This suggests that there is no effect of Covid-19 disease on athletes' FVC 25-75 development over time.

Graph 4. Changes in FVC $_{25\text{-}75}$ measurement averages by group and time.

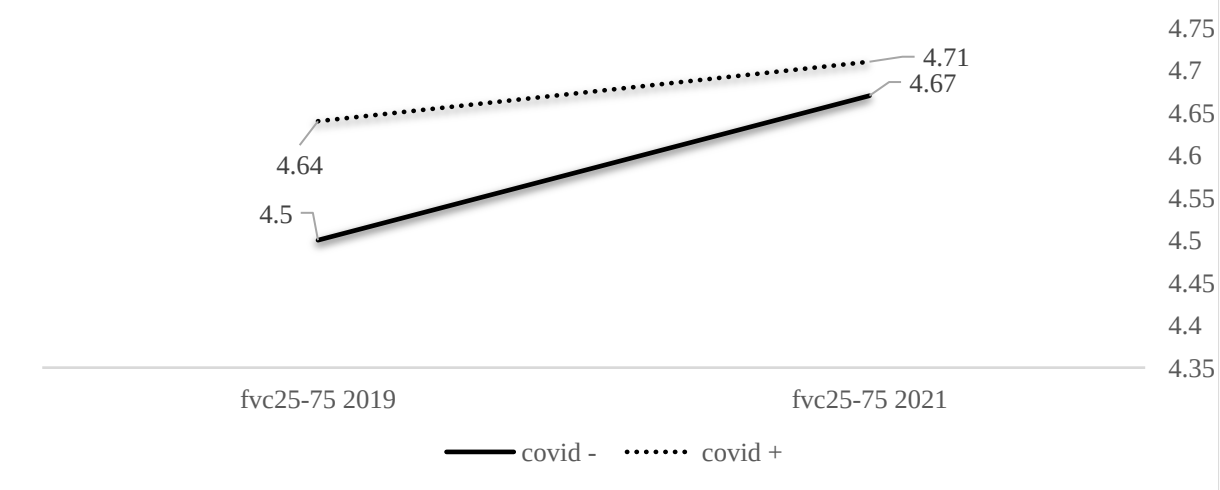


Table 8.

ANOVA Results for MVV Scores

Sources of Variance	SS	df	MS	F	p	η2
Between Groups	14301,62	25				
Group (Covid Yes/Covid No)	324,199	1	324,199	0,557	0,463	0,023
Eror	13977,42	24	582,392			
Within Groups	12178,23	26				
Time	5705,54	1	5705,54	21,300	0,000*	0,47
Time*Group	44,002	1	44,002	0,164	0,689	0,007
Error	6428,69	24	267,862			
Total	26479,85	51				

SS: Sum of Squares; Df: Degree of Freedom; **MS**: Mean Squares; **η2**: Etasquares

As a fundamental effect of the group: It is observed that there is no significant difference in the average total scores obtained from the MVV measurements in 2019 and 2021 between athletes who had and hadn't contracted Covid-19. $F_{(1,24)}$=.0557, p>.05, Partial η^2=.023. This fundamental effect of measurement: Without distinguishing between groups, it is observed that there is a significant difference in the averages of MVV test scores taken at two different times for individuals included in the study. $F_{(1,24)}$=21.300, p< .05, Partial η^2=.47. This suggests that athletes' MVV scores increase over time between the two different tests.

As the common effect of group and measurement: It is observed that there is no significant difference in MVV scores of athletes who have and haven't contracted Covid-19 over time, meaning that the common effects of contracting the disease and repeated measurement factors on MVV scores are not significant. $F_{(1,24)}$=0.164, p>.05, Partial η^2=.007. This implies that there is no effect of Covid-19 disease on athletes' MVV development over time.

Graph 5.

Changes in MVV measurement averages by group and time.

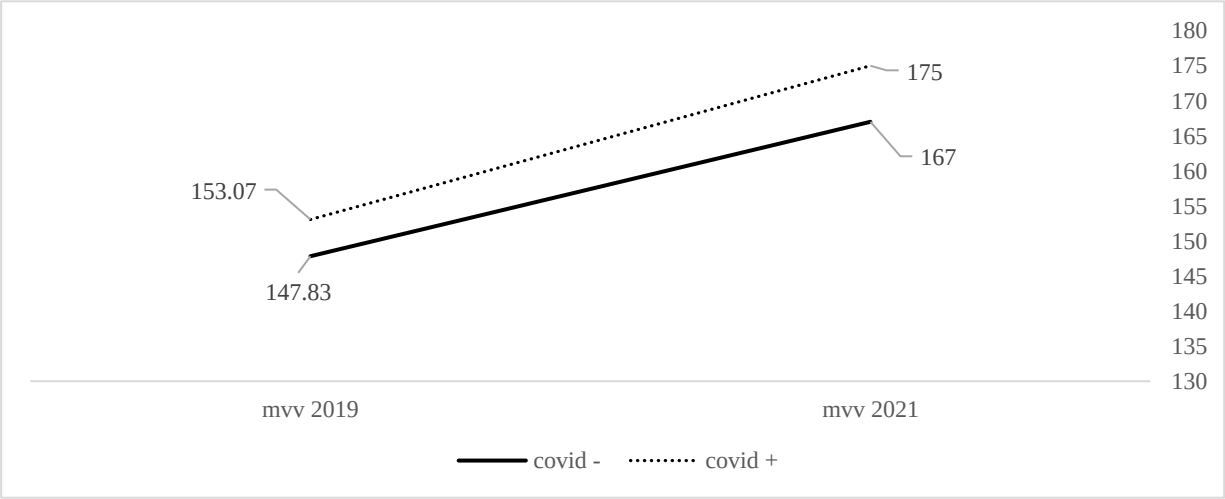


Table 9.

ANOVA Results for MIP Scores

Sources of Variance	SS	df	MS	F	p	η2
Between Groups	15350,66	25				
Group (Covid Yes/Covid No)	497,408	1	497,408	0,804	0,379	0,032
Eror	14853,26	24	618,886			
Within Groups	13047,53	26				
Time	2376,046	1	2376,05	5,766	0,024*	0,194

Time*Group	780,969	1	780,969	1,895	0,181	0,073
Error	9890,512	24	412,105			
Total	28398,19	51				

SS: Sum of Squares; Df: Degree of Freedom; **MS:** Mean Squares; η2: Etasquares

As a fundamental effect of the group: There is no significant difference observed in the average total scores obtained from the MIP measurements in 2019 and 2021 between athletes who had and hadn't contracted Covid-19. $F_{(1,24)}$=.804, p>.05, Partial η^2=.032. This suggests that there is no effect of Covid-19 disease on athletes' MIP values.

As a fundamental effect of measurement: Without distinguishing between groups, it is observed that there is a significant difference in the averages of MIP test scores taken at two different times for individuals included in the study. $F_{(1,24)}$=5.766, p<.05, Partial η^2=.194. This implies that athletes' MIP scores increase over time between the two different tests.

As the common effect of group and measurement: It is observed that there is no significant difference in MIP scores of athletes who have and haven't contracted Covid-19 over time, meaning that the common effects of contracting the disease and repeated measurement factors on MIP scores are not significant. F(1,24)=1.895, p>.05, Partial η^2=.073. This suggests that there is no effect of Covid-19 disease on athletes' MIP development over time.

Graph 6. Changes in MIP measurement averages by group and time.

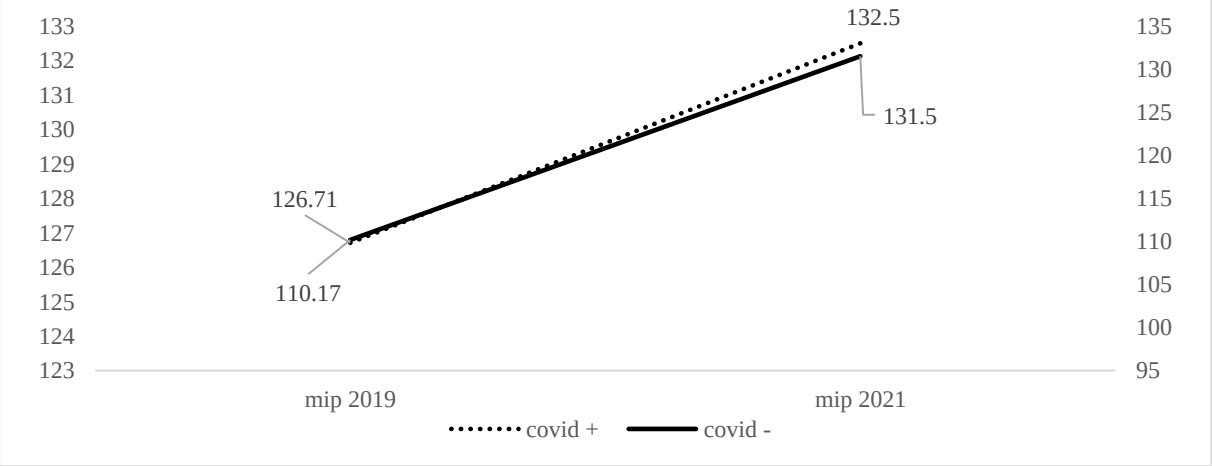


Table 10.

ANOVA Results for MEP Scores.

Sources of Variance	SS	df	MS	F	p	η2
Between Groups	22096,59	25				
Group (Covid Yes/Covid No)	3480,357	1	3480,36	4,487	0,045*	0,158
Eror	18616,23	24	775,676			

Within Groups	47429,1	26				
Time	4295,773	1	4295,77	2,632	0,118	0,099
Time*Group	3965,773	1	3965,77	2,43	0,132	0,092
Error	39167,55	24	1631,98			
Total	69525,69	51				

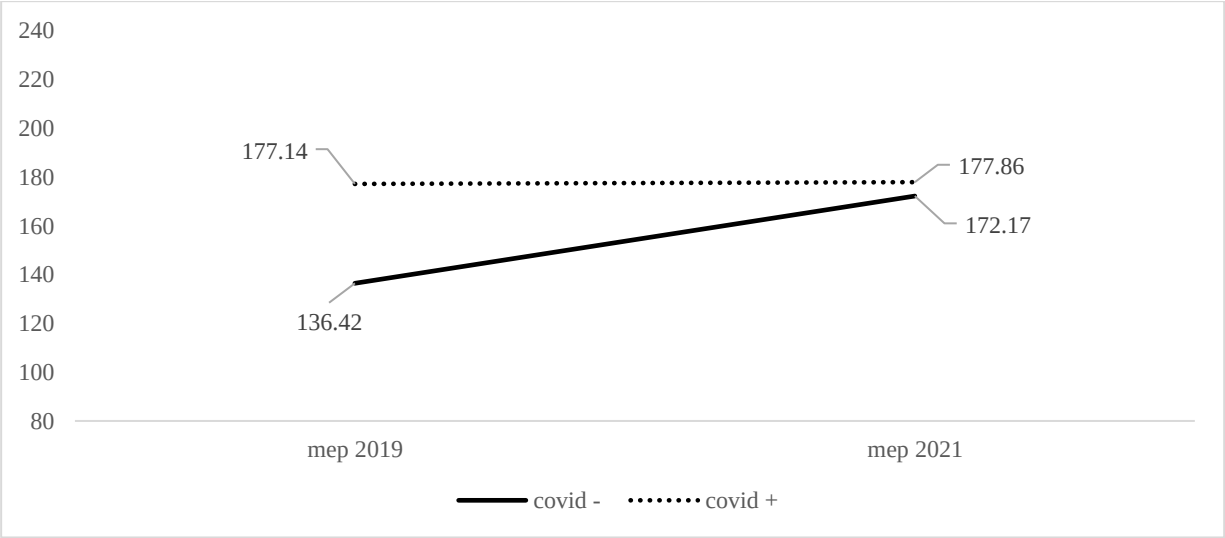
SS: Sum of Squares; Df: Degree of Freedom; **MS:** Mean Squares; **ŋ2**: Etasquares

As a fundamental effect of the group: It is observed that there is a significant difference in the average total scores obtained from the MEP measurements in 2019 and 2021 between athletes who had and hadn't contracted Covid-19. $F_{(1,24)}$=4.487, p<.05, Partial η^2=.158. This suggests that there is a significant increase in MEP values due to Covid-19 disease.

As a fundamental effect of measurement: Without distinguishing between groups, it is observed that there is no significant difference in the averages of MEP test scores taken at two different times for individuals included in the study. $F_{(1,24)}$=2.632, p>.05, Partial η^2=.099. This implies that athletes' MEP scores are similar between the two different tests.

As the common effect of group and measurement: It is observed that there is no significant difference in MEP scores of athletes who have and haven't contracted Covid-19 over time, meaning that the common effects of contracting the disease and repeated measurement factors on MEP scores are significant. $F_{(1,24)}$=2.43, p>.05, Partial η^2=.092. This suggests that there is no effect of Covid-19 disease on athletes' MEP development over time.

Graph 7. Changes in MEP measurement averages by group and time.



Discussion, Conclusion and Recommendations

The pandemic caused by Covid-19 has affected numerous individuals worldwide. Among those most affected after the elderly and children were athletes. The lack of regular physical activity led to an increase in body fat and muscle atrophy (Boonyarom & Inui, 2006). Aerobic capacity (VO_2 max) began to decrease, as seen up to six months after anterior cruciate ligament tears requiring surgery in professional soccer players (Almeida et al., 2018). Some adaptations observed during regular physical activity during training and gradual programs for post-injury recovery include increases in blood and plasma volume, cardiac output, and stroke volume during maximum effort, as well as muscle hypertrophy (Gabriel & Zierath, 2017). The inability of athletes to train sufficiently and the decrease in physical activity will reverse these adaptations induced by training (Quinn & Fallon, 2000). It is observed that Covid-19 has an effect on metabolic adaptation during exercise (Yu et al., 2006). Therefore, it is stated that in athletes who have had Covid-19, there is an increased risk of disruption in cardiovascular and muscle metabolic adaptations, in addition to a decrease in maximum and submaximal performance (Narici et al., 2021).

In our study, we found that Covid-19 did not affect respiratory development over time in the respiratory parameters we examined. Previous studies have examined athletes who have and have not had Covid-19. Celik et al. (2022) found in their study with volleyball players that inspiratory and expiratory muscle strength was impaired in players who had had the disease compared to players who hadn't. The long-term effects of Covid-19 are uncertain (Wilson et al., 2020). Busse et al. (2012) emphasized that respiratory function tests could be normal even in symptomatic patients, and therefore, additional diagnostic tests are recommended. Cytokine storm seen in individuals who have had Covid-19 is associated with abnormalities in inflammatory cytokines; continuous increasing systemic inflammation in critically ill Covid-19 patients has been associated with physiological damage and high mortality rates (Mehta et al., 2020). While cytokine storm in critical illnesses can be fatal, increased inflammatory cytokines in athletes can affect their performance (Mulcahey et al., 2021). More comprehensive studies on this subject are needed. In our study, it was concluded that Covid-19 did not statistically affect the development of inspiratory muscle strength. However, when the graphs are examined, it can be seen that athletes who had had Covid-19 had higher average inspiratory muscle strength in the 2019 measurements by chance. In this context, it can be observed that athletes with lower average inspiratory muscle strength in 2019 developed better. The same applies to expiratory muscle strength as well. It should not be overlooked that athletes who have

had Covid-19 may have been affected by increased systemic inflammation due to cytokine storm. When the graphs are examined, it can be observed that the development of PEF is better in athletes who have not had Covid-19. PEF is a parameter that shows the trachea, central airways, and expiratory muscles in healthy individuals. PEF follow-up values can be used in the evaluation of asthma and especially occupational asthma diagnosis and treatment (Ulubay et al., 2019). It is generally associated with FEV1 measurements (Castile, 2006). The lack of statistically significant results may be due to the small number of athletes.

Predicting future events with absolute certainty is beyond our capability. However, by examining past pandemics, analyzing large datasets, and evaluating multiple factors and variables, we can gather insights into potential future pandemics. Protecting the privacy and security of health information presents another challenge in the context of global data sharing. In this regard, there is an urgent need to establish strict guidelines and standardized operating procedures to overcome these challenges. The disinfection of sports facilities and educating athletes on infectious diseases, hygiene, and preventive measures can provide a significant advantage in pandemic prevention. While Covid-19 did not significantly affect respiratory parameters, trends suggest potential differences in muscle strength development. More comprehensive studies are required to determine whether Covid-19 leads to developmental deficiencies in athletes and to formulate health policies based on the findings.

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Etik Kurul İzin Bilgileri

Etik değerlendirme kurulu: Gazi Üniversitesi
Etik değerlendirme belgesinin tarihi: 26.03.2024
Etik değerlendirme belgesinin sayı numarası: 06 (Araştırma Kod No: 2024-491)

Araştırmacıların Katkı Oranları Beyanı

Araştırmanın tüm aşamalarında yazarlar eşit katkıda bulunmuştur.

Çatışma Beyanı

Yazarların araştırma ile ilgili bir çatışma beyanı bulunmamaktadır.