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Association of Skeletal Muscle Strength and Body Fat Distribution on Pulmonary Functions

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Author`s Contribution

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ABSTRACT

Objectives: The body's muscle strength and fat distribution are essential for a normal, healthy life. This study aimed to assess a link between pulmonary function tests, upper and lower extremity muscular strength, and body fat distribution in Saudi males.

Methodology: This cross-sectional study was conducted in the department of physiology at the College of Medicine, King Saud University, Riyadh, Saudi Arabia. A total of 106 participants were invited, ranging from 20-47 years old. The participants were divided into three groups, with ages ranging from 20-29 years old, 30-39 years old, and 40–47 years old. The handgrip and thigh muscle strength was assessed using isometric dynamometry. Pulmonary function tests were performed according to the American Thoracic Society's guidelines and recommendations.

Results: There was no significant difference between the three age groups in upper and lower limb muscle strength. The handgrip strength was stable from 20 to 47 years, ranging from 37 to 39. The thigh muscle strength was not affected by age among the three age groups. Skinfold measurement of the upper body showed no significant differences in biceps and triceps. However, skinfold measurements of subscapular and supra iliac were different significantly.

Conclusion: There was no association between the age groups in upper and lower limbs muscle strength. It's suggested that further large studies will be conducted to explore the findings and reach better conclusions.

Keywords: Skeletal Muscle, Body Fat, Pulmonary Functions.

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Introduction

Reduced skeletal muscle mass has been linked to impaired lung function in patients with chronic obstructive pulmonary disease (COPD).[1, 2] The easy way to estimate skeletal muscle strength is hand grip strength testing[3] Bahat et al[4] reported that peripheral muscle strength, particularly handgrip strength, was positively associated with maximal inspiratory and expiratory muscle strength in a study of male nursing home residents.

Grip strength testing is also widely recognized as a reliable objective indication of the body's muscular strength as a whole.[5] The dominant handgrip strength has also been used to predict skeletal muscle strength.[6] Likewise, Pulmonary functions are known to be influenced by respiratory muscle strength. As a result, it's possible that older people with low periphery muscular strength also have low respiratory muscle strength, resulting in poor pulmonary function. As a result, they used peak expiratory flow rate (PEFR) as an alternate measure of muscle strength in their report.[7, 8]

The distribution of body fat is a factor that influences respiratory muscle strength; even though the impact of obesity on pulmonary function tests has been studied.[9, 10] the importance of body fat distribution (REFF 2021) has gotten less attention. Therefore, in obese people, a decrease in lung volume appears to increase respiratory resistance, and body fat distribution.[11]

Accordingly, there is no study concerned with the effect of both musculoskeletal strength and fat percentage on respiratory muscle strength.

This study aimed to look at healthy Saudi adult men in different age groups to see if there was a link between pulmonary function tests, upper and lower extremity muscular strength, and body fat distribution in Saudi male amateurs.

Methodology

This cross-sectional study was conducted on normal subjects without clinically apparent lung disease. The study was carried out at the Physiology Department, College of Medicine, King Saud University. There were 106 participants, ranging in age from 20 to 47years old. The participants were placed into three groups based on their age. (1) 20-29 years old (2) 30-39 years old (3) 40-47 years old. Our study excluded participants who had a history of smoking, or respiratory or cardiovascular disease symptoms, or thoracic, spinal, or muscle malformation. And to ensure that the participants were free of blood pressure after 5 minutes of rest, blood pressure was taken from the right brachial artery with a normal mercury sphygmomanometer in the sitting posture. The blood pressure readings were taken to the nearest 2 mmHg. The research was conducted in conformity with the Declaration of Helsinki, with all participants giving their written informed consent. Each participant got a thorough physical examination before the test procedure. The anthropometric parameter of body weight was assessed using a digital weighing scale on a barefoot participant wearing light clothes (Seca, England). It was rounded to the nearest whole number in kilos. A stadiometer was used to measure the standing barefoot height to the closest 0.01 meter.

The handgrip and thigh muscle strength was assessed using isometric dynamometry. Each participant had to squeeze the dynamometer handle as hard as they could for roughly 3-5 seconds (Takei Hand Grip Strength Digital Dynamometer). For each upper limb, a mean of three maximal squeezes was collected and recorded in kilos (kg). Hand Grip strength of the hands was measured while standing erect, with the shoulder adducted and neutrally rotated and the elbow in full extension with no radioulnar deviation.

Leg strength was tested by using a constant muscle contraction dynamometer. from a standing position with knees bent at an angle of 90 degrees. The participants pull the bar up as hard as possible while trying to extend their legs. Each subject was given 3 attempts, and the best try was recorded. The subject was required to maintain a 5-second leg stretch.

Pulmonary function tests were performed according to the American Thoracic Society guidelines.[12] The results of the tests were obtained using a computerized spirometer, which provided highly reliable results. The test was performed three times, with the highest results recorded. It takes 4 to 5 minutes to complete the entire series of exams. FVC (forced vital capacity), FEV_1 (forced expiratory volume at 1 second), FEV1 /FVC percent, and PEFR (peak expiratory flow rate) were the pulmonary function measures measured while the testing was carried out in a seated position. The best FVC and FEV1 data were selected, and percentage anticipated values were determined. Only the FVC (forced vital capacity) manoeuvre required the subject to take a maximally forceful inspiration, close his nose, and then forcefully expire into the mouthpiece as quickly as possible with maximum effort, and then inspire forcefully as quickly as possible with maximum effort through the mouthpiece. After that, the value of FVC and its components were calculated and we got all of the actual and anticipated values.

The skinfold thicknesses were measured at the following sites: (1) triceps, halfway between the acromion process and the olecranon process; (2) biceps, at the same level as the triceps skinfold, directly above the centre of the cubital fossa; (3) subscapular, about 20 mm below the tip of the scapula, at an angle of 45" to the lateral side of the body; (4) supra-iliac, about 20 mm above the iliac crest, in the axillary line. Skinfolds were measured twice with a Harpenden Skinfold Caliper to the closest 1.0 mm, and the mean values were employed in the analyses

All the parameters obtained were fed into the SPSS software package (version 22.0; SPSS Inc., USA) for statistical analyses. Data were reported as means and standard deviations according to three age categories: G1 (20-29 yr.), G2 (30-39 yr.), and G3 (40-47 yr.). ANOVA with Scheffe post hoc tests was performed to test the differences in anthropometric and physiologic variables among the three age groups. The level of significance was set at 0.05 or less. In addition, Pearson correlation was used to examine the relationships between selected anthropometric Handgrip and thigh muscle strength for the whole sample.

Results

Table I shows the results of the Handgrip and thigh muscle strength measurements. The sample results were classified into three groups according to age categories. The result showed no significant difference between the three age groups in upper and lower muscle strength. Handgrip strength was stable from 20 to 47 years, ranging from 37 to 39 (kg). Also, thigh muscle strength was not affected by age for the three age groups.

From table I, A one-way ANOVA -Scheffe post hoc test indicates that each age group was significantly different from all others for FVC, FEV1, FEV1/FVC%, and PEFR. In addition, all other groups were quite different in weight, height, and body mass index. Skinfold measurement of the upper body showed no significant differences in Biceps, Triceps, and Sum of the skinfold were, however, the skinfold measurement of the lower body of the subscapular and Supra iliac were different significantly.

Pearson correlations are shown in Table II. In general, lower limb strengths were correlated significantly and moderately with skinfold measurements except for biceps skinfold, On the other hand, Hand Grips Strength correlated weakly with these skinfold measurements. The values of (FVC), (FEV_1) and (PEFR) which are measured directly by spirometer showed the strongest and most significant correlation with Hand Grips and weak correlation with Thigh muscle Strength however, the remaining spirometer values showed moderate significant correlation with Hand Grips except for (FEV_1/FVC).

Table II: Pearson Correlation between Pulmonary Function Tests of healthy Saudi males for all age groups (all values are mean ±SD).and selected anthropometric and physiologic variables (n=106)

Variables	Hand Grips	Thigh Strength
Triceps	0.09	0.25*
Subscapular	0.11	0.28**
Supra iliac	-0.05	0. 28**
Biceps	0.04	0.15
Sum of skinfold	0.07	0.23*
Fat percent	0.07	0.29**
Force vital Capacity (FVC)	0.24*	0.15
Force expiratory volume in 1 second (FEV_1)	0.21*	0.07
Peak expiratory flow (PEFR)	0.28**	0.20
Force expiratory volume / Force vital capacity (FEV_1/FVC)	0.02	-0.14

*Correlation is significant at the 0.05 level; *Correlation is significant at the 0.01 level.

Table I: Physical characteristics and Pulmonary Function Tests of healthy Saudi males in different age groups

Variables	AGE (years)			Difference between group
	20-29	30-39	40-47	
Number of subjects	38	37	31	
		Mean ±SD		
Age (year)	24.8±3	33.5±2.6	43.9±3	≤ 0.001
Body mass (kg)	72.4± 15	79.2± 16	82± 9.5	≤ 0.001
Height (cm)	172±5	169 ±6	170±5	≤ 0.001
BMI (kg. m^{-2})	24.3±5	27.2±5	29±4	≤ 0.001
Hand Grip (kg)	37.3±7	39±6	38±6	No sig
Thigh strength (kg)	115± 30	134± 43	124±38	No sig
Body surface area (m^2)	1.8±0.17	1.9±0.18	1.9±0.11	No Sig
FVC (lit)	4.3±0.6	4.4±0.6	3.7±0.7	≤ 0.001
FEV1 (lit)	3.7±0.4	3.7±0.5	3±0.6	≤ 0.001
FEV1/FVC%	86±8	83±5	82±4	≤ 0.05
PEFR (lit/sec)	10±1.8	10.5±1.7	9.3±2	≤ 0.05
Skin fold Biceps, mm	8.7±6.10	8.8±5.2	11.39±6.4	No Sig
Skin fold Triceps, mm	16.67±8.3	17.22±7.8	21.07±7.3	No Sig
Skin fold Subscapular, mm	20.76±10	24.51±9.7	28.08±8.76	≤ 0.05
Skin fold Supra iliac, mm	15.09±8.34	20.5±9.19	21.83±7.4	≤ 0.05
Sum of the skin fold, mm	59.99±28.02	67.06±25.77	71.40±17.82	No Sig

BMI=body mass index, FVC= forced vital capacity, FEV_1 = forced expiratory volume at 1 second, FEV_1 /FVC= percent, and PEFR= peak expiratory flow rate

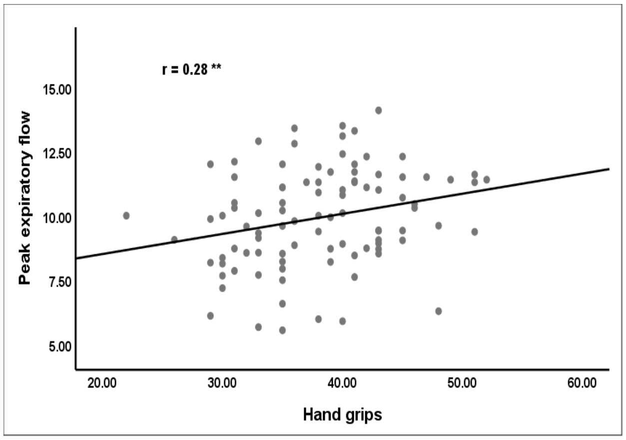

Figure 1. Moderate significant correlations between Hand grip strength and Peak expiratory flow (PEFR) which was assessed by using the Childhood Autism Rating Scale (CARS).

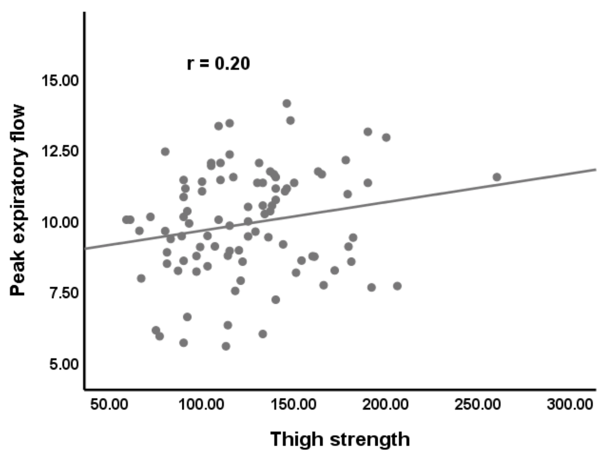

Figure 2. Moderate to low non-significant correlations between Thigh strength (kg) and Peak expiratory flow (PEFR).

The large muscle bulk of the thigh muscle compared to the size of the muscle of the hands, leading to skin fold measurements correlated significantly with Triceps, Subscapular, Supra iliac Sum of skinfold and Fat percent however, the biceps skinfold thickness had the weakest correlation

Discussion

This study aimed to assess the link between skeletal muscle strength and fat distribution in respiratory function by investing the lung functions. This suggests that having more muscle mass can help with breathing and muscle strength. These findings are in tune with the results of Takahashi et al.[13]

Body skeletal muscle strength and fat compositions change over time,[14] and thus, it is important to evaluate the effects of changes in muscle strength and fat distribution as well as lung function. Increasing BMI with age, as shown in Table 1, from 24.3±5 to 29±4 (kg. m^{-2}), is reflected in the values of FVC (lit), which decreased from 4.3 to 3.7 (lit). [15] In addition, (FVC) is dependent on chest muscle strength. The intercostal muscles (IC) are a group of muscles that run the length of the rib cage. These muscles are skeletal in both morphology and function, and they aid in the upward and outward migration of the ribs, increasing the anteroposterior diameter of the thoracic cavity.[16] However, hand grip strength and thigh strength did not change dramatically between groups because the age groups and subjects were similar in muscular structure and did not reach the stage of the elderly.

Hackett et al.[17] investigated the association of lung function and respiratory muscle strength with weightlifting strength and body composition in non-athletic males. The authors found a positive correlation between fat-free mass, appendicular lean mass, and lung function variables. But, fat-free mass and appendicular lean mass indexes were only related to respiratory muscle strength and not lung function.

Park et al. 2018 investigated the relationship between skeletal muscle mass index (SMI) and lung functions. The authors found that skeletal muscle mass index was independently associated with a decline in lung function in healthy adults. This association was sustained in subgroup analyses by gender and all age groups.[18]

The present study found that the mass muscle size in the hand grips tests is less than the muscle mass during the thigh muscle strength test. The thickness of the skin folds was not affected by the strength of the hand muscles, while the thickness of the skin folds was affected by the strength of the thigh muscles as in Table II. The current investigation discovered that FVC and FEV1 were independently related to skeletal muscle mass among the PFT parameters. In contrast, FEV1/FVC was unrelated to skeletal muscle mass.

Conclusion

There was no association between the age groups in upper and lower limbs muscle strength. It is suggested that further large sample size studies will be conducted to explore the findings and reach better conclusions.

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