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ORIGINAL RESEARCH

Respiratory muscle strength, pulmonary function and thoracoabdominal expansion in older adults and its relation with nutritional status

Força muscular respiratória, função pulmonar e expansibilidade toracoabdominal em idosos e sua relação com o estado nutricional

La fuerza muscular respiratoria, la función pulmonar y la expansibilidad toracoabdominal en adultos mayores y la relación con su estado nutricional

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ABSTRACT | This study aimed at describing Respiratory Muscle Strength, Pulmonary Function and Thoracoabdominal Expansion and associating its relation with nutritional status. It is an observational, cross-sectional study with 50 older adults of both sexes, aged between 60 and 84 years, with no previous diagnosis of respiratory pathologies, invited through local media. It have been evaluated maximal inspiratory (MIP) and expiratory (MEP) pressures, forced vital capacity (FVC), forced expiratory volume in one second (FEV1), thoracoabdominal cirtometry and anthropometric measurements (weight, height, body mass index – BMI –, and nutritional status). Values obtained from MIP, MEP, FVC, and FEV1 were lower than the values intended for this population ($p<0.05$) as well as measurements for the thoracoabdominal expansion. Regarding nutritional status, 10 older adults were classified as malnourished, 24 as eutrophic, and 16 as obese. Values of respiratory parameters showed no association with nutritional status ($p> 0.05$). It was concluded that aging influenced the respiratory parameters evaluated in this study group. Nutritional status, on the other hand, did not influence measures of respiratory muscle strength, pulmonary function, thoracoabdominal expansion.

Keywords | Elderly; Muscle Strenght; Respiration.

RESUMO | Objetivou-se descrever a força muscular respiratória (FMR), função pulmonar (FP) e expansibilidade toracoabdominal (ET) e associá-las com seu estado nutricional. Trata-se de um estudo observacional transversal com 50 idosos de ambos os sexos, com idade entre 60 e 84 anos, sem diagnóstico prévio de patologias respiratórias, convidados através de mídia local. Foram avaliadas as pressões inspiratória (PImáx) e expiratória (PEmáx) máximas, capacidade vital forçada (CVF), volume expiratório forçado no primeiro segundo (VEF1), cirtometria toracoabdominal e medidas antropométricas (peso, altura, índice de massa corporal – IMC – e estado nutricional). Os valores obtidos de PImáx, PEmáx, CVF e VFE1 apresentaram-se inferiores aos valores previstos para tal população ($p<0,05$), bem como as medidas de expansibilidade tóraco-abdominal. Com relação ao estado nutricional, 10 idosos foram classificados como desnutridos, 24 eutróficos e 16 obesos. Os valores dos parâmetros respiratórios não mostraram associação com o estado nutricional ($p>0,05$). Concluiu-se que o envelhecimento influenciou os parâmetros respiratórios avaliados nesse grupo de estudo. O estado nutricional, por sua vez, não influenciou as medidas de FMR, FP e ET.

Descritores | Idosos; Força Muscular; Respiração.

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RESUMEN | El propósito de este estudio fue describir la fuerza muscular respiratoria (FMR), la función pulmonar (FP) y la expansibilidad toracoabdominal (ET) y asociarlas con el estado nutricional de adultos mayores. Se trata de un estudio observacional transversal, del cual participaron 50 adultos mayores de ambos sexos, entre 60 y 84 años de edad, sin diagnostico anterior de patologías respiratorias, y que fueron invitados por los medios locales. Se les evaluaron la presión inspiratoria (PImax) y la presión espiratoria (PEmax) máximas, la capacidad vital forzada (CVF), el volumen espiratorio forzado en el primer segundo (VEF1), la cirtometría toracoadominal y las medidas antropométricas (peso, altura, índice de masa corporal y estado nutricional). Los valores de la PImax, la PEmax, la CVF y el VFE1 fueron inferiores a los valores previstos para los participantes (p<0,05), así como las medidas de expansibilidad toracoabdominal. Referente al estado nutricional, se clasificaron 10 adultos mayores en desnutridos, 24 en eutróficos y 16 en obesos. Los valores de los parámetros respiratorios no se asociaron con el estado nutricional (p>0,05). Se concluye que el envejecimiento influyó en los parámetros respiratorios evaluados en el grupo. El estado nutricional, a su vez, no influyó en las medidas de la FMR, FP y ET.
Palabras clave | Adulto Mayor; Fuerza Muscular; Respiración.

INTRODUCTION

According to the Brazilian Institute of Geography and Statistics (IBGE)[1], the ageing tendency of the Brazilian population remained in the latest survey and the number of older adults (individuals with more than 60 years) will quadruplicate by the year 2060, representing nearly 27% of the whole Brazilian population.

The aging process brings a range of physiological changes that result in the reduction of muscle mass, strength, and function in many systems. In the respiratory system, changes are observed in the connective tissue, causing increased stiffness of the thoracic cavity and reducing the elastic component of the lungs, directly influencing on respiratory mechanics[2], leading to the reduction in the mobility of the thoracic cavity, lung elasticity, and forced vital capacity (FVC)[3] as well as of the forced expiratory volume in one second (FEV_1), thoracic complacency, and increased lung complacency, among other changes[4].

Other aging-related phenomenon is the reduction of respiratory muscle strength. Therefore, older adults present decreased maximal inspiratory pressure (MIP) as a result of the weakness of the inspiratory muscles and decreased maximum expiratory pressure (MEP) due to reduction in the strength of the abdominal muscles and intercostal[5,6].

Other aspects that noticeably change during aging are associated with the body composition of older adults, who tend to gain weight steadily until around 70 years, then losing it from this age[7] and to present a redistribution of body fat from the extremities to the visceral area[8], which may interfere with the respiratory system.

Studies related to the respiratory characteristics of older adults frequently address respiratory pathologies, and a few focus on the population of older adults without complaints. Is of fundamental importance to know the physiological changes in order to act in the prevention of diseases. In addition, with the increasing older adults' population, health professionals must be prepared to meet this demand, in such a way to promote a better quality of life for these individuals. Thus, this study aimed at describing Respiratory Muscle Strength, Pulmonary Function, and Thoracoabdominal Expansion and associating its relation with nutritional status.

METHODOLOGY

This is an observational, cross-sectional study, approved by the Research Ethics Committee of the institution of origin under protocol no. 0356.0.243.000-11. All participants were provided with information on the research and signed an Informed Consent Form.

Sample calculation was estimated to obtain a significance level (alpha) of 5% (p<0.05) and a power level (beta) of 80%, based on the study by Burneiko et al.[9]. For the calculation, it was considered the result related with the MIP percentage, since it is the variable that showed the highest standard deviation (SD=15.64). The WinPepi program version 10.5 was used and, according to the calculation, a sample of 46 individuals was expected.

Were included in the survey older adults of both sexes, aged between 60 and 84 years, with no previous diagnosis of respiratory pathologies, invited through local media. Were excluded older adults who featured neurological and/or psychiatric pathologies, symptoms of cold and/or respiratory diseases on the day of assessment, those who were alcoholics, current smokers and former smokers for less than ten years, and who undergone thoracoabdominal surgery for less than five years.

Initially, the following evaluation procedures were performed: respiratory muscle strength, pulmonary function, and thoracoabdominal mobility.

Maximal respiratory pressures were measured by Microhard MVD500 digital manovacuometer (Globalmed – Porto Alegre/RS), in sitting position, using of a nose and mouth clip firmly pressed between the lips. Two learning procedures were used and a manual gesture was combined, which would indicate when the lungs were inflated/deflated[10].

To measure the maximum inspiratory pressure (MIP), it was requested expiration in Residual Volume (RV) level, followed by rapid and strong inspiration at Total Lung Capacity (TLC) level, sustained for at least three seconds, with verbal stimulus of the examiner. For maximal expiratory pressure (MEP), it was requested maximum inspiration at TLC level followed by maximal expiration at RV level, keeping it for at least three seconds, with verbal stimulus of the examiner[11]. Five maximal procedures were performed, with range of one minute for resting and, later, selected three acceptable and reproducible procedures (10% or less difference between the efforts), being registered the higher value[12] and compared with the value expected by the equation of Neder et al.[13], according to age and sex.

The Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEV_1) were obtained by the spirometer Respiradyne II (Model 5-7930P Sher Wood Medical Co), from the maximal inspiration, followed by a rapid and sustained expiration in the mouth piece of the instrument, for at least six seconds. There was encouragement for the effort to be "explosive" at the beginning of the procedure, repeated until three acceptable and reproducible procedures were obtained[14]. All measurements were obtained in the sitting position, using the nose clip. The evaluators were blinded as to the outcome of the study.

To measure thoracoabdominal expansion by cirtometry were used three measuring tapes, adapted with a strap of cotton shoelaces to serve as a guide in sliding of the tapes during respiratory movements. In dorsal decubitus, the tapes were placed in three anatomical reference points – axilla skinfold, xiphoid appendix, and umbilical line and the measures carried out at rest, after maximal inspiration (TLC) and maximal expiration (RV), under the command of the researcher. For each point, three measures were carried out in three different times with one-minute intervals between them[15], and the measure with greater range coefficient was selected.

The measurement of body mass and height to calculate the body mass index (BMI) was performed. Body mass was measured in digital scale G-Life CA4000 150 kg (Magna – São Paulo/SP) with individuals barefoot, wearing light clothes. Height was measured by a portable stadiometer with a resolution of 1 mm (Sanny – Fortaleza-CE), while individuals were barefoot, in upright position, leaning on a flat vertical surface, arms alongside the body, knees in touch, heels and toes apart, forming a 60° angle, head set according to Frankfurt horizontal plane, and in deep inspiration. For the measurement, the stadiometer slider was slowly lowered until the top of the head in its middle part, without pushing it down. The slider was set and the reading of the rule was carried out to the nearest millimeter, registering the score[16]. Nutritional status was defined through the BMI, being considered malnourished older adults with <22Kg/m², eutrophic between 22 and 27 Kg/m², and obese >27[17].

Finally, data were subject to nonparametric statistics by Wilcoxon Test, Mann-Whitney Test, and Kruskal-Wallis Test, adopting a significance level of 5%.

RESULTS

Participated in this study 50 older adults (35 women, 15 men), with an average age of 69.48±7.02 years (68.57±6.54 years for women and 71.60±7.84 years for men), body mass of 69.42±12.67 kg (65.94±11.99 kg for women and 77.53±10.60 kg for men), and height of 1.64±0.07 m (1.61±0.05 m for women and 1.71±0.05 m for men). Values expected and obtained from respiratory parameters of older adults, according to sex, are presented in Table 1.

In Table 2 we observe the values of thoracoabdominal expansion for axilla skinfold, xiphoid appendix, and umbilical line, according to the sex of older adults.

Table 3 presents the characterization of older adults regarding nutritional status.

Table 4 presents the comparison of the obtained variables regarding nutritional status.

Table 1. Comparison of values expected and obtained for respiratory parameters, per sex

Parameter	Sex		1Q	Median	3Q	Mean	SD	p-value
MIP	FEM	Expected	74.14	77.57	79.53	76.80	3.21	<0.001*
		Obtained	42.00	45.00	58.00	51.43	15.08	
	MALE	Expected	91.30	98.10	103.30	97.53	6.21	<0.001*
		Obtained	45.00	57.00	75.00	59.33	17.74	
MEP	FEM	Expected	70.46	74.73	77.17	73.77	4.00	<0.001*
		Obtained	46.00	57.00	67.00	58.37	15.67	
	MALE	Expected	100.50	107.79	113.46	107.62	6.47	0.001*
		Obtained	63.00	67.00	80.00	73.80	23.94	
FVC	FEM	Expected	2.39	2.56	2.73	2.57	0.24	<0.001*
		Obtained	1.75	2.16	2.60	2.17	0.57	
	MALE	Expected	3.39	3.57	3.75	3.55	0.45	0.002*
		Obtained	2.44	2.73	3.01	2.83	0.67	
FEV1	FEM	Expected	1.89	2.05	2.21	2.06	0.25	<0.001*
		Obtained	1.44	1.67	2.09	1.77	0.47	
	MALE	Expected	2.66	2.76	2.97	2.76	0.36	<0.001*
		Obtained	1.85	2.14	2.64	2.15	0.62	

*p≤0.05 – Wilcoxon test

MIP: maximal inspiratory pressure (cmH_2O); MEP: maximal expiratory pressure (cmH_2O); FVC: forced vital capacity (l/min); FEV_1: forced expiratory volume in one second (l/s); SD: standard deviation; 1Q: first quartile; 3Q: third quartile; FEM: female; MALE: male

Table 2. Comparison of values expected and obtained for parameters of thoracoabdominal expansion, per sex

Parameter	Sex	1Q	Median	3Q	Mean	SD	p-value
Axilla skinfold	FEM	3.00	4.00	5.00	4.11	1.66	0.762
	MALE	3.00	4.00	5.00	4.33	1.54	
	Total	3.00	4.00	5.00	4.18	1.61	
Xiphoid appendix	FEM	2.00	3.00	4.00	3.11	1.23	0.052
	MALE	2.00	4.00	5.00	3.93	1.39	
	Total	2.00	3.00	4.00	3.36	1.32	
Umbilical line	FEM	3.00	4.00	4.00	3.63	1.14	0.374
	MALE	2.00	3.00	4.00	3.33	1.11	
	Total	3.00	3.50	4.00	3.54	1.12	

*p≤0.05 – Mann-Whitney Test

SD: standard deviation; 1Q: first quartile; 3Q: third quartile; FEM: female; MALE: male

Table 3. Characterization of older adults regarding nutritional status

Nutritional status	n	%	Age (mean±SD) years
MAL	10	20	69.6±7.42
EUT	24	48	68.6±6.76
OBE	16	32	70.62±7.43

Descriptive analysis

MAL: malnourished; EUT: Eutrophic; OBE: obese; n: number of subjects; %: percentage of subjects; SD: standard deviation

Table 4. Comparison of variables obtained regarding nutritional status

Variable	Nutritional status	Mean	SD	Q1	Median	Q3	p-value
Obtained MIP	MAL	51.70	13.91	42.00	51.50	57.00	0.966
	EUT	53.71	15.50	44.00	50.50	63.00	
	OBE	55.08	19.06	43.00	49.00	89.00	
Obtained MEP	MAL	57.10	13.99	46.00	64.00	65.00	0.670
	EUT	63.17	21.68	49.50	61.50	70.00	
	OBE	65.77	19.47	42.00	52.00	73.00	

to be continued...

Table 4. Continuation

Variable	Nutritional status	Mean	SD	Q1	Median	Q3	p-value
	MAL	2.60	0.54	2.19	2.37	2.83	
Obtained FVC	EUT	2.41	0.73	1.85	2.45	2.89	0.441
	OBE	11.16	24.73	1.50	2.43	2.76	
	MAL	1.99	0.47	1.72	1.93	2.08	
Obtained FEV1	EUT	1.95	0.53	1.50	1.85	2.44	0.511
	OBE	12.12	28.63	1.14	2.00	2.55	
	MAL	4.60	1.78	3.00	4.00	6.00	
AXILLA	EUT	4.17	1.63	3.00	4.00	5.00	0.693
	OBE	3.88	1.50	2.00	3.00	5.00	
	MAL	3.30	1.16	3.00	3.50	4.00	
XIPHOID	EUT	3.29	1.40	2.00	3.00	4.00	0.841
	OBE	3.63	1.36	3.00	4.00	6.00	
	MAL	3.10	0.74	3.00	3.00	4.00	
UMB	EUT	3.83	1.24	3.00	4.00	5.00	0.209
	OBE	3.29	1.07	1.75	3.00	4.00	

*$p \leq 0.05$ Kruskal-Wallis Test
MIP: maximal inspiratory pressure (cmH2O); MEP: maximal expiratory pressure (cmH2O); FVC: forced vital capacity (l/min); FEV1: forced expiratory volume in one second (l/s); malnourished; EUT: Eutrophic; OBE: obese; SD: standard deviation; 1Q: first quartile; 3Q: third quartile

DISCUSSION

Maximal respiratory pressures were below the values expected for age and sex[13]. Previous studies[4,18,19,21,22] also found that respiratory muscle strength showed reduced compared with expected values for older adults, according to the equation regarding age and sex[13]. With advancing age, the reduction in respiratory muscle strength is similar to the reduction in the strength of the skeletal muscles, especially after 60 years of age[21].

It is worth noting that even though MIP decreased, no older adult presented symptoms related to decreased inspiratory force. On the other hand, MEP, although indirectly related to ventilatory activities, should be evaluated, since it closely participates in non-ventilatory activities, such as sneeze and cough, that, when not effective, can affect the pulmonary health[21].

Nabil[23] noted in his study on 325 older adults an inverse relationship of the maximal respiratory pressures with age, that is, to the extent that age increases, the respiratory pressure decreases. The reduction in respiratory muscle strength was also observed in a study[24] on 100 individuals aged between 40 and 89 years, of both sexes, concluding that with advancing age there is a reduction in inspiratory and expiratory muscle strength. Simões et al.[20] highlight that the reduction in blood pressure values are evidence of the reduction in respiratory muscle strength that occurs in older adults who are in an age group considered older, being directly related to the aging phenomenon. This fact was confirmed by the strong negative correlations between age and respiratory pressures found in their study with 60 older adults subdivided in three age groups: From 60 to 69; 70 to 79; and 80 to 90 years.

These changes may be related to aging, which, in turn, includes physiological changes that show decreased muscle mass (sarcopenia) and muscle fibers, mainly the type II one[22]. Thus, with the reduction in muscle mass, respiratory muscles lose their efficiency in generating force, reflecting in lower maximal respiratory pressure values[2,20].

Aging comprises changes in postural structure, joints start getting more rigid, there is a calcification, and degeneration of the cartilage, causing bones to be merged, thereby changing the posture of the individual, leading to decreased mobility of the rib cage, thus causing a reduction in maximal respiratory pressures. In addition, the diaphragm muscle has primary function in the respiratory system, being responsible for about 60% of the respiratory function; however, its satisfactory performance depends on the structures that surrounds it. If there is a postural imbalance, it will influence on the action of gravity on such a structure, and consequently, deficits in its performance will occur, hindering the process of inspiration and expiration[18,22,25].

The degree of thoracic mobility observed in this study is below normal parameters for a healthy young adult, which is about 7 cm[26]. We did not find in the researched literature values of specific reference to the older adult population, only to healthy young adults. This value reduces in older people due to changes in the thoracic structure[26]. Authors point out that the reduction in thoracic compliance in healthy individuals is most evident from 80 years, although it was already present since 50 years old[27].

The maximal pulmonary functional performance is reached, on average, at 20 years old in woman and 25 years old in men. Subsequently, a slow and gradual reduction in lung capacity begins, which remains, however, in a condition to provide adequate gas exchange even in extreme ages in healthy individuals. The FVC shows a 25% drop between 20 and 70 years old, and at 70 years old its value is 75% of the 20 years old value[28].

In our study, FVC and FEV_1 decreased in older adults, corroborating other studies[29,30]. The decreased thoracic expansion found can explain, in part, the reduction in FVC, since this is the index of the ability of the dilation of thoracic and pulmonary system[30], in addition to the reduction in respiratory muscle strength.

Nutritional status did not affect respiratory parameters. A correlational study verified the relationship between body fat and lung function of 17 female older adults aging 60 to 80 years, selected by convenience, of a group of this population, and found no association between body composition and BMI variables with the pulmonary function[31]. We found no other studies relating BMI/nutritional status and respiratory parameters of the population studied in our article. One hypothesis is that this result may have been determined by the use of BMI as a determinant of obesity, rather than the use of other more reliable methods. It is suggested that the location of fat could affect the respiratory system, since the excess of abdominal fat could compress the diaphragm and compromise breathing.

As a limitation of the study, we highlight the absence of a control group (composed of adults) for comparison purposes.

CONCLUSION

Aging influenced the respiratory parameters evaluated in this study group, regardless of sex. There was also a reduction in maximal respiratory pressures, FVC, FEV_1, and thoracoabdominal expansion. Nutritional status, on the other hand, did not influence measures of respiratory muscle strength, pulmonary volumes, and thoracoabdominal expansion. We highlight the importance of this knowledge to health professionals, in order that, in clinical practice, actions are directed to the prevention and promotion of the health of older adults.

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