International Journal of
Disabilities Sports and Health Sciences
e-ISSN: 2645-9094

RESEARCH ARTICLE

Comparative Analysis of the Effects of Sport and Music on the Respiratory System

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Abstract
It is known that the respiratory system develops in response to exercise. However, it is not clear whether sport or music has a greater effect. The aim of this study was to investigate whether different types of sport and music have a greater effect on the development of the respiratory system. Individuals who continued their active sports and music life, who exercised regularly at least 3 days a week and whose FEV_1/FVC ratio was above 75% were included in the study, while individuals with a history of lung disease, upper respiratory disease and less than 6 years of experience were excluded from the study. MGC Diagnostics brand spirometry was used to measure forced expiratory volume in one second (FEV_1), FEV_1/FVC, forced vital capacity (FVC), slow vital capacity (SVC), inspiratory capacity and maximal volumetric capacity, maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP) and MicroRPM (Kent, UK) electronic respiratory pressure device. In our study, basketball players had higher respiratory muscle strength than opera singers ($p<0.05$). Differences were found in pulmonary function tests for forced vital capacity, forced expiratory volume in one second, slow vital capacity and maximal voluntary volume ($p<0.05$). It was observed that athletes had higher values in pulmonary function tests (FVC, FEV_1, SVC, MVV) and maximal inspiratory MIP and MEP parameters than musicians ($p<0.05$). Therefore, exercise has a greater effect on the respiratory system than music.

Keywords
Respiratory system, sports, music

INTRODUCTION

Adaptation of the respiratory, circulatory and musculoskeletal systems to increased loads is critical to the cardiovascular health and exercise capacity of athletes (Wilson et al., 2016). Cardiovascular conditioning focuses on maximising perfusion capacity to prevent lactic acid accumulation, which leads to a decline in performance (Plentz et al., 2012). Most importantly, however, is the training and development of the respiratory muscles (McConnell, 2009).

Physiological variables are related to the general physical condition of the individual and include complementary aspects such as age, gender, general health, genetic predisposition and natural muscle fibre type (Mazic et al., 2015). Performance variables are specific to the type of training and include the duration and intensity of the target exercise (Bostancı et al., 2019). These individual differences between athletes are framed within established training paradigms in which strength, endurance or mixed training programmes are developed. Occupationally, there are large differences between individuals, even in professions such as singers and wind instrumentalists (Johnson and Sandage, 2019).

Compared to the general population, athletes develop different physiological adaptations in the respiratory system depending on the sport performed. A significant change in respiratory

Received: 01 September.2023 ; **Accepted:** …. October 2023; **Online Published:** 25 October 2023
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How to cite this article: Yılmaz, C. anad Erail, S. (2023). Comparative Analysis of the Effects of Sport and Music on the Respiratory System. *Int J Disabil Sports Health Sci*;2023;Special Issue 1:177-183.https://doi.org/10.33438/ijdshs.1354035

function occurs in respiratory volume and frequency with training (Bostancı et al., 2019; Kocahan et al., 2017).

The main instruments of singers and wind players are the upper and lower airways. The respiratory system, which is the main part of sound production for singers and wind players, also affects the quality and performance of the voice (Leanderson and Sundberg, 1988; Antoniadou et al., 2012). Singers and wind instrumentalists, known as vocal athletes, need to control lung volume and adjust sound pressure levels appropriately to achieve superior performance (Ray et al., 2018). Breathing manoeuvers performed by singers and wind instrumentalists to produce sound provide strength and improve their function by forcing the respiratory muscles (Ray et al., 2018; Yılmaz et al., 2022). Professional musicians need to practice regularly and have stronger respiratory function to achieve superior performance (Antoniadou et al., 2012; Dries et al., 2017; Ray et al., 2018; Yılmaz et al., 2022). To produce a sound, it is necessary to regulate airway pressure (subglottal pressure), laryngeal resistance and airflow. This concept, known as breath control or breath support, is considered one of the requirements for excellent singing (Ray et al., 2018; Yılmaz et al., 2022).

The respiratory muscles allow for changes in ventilation, exercise-related breathing patterns, and changes in pressure and airflow required for speaking and singing (Leanderson and Sundberg, 1988; Antoniadou et al., 2012; Dries et al., 2017; Ray et al., 2018; Yılmaz et al., 2022). Singing requires more lung volume than speaking (60%). It has long been known that the control of lung volume has a direct effect on Ps, which regulates the sound pressure level (SPL) and thus the loudness of phonation (Leanderson and Sundberg, 1988; Ray et al., 2018).

The concept that the respiratory system develops better in athletes because of the training programmes they follow, and in singers and wind players because of the efforts they make to produce sound, is not fully explained in the literature. However, the functional status of the respiratory system can be compared between the two branches using traditional measurements of lung volume and capacity. The aim of this study was to examine whether regular exercise or music has a greater effect on the development of the respiratory system.

MATERIALS AND METHODS

Study Design

A total of 100 subjects were enrolled in the study, who continued to be active in sports and music, who continued to train regularly at least 3 days a week (1 training session: 90 - 120 minutes) specific to their branch, and whose FEV_1/FVC ratio was above 75%. The study groups consisted of singers, brass instrument players, football players, basketball players and martial artists living in Samsun. Subjects with a history of lung disease, upper respiratory tract disease, and less than 6 years of experience were excluded from the study.

This study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from each study participant in accordance with the ethical standards of the Declaration of Helsinki. The study was approved by the Ethics Committee of Gümüşhane University.(2022/02;E-95674917-108.99-137506).

Data collection

Anthropometric characteristics

Participants' body weights were measured using SECA (Hamburg, Germany) brand scales (accuracy + 0.1 kg). Height was measured using a wall-mounted stadiometer (Holtain Ltd, UK) to the nearest 0.1 cm between the top of the head and the standing position. Each subject was measured in shorts and a T-shirt and barefoot.

Pulmonary function tests (PFTs)

Participants were informed about the measurements before the test. Pre-tests were performed to familiarise them. Forced expiratory volume in one second, FEV_1/FVC, forced vital capacity, slow vital capacity, inspiratory capacity and maximal volume capacity were measured using an MGC Diagnostics spirometer (ATS/ERS, 2002).

Measurement of respiratory muscle strength (maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP)) (RMS)

Respiratory muscle strength (MIP and MEP) were measured using a MicroRPM electronic respiratory pressuriser (CFMM, UK). The measurement was repeated until there was a difference of 10 $cmH2_O$ between the two best measurements and the best result was recorded in $cmH2_O$ (ATS/ERS, 2002).

Data analysis

Statistical analyses were performed using SPSS version 21.0 (SPSS Inc., Chicago, IL). The Kolmogorov-Smirnov test was used to assess normality. One-way ANOVA and independent samples t-test analyses were performed to determine differences in respiratory parameter measurements for normally distributed data groups.

RESULTS

Table 1. Demographic characteristics

	Football (n:20)	M.A (n:20)	Basketball (n:20)	W.I (n:20)	S. (n:20)	Total(n:100)
Age (year)	22,70±0,73	21,90±2,27	22,25±6,64	25,45±7,78	25,95±5,19	23,65±6,70
Weight (kg)	72,17±8,31	71,80±11,19	81,60±16,35	69,10±15,59	75,40±24,99	74,01±16,54
Height (cm)	180.45±4.72	174.95±6.63	187.85±9.37	170.05±9.29	172.05±10.63	177.07±10.47
BMI (kg/m^2)	22,11±1,72	23.39±2.83	22.88±2.34	24.34±4.94	25.31±6.68	23.61±4.20
Deneyim yılı	8.70±2.03	8.60±3.14	8.70±3.67	8.95±5.02	7.95±1.64	8.58±3.53
FEV_1 (L)	4,38±0,82	4,27±0,63	4,5±0,67	3,57±0,76	3,84±0,74	4,11±0,80
FVC (L)	5,10±0,98	4,87±0,82	5,54±1,06	4,12±0,86	4,47±0,94	4,82±1,04
FEV_1/FVC(%)	86,30±5,94	87,70±7,80	83,55±8,34	88,15±4,02	83,25±7,28	85,79±7,02
SCV(L)	4,52±1,12	4,80±0,71	4,97±1,13	3,79±1,11	3,95±1,20	4,40±1,15
İC (L)	3,01±0,83	3,32±0,54	3,64±1,16	2,95±0,81	3,17±0,84	3,22±0,88
MVV (L/min)	182,75±35,24	166,65±51	188,4±35,13	143,9±52,47	146,8±37,02	165,7±45,79
MİP (cmH_2O)	115,65±25,63	125,95±41,12	131,9±25,24	108,95±26,06	100,15±24,56	116,52±31,34
MEP(cmH_2O)	146,9±35,56	143±36,23	155±22,25	130,4±30,08	118,05±23,6	138,67±32,27

BMİ: Body Mass Index, M.A: Martial Arts, W.I: Wind Instrumentalist, S: Singers, FEV_1:Forced expiratory volume in one second, FVC:Forced vital capacity, SVC: Slow vital capacity, IC: Inspiratory capacity, MVV: Maximal volume capacity.

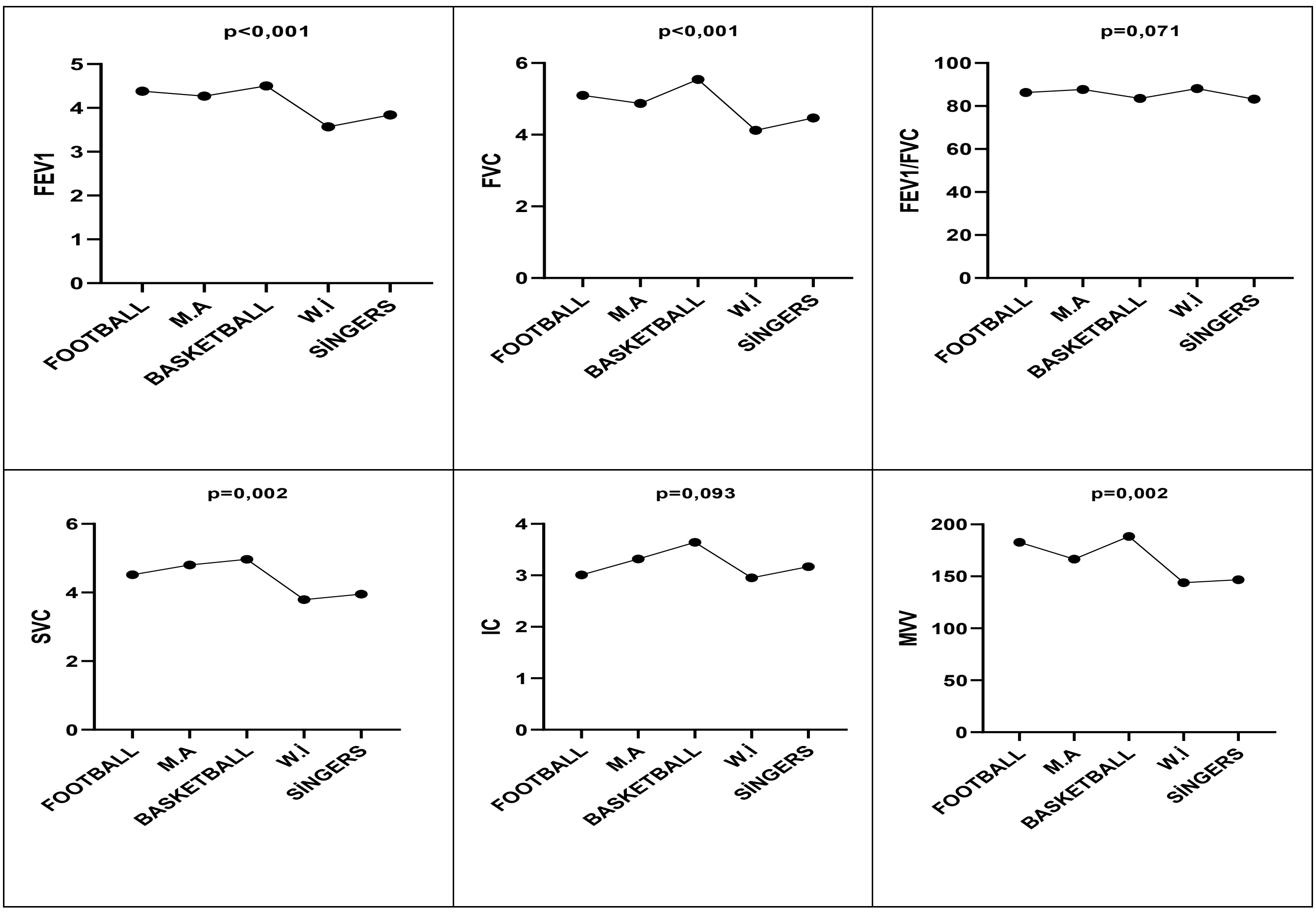

Figure 1. Comparison of respiratory function and respiratory muscle strength by research group

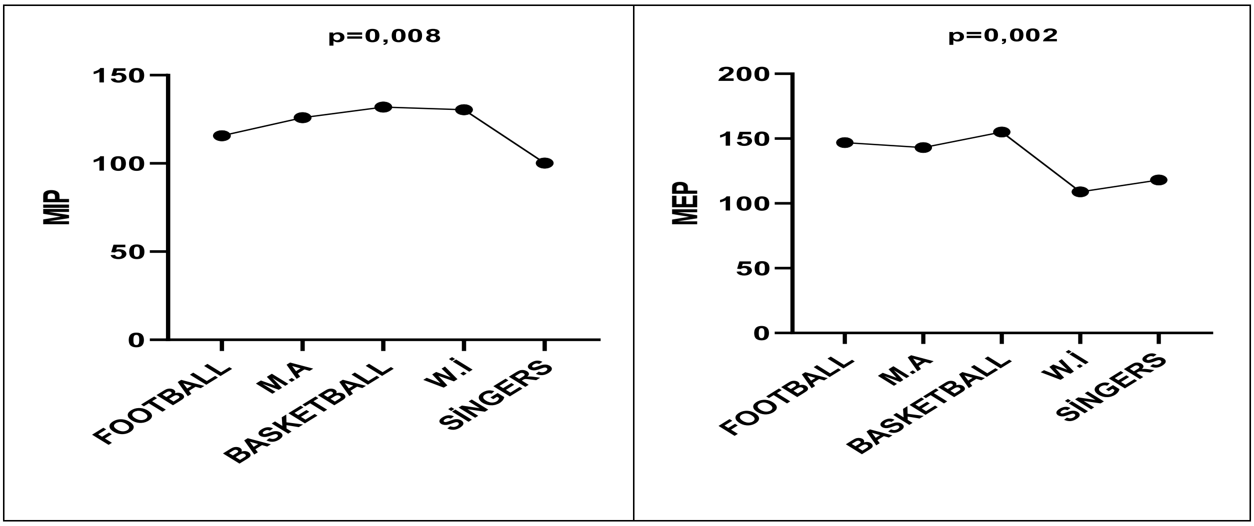

Figure 1. Continue

A significant difference was found between basketball and opera singers in MIP (p=0.008) and MEP values (p=0.002) when comparing branch and respiratory muscle strength. In pulmonary function tests, differences were observed in forced vital capacity, forced expiratory volume in one second, slow vital capacity and maximum voluntary ventilation. Basketball players were found to have higher values for all parameters except FEV_1/FVC.

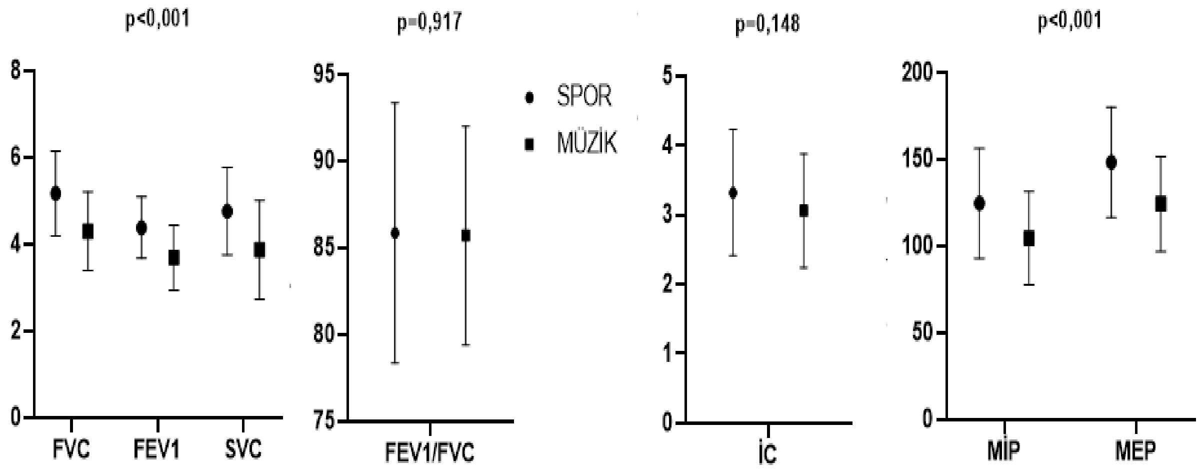

Figure 2. Comparison of respiratory values between athletes and musicians

It was observed that athletes had higher values in pulmonary function tests (FVC, FEV_1, SVC, MVV) and respiratory muscle strength parameters (MIP, MEP) than musicians (p<0.05).

DISCUSSION

Music has been shown to increase adherence to physical activity (Clark et al., 2016; Hutchinson et al., 2018), stimulation (Terry et al., 2020), relaxation (Karageorghis et al., 2018), positive emotional state (Hutchinson et al., 2018; Laukka and Quick, 2013; Elvers and Steffens, 2017), physical effort (Carlier et al., 2017), increased strength and power output (Karageorghis et al, 2018; Hutchinson et al., 2011), increased endurance (Terry et al., 2012; Savıtha et al., 2013), improved work rate (Chtourou et al., 2012; Lee & Kimmerly, 2016), synchronised movement to music (Hutchinson et al., 2018; Terry et al., 2012; Stork et al., 2015; Çelik, 2022) are known to facilitate recovery after physical activity (Çelik, 2022; Eliakim et al., 2012; Jia et al., 2016). It is not clear which of music and sport, which are known to affect the respiratory system, has a greater effect on the respiratory system. The aim of our study was to find an answer to the question of which has a greater effect on the respiratory system: sport or music.

The study found a significant difference in MIP and MEP values between basketball and opera singers when comparing branch and respiratory muscle strength. In pulmonary function tests, differences were observed in forced vital capacity, forced expiratory volume in one second, slow vital capacity and maximum voluntary ventilation. Basketball players had higher values for all measures except FEV_1/FVC. Athletes had higher values for pulmonary function tests (FVC, FEV_1, SVC, MVV) and respiratory muscle strength parameters (MIP, MEP) than musicians ($p<0.05$).

Studies of sedentary people, athletes and musicians have shown that athletes have higher respiratory parameters. Any type of regular exercise is known to increase an individual's respiratory activity and capacity (Kocahan et al, 2017; Hutchinson et al, 2018; Akdur et al, 2001; Bernardi et al, 2006; Tang et al, 2008; Cossette et al, 2008; Wendy, 2008; Natalie et al, 2016; Traser et al, 2017; Zuskin et al, 2009). During exercise, metabolic rate increases and respiratory frequency and volume increase to provide the required amount of O2 (Yiğit, 2001). Respiratory efficiency and O2 diffusion capacity also increase with exercise. The mechanical functioning of the respiratory system is largely dependent on the capacity of the respiratory muscles (Kantarson et al, 2010). It is known that respiratory muscle strength increases in exercising individuals due to the increase in tidal volume with exercise (Yiğit, 2001).

It is known that the breathing manoeuvres used by singers and brass players (trumpet, trambone and horn) to produce sound also strengthen and improve the respiratory muscles (Ray ve ark., 2018). Music can be defined as a relaxing exercise that allows a person to exercise at a low heart rate while using fewer calories and oxygen. This is because it improves respiratory efficiency without increasing workload. Vocal and instrumental forms of the same type of music have a similar effect on respiratory demand (Savıtha ve ark., 2013). Basketball is a sport based on aerobic and anaerobic structures. Due to the height of the athletes, the lung volume and diameter are larger than in other sports and music forms. This is thought to be the reason why respiratory function and respiratory muscle strength are higher. Subjects with a history of lung disease, upper respiratory tract disease, less than 6 years of experience and an FEV_1/FVC ratio below 75% were excluded from the study.

As a result, it was found that doing sports improves the respiratory system more than making music, and basketball and martial arts improve CCT and SFT parameters more than other branches. It is recommended that musicians train in basketball or martial arts (judo and wrestling) to have better respiratory parameters.

Conflicts of interest

There are no potential conflicts of interest in this article.

Funding

The authors have received no financial support for the research, writing and publication of this article.

Ethics Statement

The study was approved by the Ethics Committee of Gümüşhane University.(2022/02; E-95674917-108.99-137506). Written informed consent was obtained from participants before the study began.

Author Contribution

Study Design, CY; Data Collection, CY; Statistical Analysis, CY, SE; Data Interpretation, CY, SE; Manuscript Preparation, CY, SE; Literature Search, CY, SE. Authors have read and agreed to the published version of the manuscript.

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