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Respiratory muscle strengths and its association with body composition and functional exercise capacity in non-obese young adults

GIZEM ERGEZEN[1, B, C, D, E], MERVE YILMAZ MENEK[1, B, C, D, E], RENGIN DEMIR[2, A, B, E, F]
ORCID ID: 0000-0002-2851-9774

[1] Istanbul Medipol University, Faculty of Health Science, Department of Physiotherapy and Rehabilitation, Istanbul, Turkey
[2] Istanbul University-Cerrahpasa, Cardiology Institute, Department of Cardiology, Istanbul, Turkey

A – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Summary **Background.** The assessment of cardiopulmonary problems, exercise capacity, and inspiratory and expiratory muscle strength all depend on body composition, which is a crucial factor in determining human health.
Objectives. The present study aimed to examine the effect of body composition and functional exercise capacity on respiratory muscle strength in young healthy adults.
Material and methods. In the prospective study, sixty individuals aged between 18–25 years of age who were non-obese were evaluated in terms of body composition by body mass index, respiratory muscle strength by mouth pressure threshold and functional exercise capacities by six minute walking test and sit to stand test. Also, sociodemographic characteristics such as age, gender, education level, height and weight of the participants were recorded.
Results. The relationship between body density (BD) parameters and inspiratory muscle strength was found to be moderate ($r = 0.394$, $p < 0.05$), while the relationship between expiratory muscle strength was found to be minimal ($r = 0.282$, $p < 0.05$). When other measurements and respiratory muscle strength were compared, it was found that the parameters are unrelated to one another ($p > 0.05$).
Conclusions. Present study showed a significant correlation between body density and inspiratory and expiratory respiratory muscle strength. However, no correlation was found between body composition and functional exercise capacity and respiratory muscle strength. Body density increment will affect respiratory muscle strength negatively.
Key words: body composition, maximal respiratory pressures, functional capacity.

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Background

Body composition is an important determinant of health and is important in assessment of cardiopulmonary problems', as well as exercise capacity, inspiratory and expiratory muscular strength [1, 2]. Body mass index (BMI) is an independent prognostic factor in cardiopulmonary function. Fat and lean mass have been identified as strong predictors of muscle weakness, level of physical fitness, and mortality [1, 3]. As well as the calculation of BMI and waist-to-hip ratio (WHR), the distribution of central and peripheral fat mass throughout the body can be determined [4].

Pulmonary dysfunctions or peripheral muscle weakness can lead to a sedentary life by reducing the level of functional exercise. Furthermore, rotundity is an important factor that can potentially affect the aerobic capacity and exercise tolerance through distinct mechanisms. The original deterioration in respiratory muscle function seen in individuals with obesity is associated with a decrement in functional exercise capacity and quality of life [5].

Respiratory muscle strength is found to be associated with age, gender, weight, height and body surface area [6]. Due to the effect of anthropometric factors on respiratory muscle strength and body, some studies argue that composition measurements in morbidly obese women can be considered predictive equations for respiratory muscle strength [7, 8]. It is also known that age and BMI negatively affect maximum respiratory pressure measurements in non-obese women [9].

Studies investigating the effect of respiratory force based on body composition are contradictory. Some indicate inefficiency and low endurance, while others indicate that impaired body composition does not affect these muscles [10]. The view that breathing against fat resistance in the neck, abdomen and chest area is a “training effect” that increases the strength of these muscles also leads to conflicting results [11].

Objectives

Based on literature, the present study was aimed to examine the effect of body composition and functional exercise capacity on respiratory muscle strength in young healthy adults.

Material and methods

Study design

This was a prospective study conducted in university settings. The institutional review board at Istanbul Medipol University approved all recruitment and testing procedures (Approval no. E-10840098-772.02-829, Date. 08/02/2022), and participants provided written, informed consent upon enrollment. The data collection and analysis process of our study has been taken 8 months.

Participants

Inclusion criteria for the study was no history of cardiopulmonary, orthopedic, rheumatic or metabolic disease in the last 6 months; people with similar physical activity levels; between 18–25 years of age; volunteers who are not classified as obese. Those diagnosed with uncontrolled lung or heart disease, with psychological disorders, smokers/recent quitters, and professional athletes were excluded. The study was conducted in accordance with the principles of the Declaration of Helsinki.

At the end of the study, 60 people who met the criteria were included and the evaluation results were analyzed.

Data measurement

Sociodemographic characteristics such as age, gender, education level, height and weight of the participants were recorded in the 'Evaluation Form', and the participants were questioned about their exercise habits to determine their physical activity levels. Body composition, respiratory muscle strength and functional exercise capacities of the participants were evaluated.

Participants' physical activity levels were determined by using the International Physical Activity Questionnaire (IPAQ) short form. The participants were classed as physically inactive, minimally active, and sufficiently active based on their MET min/week values [12]. Fat ratios of the triceps, suprailiac and thigh areas in women and the chest, abdomen and thigh regions in men were determined by measuring with a skinfold caliper [13]. Measurements were inserted into formulas to calculate body density (BD) and body fat percentage (BF%). BD was obtained using the Jackson Pollock formula and BF% using the Siri equation [14].

Respiratory muscle strength was measured using a portable electronic mouth pressure monitor (Micro RPM, Micro Medical Ltd, Kent, UK). MIP and MEP tests were performed to evaluate the strength of the respiratory muscles. Measurements were performed in a sitting position with the nose clip attached. Average values were obtained as a result of 3 technically acceptable measurements [15].

Functional capacity was evaluated with the 6-MWT and 30-second SST [15]. Pre-assessment and post-assessment heart rate (HR) and oxygen saturation (SpO_2) were recorded. SpO_2 was analyzed with a pulse oximeter (KPTS, Seoul, Korea). The SST was performed with a standard-height chair without armrests. Participants held their arms steady by placing their hands on their hips. Subjects were asked to complete sitting and standing positions correctly and completely by 30 seconds. How many times the person sat and stood for thirty seconds was recorded [16].

Statistical analyses

Statistical analyses was performed by using SPSS 23.0 (Statistical Package for the Social Sciences, Chicago, Illinois). Descriptive statistics were determined for all variables, and the data were expressed as mean (M) ± standard deviation (SD) and percentage (%). Data normality was tested using the Shapiro-Wilk test. Given the inconsistent data, normality relationships were assessed using the Pearson correlation coefficient, which is a parametric test. The alpha level for significance was set at $p = 0.05$.

Results

Anthropometric, demographic, inspiratory muscle strength and physical function variables are given in Table 1 ($n = 60$).

Table 1. The characteristics of the participants

Anthropometric and physiological variables	Total ($n = 60$) Mean (SD)
Age (years)	21.60 (1.5)
Weight (kg)	62.83 (11.36)
Height (cm)	168.97 (7.59)
Fat mass (%)	21.93 (3.20)
Body density	1.05 (0.01)
BMI (kg/m^2)	21.93 (3.21)
Waist/Hip	0.89 (0.16)
SBP (mm Hg)	73.33 (10.90)
Delta SBP (mm Hg)	4.70 (14.86)
DBP (mm Hg)	110.75 (13)
Delta DBP (mm Hg)	6.88 (19.18)
SaO_2 (%)	96.07 (3.12)
Delta SaO_2 (%)	1.13 (2.64)
Inspiratory and expiratory muscle strength	
MEP (cm H_20)	82.03 (22.54)
MIP (cm H_20)	91.33 (26.11)
Physical function variables	
6 MWT (m)	607.89 (151.29)
30-s STS (rep)	20.28 (3.16)

SD – standard deviation; SBP – systolic blood pressure; DBP – diastolic blood pressure; SaO_2 – oxygen saturation; 6MWT – 6-minutes walking test; STS – sit to stand test.

BD and inspiratory muscle strength were found to be moderately related ($r = 0.394$, $p < 0.05$) and expiratory muscle strength was found small related ($r = 0.282$, $p < 0.05$) (Table 2). When the relationship between other parameters and respiratory muscle strength was examined, there was no statistically significant relationship with each other ($p > 0.05$) (Table 2).

Table 2. Relationship between respiratory muscle strength, body composition and functional exercise capacity ($n = 60$)

Parameters	MEP		MIP	
	r	*p*	*r*	*p*
Fat mass	-0.059	0.657	-0.052	0.695
Body density	0.282	**0.029**	0.394	**0.002**
BMI	-0.059	0.657	-0.052	0.659
Waist/Hip	-0.05	0.682	-0.028	0.833
6 MWT	0.216	0.097	0.205	0.115
30-s STS	0.216	0.097	0.205	0.115

MEP – maximum expiratory pressure; MIP – maximum inspiratory pressure; 6MWT – 6-minutes walking test; STS – sit to stand test.

Discussion

In our study which is investigating the relationship between respiratory muscle strength with body composition and functional exercise capacity in non-obese young adults, we found that body composition and functionality were not associated with respiratory muscle strength, but body density had a moderate relationship. To the best of our knowledge, this is the first study to question the relationship between respiratory muscle strength and body composition in non-obese young healthy individuals.

Literature clearly shows that body composition correlates with respiratory muscle strength. Studies involving individuals with chronic obstructive pulmonary disease (COPD) provide evidence of the influence of body composition with changes in lean mass index (FFMI) and fat percentage, even when BMI is within the normal range [17]. It has also been shown that FFMI values are decreased in those with inspiratory muscle weakness compared to those without [18]. Studies have proven an association between inspiratory muscle weakness and FFMI in individuals with COPD with a normal body mass [19]. In our study, we investigated whether there was a relationship between fat ratio and respiratory muscle strength in young adults with normal BMI, and we found that there was no correlation.

It seems possible that lung function may deteriorate over a large age range or over many years and disease states due to decreased body composition, skeletal muscle mass, increase in inflammatory mediators that cause deterioration of lung elasticity and expansion [20]. It might be possible that the population in our study did not show a significant relationship because it consisted of healthy and young individuals. In healthy young adults, skeletal muscle index has been shown to correlate with MIP relative to body mass [21, 22]. To date, no study has been found that investigated the relationship between body fat percentages, body density and respiratory power in healthy individuals with no known functional loss and within normal BMI. Although there was no significant relationship between BMI and respiratory muscle strength in our study, a positive correlation was found with body density. When compared with the literature presented, it can be thought that body density was affected due to the different muscle mass of the participants in our study.

In young male athletes, respiratory muscle strength was positively correlated with FFMI, but fat mass and BF% did not affect lung function or respiratory muscle strength, possibly due to the relative thinness of the participants [6, 23]. To date, no study has been found that investigated the relationship between BF%, BD and respiratory power in healthy individuals with no known functional loss and within normal BMI. Although there was no significant relationship between BMI and respiratory muscle strength in our study, a positive correlation was found with body density. It is thought that due to the different muscle mass in the literature than our study, it affects the density and creates a different result.

It is known that inspiratory and expiratory muscle strengths have a significant positive correlation with peripheral muscle strength. However, body composition also appears to affect both respiratory muscle strength and lung function. By looking at these relationships, it is expected that respiratory functions is weakened in individuals with weak peripheral muscle mass. A study conducted in this context by Ro et al. showed that skeletal muscle index relative to body mass was associated with MIP in healthy young adults. Decreased skeletal muscle mass and increased fat mass may indirectly affect lung function by increasing inflammatory responses [8, 24]. In contrast, waist circumference and WHR does not influence the respiratory muscle strength of obese women [25, 26]. With pathophysiological factors related to excessive fat accumulation in the thoracic-abdominal region, decreased muscle function in obese individuals may also be associated with chronic low-grade inflammation [27, 28]. In our study, there was a significant correlation between respiratory muscle strength and body density, but no significant correlation was found between fat mass, BMI and WHR. This may be because the individuals included in the study were not obese.

In fact, decreases in peripheral muscle strength directly affect functional exercise capacity [21, 29]. This effect can be examined as follows: Since the respiratory muscles are structurally striated muscles, they get tired after overwork. Ongoing fatigue creates auto-inhibition signals, resulting in decreased motor signals, resulting in respiratory failure [30]. Simões et al. reported a correlation between respiratory and lower extremity muscle strength and walking distance in elderly participants. As a result, they suggest that increasing respiratory muscle strength may make a significant contribution to preserving functional capacity in the elderly [9]. In addition, another study found a strong correlation between 6-minute walking test distance and MIP [31]. In our study, no significant correlation was found between respiratory muscle strength and the 6-MWT test and 30-s SST. We consider that the low average age of the participants and their good physical activity levels may cause this.

Conclusions

Present study showed a significant correlation between body density and inspiratory and expiratory respiratory muscle strength. However, no correlation was found between body composition and functional exercise capacity and respiratory muscle strength. Body density increment affect respiratory muscle strength negatively.

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References

1. Schols AM, Slangen J, Volovics L, et al. Weight loss is a reversible factor in the prognosis of chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 1998; 157(6): 1791–1797.
2. Celli BR, Cote CG, Marin JM, et al. The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. *N Engl J Med* 2004; 350(10): 1005–1012.
3. Engelen MP, Schols AM, Does JD, et al. Skeletal muscle weakness is associated with wasting of extremity fat-free mass but not with airflow obstruction in patients with chronic obstructive pulmonary disease. *Am J Clin Nutr* 2000; 71(3): 733–738.
4. Crummy F, Piper AJ, Naughton MT. Obesity and the lung: 2. Obesity and sleep-disordered breathing. *Thorax* 2008; 63(8): 738–746.
5. Ozalevli S, Ozden A, Itil O, et al. Comparison of the Sit-to-Stand Test with 6 min walk test in patients with chronic obstructive pulmonary disease. *Respir Med* 2007; 101(2): 286–293.
6. Harik-Khan RI, Wise RA, Fozard JL. Determinants of maximal inspiratory pressure. The Baltimore Longitudinal Study of Aging. *Am J Respir Crit Care Med* 1998; 158(5 Pt. 1): 1459–1464.
7. Black LF, Hyatt RE. Maximal respiratory pressures: normal values and relationship to age and sex. *Am Rev Respir Dis* 1969; 99(5): 696–702.
8. Neder JA, Andreoni S, Lerario MC, et al. Reference values for lung function tests. II. Maximal respiratory pressures and voluntary ventilation. *Braz J Med Biol Res* 1999; 32(6): 719–727.
9. Simões RP, Deus AP, Auad MA, et al. Maximal respiratory pressure in healthy 20 to 89 year-old sedentary individuals of central São Paulo State. *Rev Bras Fisioter* 2010; 14(1): 60–67.
10. Magnani KL, Cataneo AJ. Respiratory muscle strength in obese individuals and influence of upper-body fat distribution. *Sao Paulo Med J* 2007; 125(4): 215–219.

11. Shepherd KL, Jensen CM, Maddison KJ, et al. Relationship between upper airway and inspiratory pump muscle force in obstructive sleep apnea. *Chest* 2006; 130(6): 1757–1764.
12. Saglam M, Arikan H, Savci S, et al. International physical activity questionnaire: reliability and validity of the Turkish version. *Percept Mot Skills* 2010; 111(1): 278–284.
13. Harrison GG, Buskirk ER, Carter JEL, et al. *Skinfold thicknesses and measurement technique*. In: Lohman TG, Roche AF, Martorell R, eds. *Anthropometric standardization reference manual.* Champaign (IL): Human Kinetics Books; 1988: 55–70.
14. Jackson AS, Pollock ML, Ward A. Generalized equations for predicting body density of women. *Med Sci Sports Exerc* 1980; 12(3): 175–181.
15. American Thoracic Society/European Respiratory Society. ATS/ERS Statement on respiratory muscle testing. *Am J Respir Crit Care Med* 2002; 166(4): 518–624.
16. Barrios-Fernández S, Pérez-Gómez J, Galán-Arroyo MDC, et al. Reliability of 30-s Chair Stand Test with and without Cognitive Task in People with Type-2 Diabetes Mellitus. *Int J Environ Res Public Health* 2020; 17(4): 1450.
17. Cesari M, Pedone C, Chiurco D, et al. Physical performance, sarcopenia and respiratory function in older patients with chronic obstructive pulmonary disease. *Age Ageing* 2012; 41(2): 237–241.
18. Marinho PE, Castro CM, Raposo MC, et al. Depressive symptoms, inflammatory markers and body composition in elderly with and without chronic obstructive pulmonary disease (COPD). *Arch Gerontol Geriatr* 2012; 54(3): 453–458.
19. Lee LW, Lin CM, Li HC, et al. Body composition changes in male patients with chronic obstructive pulmonary disease: Aging or disease process? *PLoS ONE* 2017; 12(7): e0180928.
20. Martínez-Luna N, Orea-Tejeda A, González-Islas D, et al. Association between body composition, sarcopenia and pulmonary function in chronic obstructive pulmonary disease. *BMC Pulm Med* 2022; 22(1): 106.
21. Shin HI, Kim DK, Seo KM, et al. Relation Between Respiratory Muscle Strength and Skeletal Muscle Mass and Hand Grip Strength in the Healthy Elderly. *Ann Rehabil Med* 2017; 41(4): 686–692.
22. Park JE, Chung JH, Lee KH, et al. The effect of body composition on pulmonary function. *Tuberc Respir Dis* (Seoul) 2012; 72(5): 433–440.
23. Talaminos Barroso A, Márquez Martín E, Roa Romero LM, et al. Factors Affecting Lung Function: A Review of the Literature. Factores que afectan a la función pulmonar: una revisión bibliográfica. *Arch Bronconeumol* (Engl Ed) 2018; 54(6): 327–332.
24. Ro HJ, Kim DK, Lee SY, et al. Relationship Between Respiratory Muscle Strength and Conventional Sarcopenic Indices in Young Adults: A Preliminary Study. *Ann Rehabil Med* 2015; 39(6): 880–887.
25. Jandt SR, Caballero RM, Junior LA, et al. Correlation between trunk control, respiratory muscle strength and spirometry in patients with stroke: an observational study. *Physiother Res Int* 2011; 16(4): 218–224.
26. Carbone S, Billingsley HE, Rodriguez-Miguelez P, et al. Lean Mass Abnormalities in Heart Failure: The Role of Sarcopenia, Sarcopenic Obesity, and Cachexia. *Curr Probl Cardiol* 2020; 45(11): 100417.
27. Lin CK, Lin CC. Work of breathing and respiratory drive in obesity. *Respirology* 2012; 17(3): 402–411.
28. Lima TRL, Almeida VP, Ferreira AS, et al. Handgrip Strength and Pulmonary Disease in the Elderly: What is the Link? *Aging Dis* 2019; 10(5): 1109–1129
29. Izawa KP, Watanabe S, Oka K, et al. Respiratory muscle strength in relation to sarcopenia in elderly cardiac patients. *Aging Clin Exp Res* 2016; 28(6): 1143–1148.
30. Donaldson AV, Maddocks M, Martolini D, et al. Muscle function in COPD: a complex interplay. *Int J Chron Obstruct Pulmon Dis* 2012; 7: 523–535.
31. Souza Y de, Suzana ME, Medeiros S, et al. Respiratory muscle weakness and its association with exercise capacity in patients with chronic obstructive pulmonary disease. *Clin Respir J* 2022; 16(2): 162–166.

Tables: 2
Figures: 0
References: 31

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Address for correspondence:
Gizem Ergezen, PhD
Faculty of Health Science
Department of Physiotherapy and Rehabilitation
Ataturk St.
Istanbul
Turkey
Tel.: +90 5347098414
E-mail: gergezen@medipol.edu.tr