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Original Article

Effect of body size on pulmonary function in male and female dancers

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Abstract

Introduction: Pulmonary function influence the performance of dancers during their trainings and also their performance stage. Therefore, it is important to investigate the factors that effects the pulmonary function. The effect of body size on resting pulmonary function in modern dancers is unknown but may be related to sex differences. Accordingly, the purpose of this study was to determine the effect of body size on resting pulmonary function in male and female modern dancers with the same training levels. **Materials and Methods:** Thirty-eight (*n*=18 male; *n*=20 female) undergraduate modern dancers participated voluntarily and their exercise levels (minimum of 5 days/week, 3 hours/day) and training histories (at least 4 years) were similar.

All dancers completed pulmonary function test with a computerized spirometer (MIR, Spirobank, Rome, Italy) according to the American Thoracic Society (ATS) guidelines. **Results:** There was a significant difference ($p < 0.05$) between the genders in terms of vital capacity-best (VC-best) and maximum voluntary ventilation-best (MVV-best). The values were significantly higher in the male than in female dancers, and body size had a significant effect, with a small effect size (< 0.2) on the VC-best ($F_{(1,25)}$= 4.902, p = 0.036) and MVV-best ($F_{(1,25)}$ = 7.864, p = 0.010) values. **Conclusion:** Although the effect size was small, the effects of body weight, height, and body mass index on the VC-best and MVV-best values were influenced by the fact that male dancers have higher resting respiratory function performance. In a practical contribution, the current results suggest that it is necessary to consider the gender factors when planning and organizing dance training with different models.

Key Words: Anthropometric measurements, dance, gender differences, pulmonary function testing, spirometer comparison

Introduction

Lung capacity is a prominent component of respiratory function and refers to the volumes of air associated with the different phases of the respiratory cycle. Pulmonary function is influenced by genetic, environmental, and nutritional factors (Mahotra & Shrestha, 2013), as well as exercises such as aerobic and respiratory (Seo, 2017). In addition to sporting activities, dance involves continuous body movements, and dancing as a physical activity may have some impact on lung function variables (Banerjee *et al.,* 2014).

Modern dance, which is one type of dance, has a complex structure that requires dancers to be both artistic and athletic (Agopyan *et al.,* 2013). Modern dance consists of "centering, gravitation, balance, posture, gestures, rhythm, motion in space, and breathing" (Gorwa *et al.,* 2014). In this complex structure walking, running, the sets of jumps and leaps across the floor with wide range of motion, poses in natural or external rotation of the lower limbs (turnout), consecutive *pirouettes*, static and dynamic balances, flexibility elements, some roll in the floor and partnering skills (e.g. pulling, pushing lifting etc.) are executed in the performances. Especially, the components of different movements, such as use of the floor, falls, weight transfers from feet to hands, contact between dancers are contributed to increased physical demands (Rodrigues-Krause *et al.*, 2015). This kind of dance movements frequently start from the middle of the body, using the muscles of the abdomen often coupled with exhalation. Therefore, the use of breath is one of the movement principles that unites the various styles of modern dance (Giguere, 2014). During dance training, requirements for oxygen and substrates in the skeletal muscles increase, and changes occur in the metabolic, cardiovascular and ventilatory functions to meet increased demand (Sabaananth *et al.*, 2014). Therefore, these vigorous physical activities require high level of cardiovascular demand to accomplish workloads during rehearsals and performances in the stage (Agopyan *et al.,* 2016). Since the body is the instrument of the dancer's expression, physiological and motoric capabilities as well as body composition are equally important components of physical fitness (Agopyan *et al.,* 2016; Angioi *et al.,* 2009). Besides all these features, demands of the performance vary significantly and the absolute physiological workload on the choreography performed, the relative intensity is related to the dancer's physical fitness (Wyon, 2005)

Scientific research has proved that in both males and females, dance training and physical activity can have a positive effect on physical fitness and increase capabilities including lung function, lung capacity, flexibility, aerobic capacity (Blair *et al.*, 2001), muscular strength, power, endurance (Rodrigues-Krause *et al.,*

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2015) and also strengthen and improve cardiorespiratory efficiency (Sabaananth *et al.,* 2014). Nevertheless, significant differences in pulmonary functions were found among types of athletic training (Mazic *et al.*, 2015; Durmic *et al.*, 2017). In addition to exercise, many factors such as anthropometric features (age, sex, race, height and weight, body mass index (BMI), waist circumference and waist hip ratio), balance lung recoil, chest elasticity, thoracic and abdominal muscle strength, lung elasticity, and individual posture have been shown to influence lung function (Lazovic-Popovic *et al.*, 2016; Soundariya & Neelambikai, 2013). Therefore, anthropometric measurements are an important, widely applicable, noninvasive, and inexpensive technique for assessing body size, proportions, and composition and are frequently used in their relationship to lung respiration level (Aung et al., 2020; Lazovic-Popovic *et al.*, 2016; Molgat-Seon *et al.,* 2018). There is a close relationship between lung function and anthropometric measurements, as both are indicators of the level of training and performance, but also, good measurements of anthropometrics are associated with better parameters in a pulmonary function test (Alonso-Calvete *et al.* 2020).

Pulmonary structures and morphological differences have been found between the genders. Sex differences in the morphometry of the respiratory system also exist. Females have proportionally smaller lungs and airways than males, and the shape of the rib cage and lungs differs between the sexes (Molgat-Seon *et al.,* 2018). Females have smaller vital capacity and maximal expiratory flow rates, reduced airway diameter, and a smaller diffusion surface than age- and height-matched males. These differences may affect the integrated ventilatory response, respiratory muscle work, and pulmonary gas exchange during exercise (Harms, 2006). Sex differences have been shown in resting pulmonary function, which may impact the respiratory response to exercise (Sheel, *et al.,* 2004). Furthermore, some studies have reported that difference results according to the structure of the sports (Johari *et al.,* 2017; Alonso-Calvete *et al.,* 2020). Gender differences are remarkable, as male and female athletes have unequal pulmonary function parameters and anthropometric characteristics in young in young competitive triathletes (Johari *et al.,* 2017). On contrary, Alonso-Calvete *et al.* (2020) found that there is difference in anthropometric characteristics for long-distance triathlon and duathlon athletes, but the gender differences do not play an important role in pulmonary function parameters. Therefore, the understanding of the differences and similarities in the structure and function of the respiratory systems of both genders remains incomplete, and more research is required (Molgat-Seon *et al.*, 2018).

The effect of dance activity on the respiratory capacity was elucidated by limited research. However, most research has focused on the impact on the pulmonary and biochemical characteristics of smoking and non-smoking in modern dancers (Agopyan *et al.,* 2016) and substance use and misuse in professional ballet dancers (Sekulic *et al.,* 2010), on the other hand, the relationship between anthropometric features and respiratory capacity in the field of dance, has not been clearly revealed.

In light of the available information, the inherent sex-differences in the structure of the respiratory system have important effects on resting pulmonary function and the integrative response to exercise (Molgat-Seon *et al.*, 2018). However, to the author knowledge, it is remarkable that there are no studies on the effect of anthropometric properties on lung respiratory capacity in modern dancers. On the other hand, most dancers perform individually and/or collectively and dance choreographies can be performed as a solo, duet or group. Therefore, male and female dancers train with a common working model in technical classes. Identifying resting pulmonary function profiles and understanding the influence of body size of male and female dancers can be provide dance educators, coaches, trainers, and exercise scientists with better working knowledge of this particular group of dancers, especially while planning training and stage performance for both genders. Therefore, the aim of this study was to compare the resting pulmonary function between male and female modern dancers based on the same levels of training. It is also hoped that the finding of this study will have to apply in further study by using basic data of respiratory function variables of male and female modern dancers.

Material & methods

This study has adopted a cross sectional observational comparative research design.

Participants

The participants were 38 trained female (n = 20) and male (n = 18) university-level modern dancers aged 20 to 33 years old (age: 23.65 ± 3.1 years). The participants' values were assessed using computer software (G*Power, Franz Faul, University of Kiel, Germany). The effect size, α error probability and β error probability were set as 0.25, 0.05, and 0.80, respectively (Cohen, 1992). The total sample size was calculated as at least 32, 16 for each gender.

All of the dancers in this study participated voluntarily and their exercise levels (minimum of 5 days/week, 3 hours/day) and training histories (at least 4 years) were similar. None of the subjects were diagnosed with acute or chronic diseases. All of the participants were non-smokers. An exclusion criterion was a history of cardiovascular or other diseases representing contraindications to exercise. Dancers with an FVC of less than 80% and a 1 s FEV1/FVC ratio of less than 75% of the predicted values were excluded from this study. All of the dancers were informed of the aims, protocol, and possible risks of participation, and all provided written informed consent. All of the procedures were approved by the Research Ethics Committee of the local university (SAG-D-040712-0272) and were conducted in accordance with the World Medical Association Declaration of Helsinki for medical research involving human subjects.

Testing procedures

The tests were completed in one day at the same time of day (9:00-12:00 am) under standard environmental conditions. The participants were familiarized with all of the experimental tests before baseline assessment. The dancers were asked not to perform strenuous exercises 24 hours before testing. The anthropometric and the pulmonary function measurements were obtained in the morning about 3 hours after breakfast.

Anthropometric measurements

All of the anthropometric measurements were obtained with the subjects in light clothing and barefoot, according to the described standardized procedures (Marfell-Jones *et al.,* 2012). Body mass was measured to the nearest 0.1 kg using a portable scale (SECA, Hamburg, Germany). Height was measured to the nearest 0.1 cm using a portable anthropometer (Holtain, Crymych, UK). BMI was calculated as body weight/height^2 (kg/m^2).

Pulmonary function measurements

The acceptability and reproducibility criteria for the pulmonary function tests were assessed by an expert physiotherapist using a computerized spirometer (MIR, Spirobank, Rome, Italy) according to the American Thoracic Society (ATS) guidelines (Culver *et al.,* 2017, Dempsey & Scanlon, 2018). The predicted (reference) values for gender, age, and height were in accordance with the ATS guidelines (Culver *et al.,* 2017). The participants were instructed not to smoke, consume alcohol, drink caffeinated beverages, exercise, take theophylline, or use β-agonist inhalers prior to the spirometry tests. All of the tests were conducted using the same instruments and techniques in a laboratory setting. The measurements were carried out under standard environmental conditions: at a comfortable temperature (18-22°C), at a relative humidity of 30-60%, and at an atmospheric pressure of 760 mmHg. The temperature, humidity, and atmospheric pressure in the laboratory were continuously monitored. The dancers' personal information (age, height, weight, sex, and race) were recorded by the spirometer and then they underwent the pulmonary function test in a sitting position. The nose was closed with a soft latch and a suitable disposable mouthpiece was placed between the lips and firmly fixed. The participants inhaled deeply and then sealed their lips around the mouthpiece and exhaled as hard and as fast as possible. Pulmonary function was assessed based on TV, MVV, VC, FVC-litres, FVC%, and FEV1-litres, FER = FEV1/FVC, 25% and 75% of vital capacity (FEF 25-75%), and ERV-litres. The forced expiratory ratio (FEV1/FVC × 100) was also calculated (%) (Miller *et al.,* 2005). The variables were obtained from the best of three reproducible forced expiratory manoeuvres. For all of the manoeuvres, the attempts were repeated, with a 30 s interval between each attempt to prevent the development of respiratory muscle fatigue, until a maximum value was reached. All of the variables were then converted into percentage predicted values and each spirometric value was calculated according to the dancer's age, sex, weight, and height.

Statistical Analyses

The descriptive data are presented as group mean values ± standard deviations (SD) and were tested for normal distribution using the Shapiro-Wilk test. If baseline differences between the groups were found, adjustments were made with the baseline measurements as covariate. The body height, body weight, and BMI were determined to be very strong components, respectively (0.850, 0.896, and 0.828), and a new variable called the body size factor was created.

ANCOVA was used to examine whether the variables of the males and females differed significantly could explain the observed sex differences in pulmonary function. The main effects of the independent variables were examined after the dependent variable scores were adjusted for differences associated with one or more covariates. The data met the assumptions for linearity using scatterplots (R-squared values). The interaction between the covariate and the factor was used to test the homogeneity of regression effect in covariate ($p \leq 0.05$). For a better interpretation of the results, the Cohen's d effect size (Cohen, 1992) defined as (difference between the means)/SD was calculated for all of the parameters between the genders. Effect sizes of < 0.1, 0.1-0.3, 0.5-0.8, and > 0.8 were considered trivial, small, moderate, and large, respectively (Batterham & Hopkins, 2005).

A significant level was accepted at the 95% confidence level for all of the statistical parameters. All of the statistical analyses except Cohen's effect size were assessed using the Statistical Package for the Social Sciences (SPSS) version 22.0 (SPSS Inc., Chicago, IL, USA), and p values < 0.05 were considered statistically significant.

Results

Participant characteristics

The test results were presented by the descriptive methods of statistics, as the measured values, and as the values calculated in relation to the predicted values. The descriptive statistics were expressed as mean ± SD, 95% confidence intervals, and effect size.

The descriptive data of the participants' characteristics are presented in Table I. A significant difference was found between the female and male dancers in terms of body height, weight, and BMI ($p < 0.001$), which were significantly higher in the males than in the females.

Table I. The descriptive data of the participants' characteristics

Variable	Female dancers (n = 20) (mean ± SD/*range*)	Male dancers (n = 18) (mean ± SD/*range*)	*p* value
Age (years)	23.3 ± 3.6 *(20-33)*	24.5 ± 2.4 *(22-30)*	0.196
Height (cm)	162.1 ± 6.2 *(152-177)*	176.4± 4.6 *(172-185)*	0.001*
Weight (kg)	52.0 ± 5.4 *(46-66)*	69.8 ± 5.9 *(57-75)*	0.001*
Body mass index (kg/cm^2)	19.8 ± 1.8 *(17-23)*	22.4 ± 1.4 *(19-23)*	0.001*
Experience (years)	9.5 ± 4.4 *(4-17)*	9.4 ± 4.9 *(4-15)*	0.343
Total dance training hours per week (h/w)	17.9 ± 3.8 *(6-28)*	18.3 ± 3.6 *(6-26)*	0.126
Total dance training day per week (d/w)	5.2 ± 0.8 *(4-7)*	5.1 ± 1.1 *(4-7)*	0.828

The level of significance was set to p < 0.05, and differences that reached the level of significance are denoted by*.

Pulmonary function profile

The results of ANCOVA are shown in Table II, including the effect sizes calculated (Batterham & Hopkins, 2005). The results of the analyses indicated that there was a significant difference (p < 0.05) between the genders in terms of VC-best (Fig.1) and MVV-best values and body size (Fig. 2) had a significant effect on the VC-best ($F_{(1,25)} = 4.902$, p = 0.036) and MVV-best values ($F_{(1,25)} = 7.864$, p = 0.010). These relationships had a small effect size ($d_{VC\text{-best}} = 0.16$; $d_{MVV\text{-best}} = 0.125$). The male participants had higher levels of VC-best and MVV-best than the females. In addition, although the FCV-best, FEV1-best, PEF-best, FEF-25-75%best, and TV-best values were significantly higher in the males than the females, and body size did not have a significant effect on the respiratory values (p > 0.05). The differences between the genders in relation to the measured values were not significant for any of the other spirometric parameters evaluated (p > 0.05), and body size had no significant effect on the respiratory values. The size of these non-significant relationships was small (η ≤ 0.05 for all).

Table II. Summary of ANCOVA for the effects of gender on pulmonary function tests and body size variables as covariates[a].

Variable	Female dancers (n = 20) Predicted	Female dancers (n = 20) Measured *(best)*	Male dancers (n = 18) Predicted	Male dancers (n = 18) Measured *(best)*	*p* value[ⱡ]	Body size (covariate) *F* value	Body size (covariate) *p* value[ⱡⱡ]	Body size (covariate) Effect size
VC (L)	3.59 ± 0.3	3.61 ± 0.4	5.13 ± 0.6	5.16 ± 0.5	0.025*	4.902	0.036*	0.160
FVC (L)	3.59 ± 0.3	3.69 ± 0.4	5.13 ± 0.6	5.21 ± 0.6	0.030*	3.694	0.666	0.129
FEV_1 (L)	3.10 ± 0.2	3.25 ± 0.4	4.32 ± 0.5	4.40 ± 0.3	0.033*	3.812	0.062	0.132
FEV_1%	86.93 ± 1.6	88.35 ± 2.8	84.46 ± 1.1	89.33 ± 4.8	0.714	2.605	0.119	0.001
PEF (L)	6.58 ± 0.3	6.63 ± 0.7	9.23 ± 1.1	9.73 ± 0.6	0.001**	0.925	0.345	0.036
FEF (25-75)	3.66 ± 0.2	3.67 ± 0.4	4.68 ± 0.4	5.32 ± 0.8	0.010**	0.725	0.402	0.028
FEV_1/FVC (%)	86.93 ± 1.6	90.27 ± 4.8	84.46 ± 1.0	87.96 ± 3.9	0.722	1.540	0.226	0.056
TV (l)	0.60 ± 0.2	0.60 ± 0.2	0.77 ± 0.2	0.77 ± 0.2	0.027*	1.910	0.179	0.071
MVV (L)	114.48 ± 6.1	122.56 ± 17.5	141.8 ± 12.82	183.78 ± 20.6	0.038*	*3.556*	0.01**	0.125

VC: vital capacity; FVC: forced vital capacity; FEV1: forced expiratory volume in one second; FEV1%: percent of FEV1; FER = FEV1/FVC: forced expiratory ratio; PEF: peak expiratory flow; FEF 25-75%: forced expiratory flow of mean forced expiratory flow between 25% and 75% of FVC; ERV: expiratory reserve volume; TV: tidal volume; MVV: maximum voluntary ventilation.[a]Data are expressed as mean ± SD. [ⱡ]The results of ANCOVA for the differences of gender on pulmonary function tests. [ⱡⱡ]The results of ANCOVA for the effects of gender on pulmonary function tests and body size variables as covariates *Significant at the p < 0.05 level. **Significant at the p < 0.01 level, and differences that reached the level of significance are denoted by *.

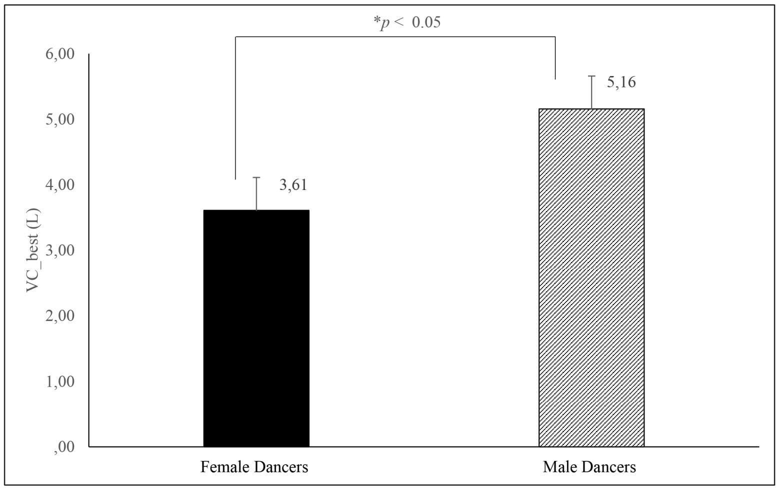

Fig. 1. VC- best (L): Vital capacity-best. Significantly different from female and male dancers with $p < 0.05$. Results are presented as mean ± SD.

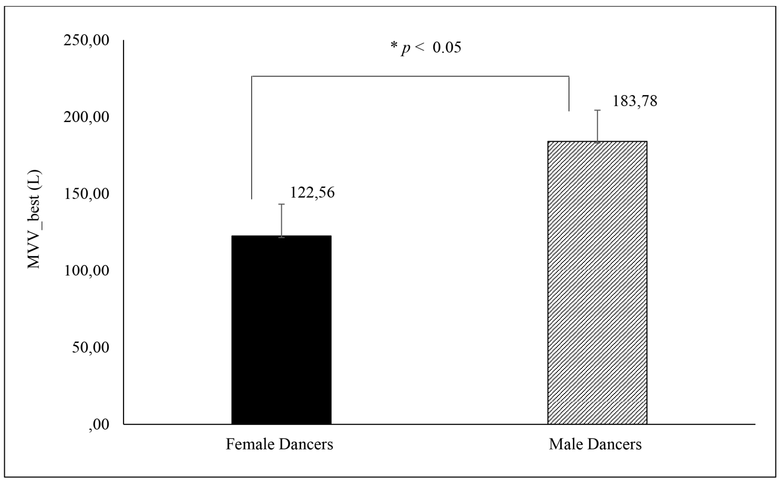

Fig. 2. MVV- best (L): Maximum voluntary ventilation-best. Significantly different from female and male dancers with $p < 0.05$. Results are presented as mean ± SD.

The resting pulmonary function in the males was higher than in the females and the effect of body structure was low. Although the effect size was small, body size had an effect on the dancers' respiratory function.

Discussion

This study aimed to compare the values of the resting respiratory function of male and female modern dancers with the same training levels (5 days/week, 3 hours/day for at least 4 years) and show the effects of body measurements on these values. The most fundamental result of this research is that the performance of the resting pulmonary function of the males was significantly higher than the females. Although the effect size was small, the subjects' body sizes had some effect on their respiratory function components. The significant difference between the male and female dancers in terms of the VC-best and MVV-best values was due to the higher body weights and body heights of the male dancers compared to the females. This result in particular emphasizes the importance of planning dance exercises and performances considering the gender factors.

To the best of our knowledge, the present research is the first study to compare the gender differences in resting respiratory function values in modern dancers and reveal the effects of body size. Thus, these results can be compared with other studies in the literature at a certain scale.

According to the literature, most studies on respiratory function values concentrate on males (Mazic *et al.,* 2015; Durmic *et al.,* 2017). Few studies have found differences between females or genders in the general or athletic populations (Sheel *et al.,* 2004; Molgat-Seon *et al.,* 2018). It was reported that gender influenced the structure and function of the respiratory system and that gender differences exist (Molgat-Seon *et al.,* 2018; Sheel *et al.,* 2004). In addition, significant differences persist between males and females in short and long exercises, but the causes are questionable (Sheel *et al.,* 2004). Differences in the structural characteristics of male and female individuals are attributed to the lower diffusion capacity of carbon monoxide compared to males, lower airway diameters, and lower lung volumes than males (Hopkins & Harms, 2004). Even when the lengths are similar, it is reported that females have smaller lung dimensions than males. Structural differences in the respiratory system between the sexes also affect the resting respiratory functions and exercise responses (Molgat-Seon *et al.,* 2018). The present study determined that the values of MVV, VC, FVC, FEV1, PEF, and FEF 25-75% of respiratory function components were significantly higher in the male dancers than in the females. These results are consistent with studies that reported differences between the genders in general (CHMS, 2011) and athletic (Sheel *et al.,* 2004) populations and found that respiratory function values were higher in males than in females (Sheel *et al.,* 2004; CHMS, 2011).

The primary difference between the genders in the human respiratory system is related to morphometry (Molgat-Seon *et al.,* 2018). Various studies found that the height and the age of the lung volume were the most important determinants (Cotes *et al.,* 2001), and that race, weight, and gender, structure and morphological characteristics (Harms, 2006), progesterone and oestrogen hormones (Harms, 2006), geometry of the thorax (Molgat-Seon *et al.,* 2018), fat-free body weight, thoracic diameter and trunk length, and anatomical and mechanical factors (Mazic *et al.,* 2015) were revealed. In the present study, the body length, body weight, and BMI values were examined from structural factors; VC-best and MVV-best were the effects of body measurements in the occurrence of differences between genders. This result is consistent with other studies (Cotes *et al.,* 2001; Harms, 2006) reporting that the differences between the genders in respiratory function values may be due to various causes, mainly body measurements and shape. In the present study, the male dancers had longer, heavier, and larger muscle masses than the females, indicating that respiratory function values were higher (Cotes *et al.,* 2001). These differences can also be attributed to the fact that females have relatively smaller lungs and airways than males (Molgat-Seon *et al.*, 2018). However, these structural features were not examined in more detail in our study; these can be examined in future research.

Another important result of this study is that the FEV1/FVC ratios of the females were higher than that of the males and were similar to the literature (CHMS, 2011). Our results are consistent with the finding that women in all age groups, except those aged 40-59 years, in the general population had a higher FEV1/FVC ratio than males (CHMS, 2011). The mechanical properties of the lungs are thought to vary according to gender and that female lungs have more ventilation perfusion homogeneity than males, which may be the cause of this difference.

Increased oxygen requirements of skeletal muscles during dance training leads to changes in metabolic, cardiovascular, and respiratory function and increases these demands (Sabaananth *et al.,* 2014). With this approach, when dance training is carried out within the same loading guidelines for both genders, the body will have different responses according to gender. Therefore, our research results show that modern dance training planning should be adjusted with more consideration of gender factors, and a detailed examination of the mechanical properties of the respiratory system is also important. It is estimated that under similar demands, females are more susceptible to pulmonary limitations during exercise compared to males (Harms, 2006). In contrast, it has been shown that the female diaphragm, as in other skeletal muscles, may be more resistant to fatigue during constant load exercises, at least at the same relative density as the male diaphragm (Guenette *et al.,* 2013). It is also noteworthy that pulmonary limitations were observed during exercise in both genders in individuals with different fitness levels (Hopkins & Harms, 2004). It is important that the differences between the genders in respiratory function values can affect the respiratory response during exercise (Sheel *et al.,* 2004). Therefore, it is advisable to investigate the differences in respiratory function during dance training in future studies.

Although the male and female participants with the same training levels had significantly different resting respiratory function values, the current study has some limitations. The number of participants was small, and the physical characteristics were limited only by height, body weight, and BMI. Our findings reflect only the respiratory function profiles of young female and male modern dancers. Our results should be accepted as a pilot study and respiratory functions should be assessed with a larger sample size in future studies. Since the current research subjects consisted only of modern dancers 20-33 years old, the generalization of these results to other age groups is limited.

Conclusions

To the best of our knowledge, this is the first study to show that the performance of resting respiratory functions significantly differs in male and female modern dancers with the same training levels. The theoretical contribution of this study is to demonstrate that 25-75% of the pulmonary function components of MVV, VC, FVC, FEV1, PEF and FEF are significantly higher in male dancers than in females. Although the effect size was small, the effects of body weight, height, and BMI on the VC-best and MVV-best values were influenced by the fact that male dancers have higher resting respiratory function performance.

In a practical contribution, the current results suggest that it is necessary to consider the gender factors when planning and organizing dance training with different models. Physiotherapists, dance instructors, choreographers, and dancers can use this information as a strategy in the exercise models to develop dance techniques because body structure is a factor in some parameters of respiratory function capacity. It is suggested that while the training programs are been planning, especially for the activate respiratory function, the intensity of exercises should be prepared according to the gender in modern dance. It may be appropriate for dance instructors and health professionals to analysis respiratory function tests of dancers before the season.

Furthermore, it may be suitable to plan all trainings taking into account the gender differences in physical fitness parameters and to follow the developments at regular intervals. The present study is intended to help generate guidance in further study by using apply basic data in order to respiratory function variables of modern dancers.

The application of pulmonary function tests to different dance techniques such as classical ballet, flamenco, breakdancing, and Latin dance should be the subject of future research. Further investigations using a larger and randomly selected sample of dancers are recommended to confirm our results. It is also important to investigate the functions of the respiratory muscles during exercise according to time and training components (the duration of training and density) and reveal the contributions of genetic factors through longitudinal studies.

Conflicts of interest - There is no conflict of interest regarding the publication of this article.

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