

Original Article

Analysis of respiratory function and muscle strength of elite judo athletes and sedentary females

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ABSTRACT

The purpose of this study is to analyse the respiratory function and muscle strengths of elite female judo athletes and sedentary females. 20 elite female judo athletes (EG) and 20 sedentary healthy females (CG) participated in our study. The subjects' respiratory function tests were conducted in sitting position with spirometry, while the respiratory muscle strength tests were conducted by using intraoral barometry. SPSS 22.0 program was used for statistical analysis. When EG and CG were analysed in terms of respiratory functions, no statistically significant difference was found ($p>0.05$). However, when MIP* and MEP** values were analysed, it was found statistically that female judo athletes (EG) had much higher results when compared with sedentary females (CG) (* $p<0.05$, ** $p<0.01$). As a conclusion, it can be seen that elite female judo athletes had stronger respiratory muscles when compared with sedentary females, while their lung capacities were found to be similar. Based on the results of our study, it is thought that by doing extra respiratory muscle and function developing trainings, these parameters influencing performance can be developed in female judo athletes. In addition, our study has the characteristic of a reference in terms of respiratory functions and especially respiratory muscle strength in the branch of judo. **Keywords:** Female judo athletes; Respiratory; MIP; MEP.

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INTRODUCTION

Healthy respiration functions and strong respiratory muscles have a great significance for athletes (Shin et al., 2017). During exercise, athletes inhale and exhale thousands of times and meanwhile their respiratory muscles work intensely (Amonette & Dupler, 2002). Studies conducted clearly show that high values in respiratory functions and respiratory muscle strength have acute and chronic positive effect on athletes' performances (Özdal, 2016; Özdal et al., 2016). Respiratory functions and respiratory muscle strength can be measured objectively and physiological characteristics can be found for patients, healthy individuals or athletes and average values can be found for branches.

Maximal inspiratory mouth pressure (MIP) and maximal expiratory mouth pressure (MEP) are frequently used to measure inspiratory and expiratory muscle strength. These data reflect the combined force forming capacity of inspiratory and expiratory muscles during a semi-static constriction. MIP and MEP are generally used as a reference for muscle training in elite athletes (HajGhanbari et al., 2013). Respiratory functions similarly have great significance in athletes in terms of their effect on performance. It is a known fact that athletes with developed respiratory muscles and respiratory functions stand out in performance parameters of the sport they are doing and even specific exercises are developed to improve these functions (Forbes et al., 2011; Arend et al., 2015; Lomax & McConnell, 2009).

In branches which are categorized according to weight, especially like judo, some cardiovascular problems are known to occur due to over loading and due to excessive weight in heavy weight athletes. In studies they conducted, experts reported that the changes in systems such as muscoskeletal and respiratory system influence athletes' performance (Berglund et al., 2011; Shin et al., 2017).

When the literature is reviewed, it can be seen that researches generally intensify on male athletes and that there are limited numbers of studies especially in respiratory muscle strength. In studies which analysed the differences in gender in terms of respiration, no obvious differences were found (O'Brien et al., 2009).

The primary aim of our present study was planned as finding out respiratory functions and MIP and MEP characteristics in elite female judo athletes and to compare with sedentary females.

MATERIAL AND METHOD

Subjects

A total of 40 volunteers, 20 female judo athletes between the ages of 18 and 25 who were elite athletes as the experimental group (EG) and 20 sedentary healthy females as the control group (CG) participated in our study. The athletes were given a questionnaire before the study and those who had a history of injury or those who had a serious injury were excluded from the study.

Measurements

Gaia 359 Plus BodyPass body analyser was used to find out the height, weight and BMI parameters of the subjects who participated in the study. The results were recorded as height (cm), weight (kg) and BMI (kg/m²) values. SPIROLAB III (Medical International Research, Rome, Italy) spirometry was used to find out respiratory function tests. Forced vital capacity (FVC), forced expiration volume in 1 second (FEV1), FEV1/FVC ratio (FEV1/FVC) and maximal voluntary ventilation (MVV) values of the subjects were measured respectively. Expirite make flow meter was used to find out the Peak Expiration Flow (PEF) values of the subjects.

MIP and MEP measurement: A MicroRPM (CareFusion Micro Medical, Kent, UK) intraoral barometer was used to find out MIP and MEP parameters. For MIP measurement, after suitable filter and holders were fixed, the nose air way was closed with a clip. The test was completed when the subject was standing with residual volume, the holder was taken into the mouth, and maximal inspiration was made at maximal speed for 1-3 seconds. For MEP measurement, the same method was applied as in MIP. However, unlike residual volume, the test was started at total lung capacity. The measurement was repeated between the two best measurements until 10 cmH₂O difference was left and the best result was recorded in cmH₂O (Lomax & McConell, 2009). A pilot study was conducted before all measurements and the tests were completed within the same hour interval for all the subjects (between 14:00 AM and 16:00 AM).

Statistical Analysis

SPSS IBM 22.0 program was used for statistical analysis. The data were presented as mean and standard deviation. Normality assumption of the data was conducted with Shapiro-Wilk test, while the homogeneity assumption was conducted with Levene test. In comparisons between groups, Independent Sample T-test was used for data sets which were normally distributed, while Mann-Whitney U test was used for data sets which were not normally distributed. The results were assessed statistically at $p < 0.05$ significance level.

RESULTS

Table 1. Comparison of descriptive data of the groups

Variables	Group	N	Mean \pm S.D	t	p
AGE (years)	JUDO	20	20.24 \pm 1.56	-1.209	0.239
	CONTROL	20	21.19 \pm 2.76		
HEIGHT(cm)	JUDO	20	163.76 \pm 5.29	-0.669	0.509
	CONTROL	20	165.06 \pm 5.82		
WEIGHT (kg)	JUDO	20	54.88 \pm 6.20	-0.760	0.453
	CONTROL	20	56.38 \pm 4.96		
BMI (kg/m ²)	JUDO	20	20.51 \pm 2.46	-0.271	0.788
	CONTROL	20	20.70 \pm 1.63		

Table 1 presents the descriptive data of the groups as mean and standard deviation. When descriptive data were analysed statistically, no statistically significant difference was found in age, height, weight and BMI ($p > 0.05$).

Table 2. Comparison of respiratory function parameters of the judo athletes and the control group

Variables	Group	N	Mean \pm S.D	t	p
FVC(lt)	JUDO	20	3.51 \pm 0.47	-0.750	0.459
	CONTROL	20	3.66 \pm 0.71		
FEV1(lt)	JUDO	20	3.15 \pm 0.41	-1.037	0.308
	CONTROL	20	3.31 \pm 0.48		
FEV1/FVC(%)	JUDO	20	90 \pm 0.09	-0.682	0.501
	CONTROL	20	92 \pm 0.08		
MVV(lt/min)	JUDO	20	128.12 \pm 16.66	0.985	0.333
	CONTROL	20	120.94 \pm 24.26		
PEF(lt/sec)	JUDO	20	451.35 \pm 31.20	0.31	0.976
	CONTROL	20	450.69 \pm 80.97		

Table 2 presents the respiratory function test results of the groups as mean and standard deviation. When the groups' respiratory function test results were analysed, no statistically significant difference was found ($p>0.05$).

Table 3. Comparison of respiratory muscle strength of the judo athletes and the control group

Variables	Group	N	Mean \pm SD	t	p
MIP(cmH ₂ O)	JUDO	20	103.47 \pm 23.24	3.304	0.003*
	CONTROL	20	81.38 \pm 14.40		
MEP(cmH ₂ O)	JUDO	20	135.70 \pm 27.07	4.974	<0.001**
	CONTROL	20	95.06 \pm 19.47		

* $p<0.05$, ** $p<0.001$

Table 3 presents the respiratory muscle strength results of the groups in mean and standard deviation. When the respiratory muscle strength values between groups were analysed, it was statistically found that female judo athletes had higher MIP and MEP values when compared with sedentary individuals (* $p<0.05$, ** $p<0.01$).

DISCUSSION

Respiratory function and muscle strength tests performed in different sport branches are important sources for researches conducted and at the same time they allow for the opportunity to assess the results within a cause-effect relationship. However, when the studies conducted are analysed, it can be seen that while there are sources about especially men in different sport branches (Chin et al., 1992; Zaccagni et al., 2009), there is a lack of sources in respiratory function tests, especially respiratory muscle strength, in martial arts in both males and females.

Our study is on judo, which is one of the popular martial arts. It can be seen clearly from the literature review that due to factors such as place and training systems, etc., martial arts with different systems and types have different physical and physiological characteristics (Chaabene et al., 2012; Murata et al., 2016; Ouergui et al., 2015). When respiratory functions (FVC, FEV₁, FEV₁/FVC, MVV, PEF) were analysed in our study, no statistically significant difference was found between EG and CG. Studies conducted show that in measurements which were conducted without any training protocol, female athletes and healthy individuals showed parallel results with the results of EG group in our study (Kellens et al., 2011; Romer et al., 2004). However, it can be clearly seen that function values show high results in groups in which some specific programs are organized such as respiratory muscle training and especially swimmers (Vasconcelos et al., 2017; Cordain & Stager, 1988; Doherty & Dimitriou, 1997). It is thought that the reason for this is different physiological characteristics of branches and the positive effects of trainings on respiratory functions.

Respiratory muscles have vital importance on athletes' performance and they influence exercise tolerance significantly (Amonette & Dupler, 2002). When the results of our study are examined, it can be seen that female judo athletes have much higher MIP values when compared with sedentary female. The muscles which have primary influence on respiratory muscle strength are diaphragm and external intercostal muscle, while the secondary muscles are trapezius, scalene, sternocleidomastoid, serratus anterior muscles (Cameron & Monroe, 2007). Studies have been found which show that the muscles related with respiratory are developed especially in judo athletes (Radovanovic et al., 2011). When the literature is reviewed, it can be seen that female athletes have much higher MIP and MEP values when compared with healthy individuals, while there are different results among branches (Ohya et al., 2017; Ohya et al., 2016; Rodriguez, 2000). This difference is thought to result from the fact that branch-specific training techniques and different energy

systems are used and also from specific training methods for respiratory muscles. The results of studies conducted are in parallel with this thought (Ohya et al., 2017; Rodriguez, 2000; Cordain & Stager, 1988; Strongoli et al., 2010).

As a conclusion, this study shows that MIP and MEP characteristics in female elite judo athletes show higher results when compared with sedentary healthy females. It is an expected result for exercise-related inspiratory and expiratory muscular pressure of athletes to have higher MIP and MEP values when compared with healthy individuals. The results concluded support the expected results. Our study can be resources for studies about respiratory functions and muscles, which are in limited number especially in female athletes.

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