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ORIGINAL RESEARCH

Influence of age, anthropometric characteristics and body fat distribution in women's thoracic mobility

Influência da idade, das características antropométricas e da distribuição de gordura corporal na mobilidade torácica de mulheres

La influencia de la edad, de las características antropométricas y de la distribución de grasa corporal en la movilidad torácica de mujeres

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ABSTRACT | The accumulation of fat in the chest can contribute to reduced thoracic mobility (TM) with a decrease of lung volumes. TM changes can also occur in aging, due to progressive calcification of joints involved in respiratory movements and reduced intervertebral spaces. The objective of this study was to verify the influence of age, anthropometric characteristics and distribution of body fat on the behavior of women's TM and to check which of these variables is more relevant to the TM. This is a cross-sectional study with 100 women, from 25 to 75 years and body mass index (BMI) between 18.5 and 55kg/m^2. Circumferences of neck (NC), waist, hips and waist/hip ratio were measured. TM was assessed by thoracic cirtometry, in axillary and xiphoid levels and, after three measures, the TM was determined by the difference between the highest value obtained in the inspiration and the lowest value at expiration. We used correlation tests and multiple linear regression. Results show, through significant correlations, that with increasing age and obesity, TM decreases. The NC had the greatest influence (16.60%) on TM in axillary level and on BMI in xiphoid level (18.16%). It is concluded that TM is reduced with aging and obesity and that the deposition of fat in the neck and the increase of BMI are the most important factors in the commitment of women's TM.

Keywords | Aging; Obesity; Thorax; Lung Volume Measurements.

RESUMO | O acúmulo de gordura no tórax pode contribuir para a redução da mobilidade torácica (MT) com declínio de volumes pulmonares. Alterações da MT também podem ocorrer no envelhecimento, devido à progressiva calcificação das articulações envolvidas nos movimentos respiratórios e redução dos espaços intervertebrais. O objetivo deste estudo foi verificar a influência da idade, das características antropométricas e da distribuição de gordura corporal no comportamento da MT de mulheres e verificar qual dessas variáveis é mais relevante para a MT. Trata-se de um estudo transversal, com 100 mulheres com idades entre 25 e 75 anos e índice de massa corporal (IMC) entre 18,5 e 55kg/m^2. Foram mensuradas as circunferências do pescoço (CP), da cintura, do quadril e a relação cintura/quadril. A MT foi avaliada pela cirtometria torácica nos níveis axilar e xifoidiano e, após a realização de três medidas, a MT foi determinada pela diferença entre o maior valor obtido na inspiração e o menor valor obtido na expiração. Foram utilizados testes de correlação e de regressão linear múltipla. Os resultados mostram, por meio de correlações significativas, que com o aumento da idade e devido à obesidade ocorre diminuição da MT. A

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CP exerceu maior influência (16,60%) sobre a MT no nível axilar e o IMC no nível xifoidiano (18,16%). Conclui-se que a MT está reduzida com o envelhecimento e obesidade e que a deposição de gordura no pescoço e o aumento do IMC são os fatores mais importantes no comprometimento da MT de mulheres.
Descritores | Envelhecimento; Obesidade; Tórax; Medidas de Volume Pulmonar.

RESUMEN | La acumulación de la grasa torácica puede contribuir a la reducción de la movilidad torácica (MT) con disminución del volumen pulmonar. También las alteraciones de la MT pueden ocurrir en el envejecimiento, debido a la progresiva calcificación de las articulaciones implicadas en los movimientos respiratorios y a la reducción de los espacios intervertebrales. Este estudio tuvo el objetivo de verificar la influencia de la edad, de las características antropométricas y de la distribución de grasa corporal en conductas de la MT de mujeres, así como verificar cuál de las variables es la más relevante para la MT. Se trata de un estudio transversal, del cual participaron 100 mujeres con edades entre 25 y 75 años y con índice de masa corporal (IMC) entre 18,5 y 55kg/m^2. Se midieron las circunferencias del cuello (CC), de la cintura, de las caderas y la relación entre cintura/cadera. Se evaluó la MT a través de la cirtometría torácica en los niveles axilar y xifoides y, tras realizarse las tres mediciones, se determinó la MT por la diferencia entre el valor más grande obtenido en la inspiración y el menor valor en la espiración. Se emplearon los test de correlación y de regresión lineal múltiple. Mediante las correlaciones significativas, los resultados demostraron que la MT disminuye debido al aumento de edad y a la obesidad. La CC tuvo mayor influencia (16,60%) bajo la MT en el nivel axilar y el IMC en el nivel xifoides (18,16%). Se concluyó que la MT redujo con el envejecimiento y la obesidad, y que la acumulación de grasa en el cuello y el aumento del IMC son los factores que más influyen en el comprometimiento de la MT de mujeres.
Palabras clave | Envejecimiento; Obesidad; Tórax; Medidas de Volumen Pulmonar.

INTRODUCTION

In morbidly obese individuals, excess fat stored in the chest and abdominal cavities have a direct mechanical effect on the rib cage and diaphragm muscle, restricting the thoracic mobility (TM), with consequent reduction of pulmonary volumes[1], even in the absence of pathological changes of respiratory system[2,3]. The restriction of the chest wall to expansion in obese in a sitting position is 70%, increasing to 80% of the total resistance of the respiratory system in supine[4] position, causing muscular overload for ventilation and consequent respiratory[5] muscle dysfunction.

Aging, as well as obesity, entails restrictions on TM, due to calcification of the joints involved, reduction of the intervertebral spaces and changes in the respiratory system[6], such as the weakness of the respiratory muscles, as a result of the replacement of muscles by adipose tissue, in addition, it occurs the reduction of lung elastic retractability and its complacency[7,8].

Under the changes that obesity and aging can bring, the execution of periodic assessments of the respiratory system contribute to monitor and assist the orientation of preventive measures[9].

Thoracic cirtometry is an assessment instrument of the respiratory system composed by a set of circumference measures of the chest during breathing movements with the purpose to evaluate the TM in a simple, accessible and reliable way[10], it also can be used in physiotherapy, for treatment evaluation and prescription, providing accurate information about the TM[11].

Considering that aging and anthropometric characteristics, especially the distribution of body fat, are mechanical factors that may alter respiratory mechanics, the hypothesis of this study was that these variables can interfere, in a differentiated manner in women's TM.

The objective of this study was to verify the influence of age, anthropometric characteristics and distribution of body fat on the behavior of women's TM and to check which of these variables is more relevant to the TM.

METHODOLOGY

Participants

This is a cross-sectional study, observational, in which 100 sedentary women participated, aged between 25 and 75 years and body mass index (BMI) between 18.5 and 55 kg/m^2. Women with chronic lung disease, smokers, respiratory infections in the past two weeks, presence of osteoarticular and neuromuscular diseases and those who practice physical activity regularly were excluded from the study.

All volunteers signed an informed consent form after being properly guided about the study, according to resolution 196/96 of the National Health Council (NHC). Approved by the Research Ethics Committee of the Universidade Metodista de Piracicaba (CEP-UNIMEP) under no. 48/12.

Volunteers were classified and separated into groups according to BMI: Eutrophic-volunteers with a BMI between 18.5 and 24.99kg/m^2; Overweight with a BMI between 25 and 29.99kg/m^2; Obese-volunteers with BMI between 30 and 39.99kg/m^2 and Morbidly obese volunteers with a BMI between 40 and 55kg/m^2.

Evaluation

Volunteers were initially subjected to anamnesis and subsequently to the anthropometric assessment, in which the measures of the body mass and stature were taken, obtaining the BMI. Body mass was obtained by a digital scale (Filizola® São Paulo/Brazil) properly measured, with a maximum capacity of 300kg and resolution of 100 grams. The stature was verified by a wall-mounted stadiometer (Wiso®, São José/Santa Catarina, Brazil), with the resolution in millimeters. The calculation of BMI was obtained by the equation: body weight (kg)/height^2 (m).

The distribution of body fat was carried out in standing position, using a tape measure staggered in centimeters (cm) with the measures of the circumferences of the neck (NC), waist (WC), hip (HC) and the waist/hip ratio (W/H). NC was measured at the cricoid cartilage[12] level, the WC at the midpoint between the margin of the last rib and the superior margin of the iliac crest[13] and the HC at the level of the femur greater trochanter[13], from the last two measures, W/H was obtained.

TM was assessed by thoracic cirtometry through a measuring tape staggered in cm, the volunteers were oriented to perform maximum and deep inspirations and expirations, standing in orthostatic position. TM was evaluated in two wlevels: axillary and xiphoid. For each level, three measurements were made and the TM for each level was determined by the difference between the highest value obtained in inspiration and the smallest value obtained in expiration.

Data analysis

For statistical analysis the statistical programme BioEstat, 5.3 version, was used. The normality of the data was checked by the Kolmogorov-Smirnov test. To check the influence of age, anthropometric characteristics and body fat distribution on TM, Pearson and Spearman correlation tests were used. Then, for the variables with significant correlation tests, multiple linear regression test was used with "stepwise" selection criteria to verify among the variables which one is the most relevant to the TM changes. A significance level of 5% was adopted and correlation r between 0.30 and 0.70 was considered moderate.

RESULTS

One hundred women were evaluated between the ages of 25 and 75, being 25 eutrophic (18.5 to 24.99kg/m^2), 25 overweight (25 to 29.99kg/m^2), 25 obese (30 to 39.99kg/m^2) and 25 morbidly obese (≥4 kg/m^2). Table 1 indicates data of age, anthropometric characteristics, body fat distribution and the TM of the volunteers studied.

Table 1. Age, anthropometric characteristics, body fat distribution and thoracic mobility of 100 volunteers, distributed in the groups Eutrophic, Overweight, Obese and Morbidly Obese

Variables		Eutrophic (n=25)	Overweight (n=25)	Obese (n=25)	Morbidly Obese (n=25)
Anthropometric characteristics	Age (years)	44.32±11.46	44.76±10.52	48.28±12.91	41.00±12.93
	Mass (kg)	58.43±6.24	70.46±6.51	90.95±11.32	118.93±13.54
	Height (m)	1.61±0.06	1.61±0.06	1.60±0.05	1.61±0.06
	BMI (kg/m^2)	22.63±1.63	27.10±1.84	35.46±3.24	45.61±3.88
Body fat distribution	NC (cm)	31.74±2.22	33.12±2.83	37.88±3.07	40.64±2.62
	WC (cm)	77.14±6.31	90.12±9.34	105.86±20.50	126.30±10.89
	HC (cm)	95.88±7.42	106.16±5.30	119.76±9.10	139.86±9.42
	W/H	0.81±0.11	0.85±0.07	0.89±0.17	0.92±0.07
Thoracic mobility	Axillary (cm)	5.46±1.70	5.58±2.49	4.00±1.39	3.70±2.06
	Xiphoid (cm)	4.68±1.78	4.04±1.91	3.56±1.34	3.06±1.28

BMI: body mass index; NC: neck circumference; WC: waist circumference; HC: hip circumference; W/H: waist/hip; Kg: kilograms; m: meters; kg/m^2: kilogram per square meter; cm: centimeters

Table 2 expresses the results of the correlation analyses, to verify the influence of age, anthropometric characteristics and body fat distribution on TM.

According to the Table, it can be observed that the age showed significant, negative and weak correlation with axillary and xiphoid levels, showing reduction of TM with aging.

Regarding anthropometric characteristics, body mass and BMI showed significant, negative and moderate correlations with the levels assessed, as well as the variables that represent the distribution of body fat (except W/H that obtained weak correlation), suggesting reduction of TM in obesity.

Then, multiple linear regression test was applied with "stepwise" selection criteria to verify, among the variables, the one that was more relevant to TM changes. Figure 1 demonstrates the most relevant variables for the variability of TM in the axillary and xiphoid levels.

It can be observed that of all variables included in the model, the NC was the one that had the greatest influence (16.60%) on TM changes in the axillary level. Therefore, the adiposity in the neck region influenced the movements of the rib cage, which may restrict its expansion; also, BMI was the variable that exercised the greatest influence (18.16%) on TM changes in the xiphoid level.

Table 2. Results of the age correlation analysis, anthropometric characteristics and distribution of body fat with thoracic mobility

Variables		Thoracic mobility			
		Axillary level		Xiphoid level	
		r	p	r	p
Anthropometric characteristics	**Age**	-0.28	0.0061*	-0.21	0.0339*
	Height (m)	0.12	0.25	0.16	0.1081
	Body mass	-0.32	0.0011*	-0.68	0.0001*
	BMI	-0.38	0.0001*	-0.42	0.0001*
Body fat distribution	**NC**	-0.41	0.0001*	-0.39	0.0001*
	WC	-0.34	0.0005*	-0.40	0.0001*
	HC	-0.31	0.002*	-0.35	0.0004*
	W/H	-0.20	0.0475*	-0.37	0.0002*

BMI: body mass index; NC: neck circumference; WC: waist circumference; HC: hip circumference; W/H: waist/hip relation. *significant correlation

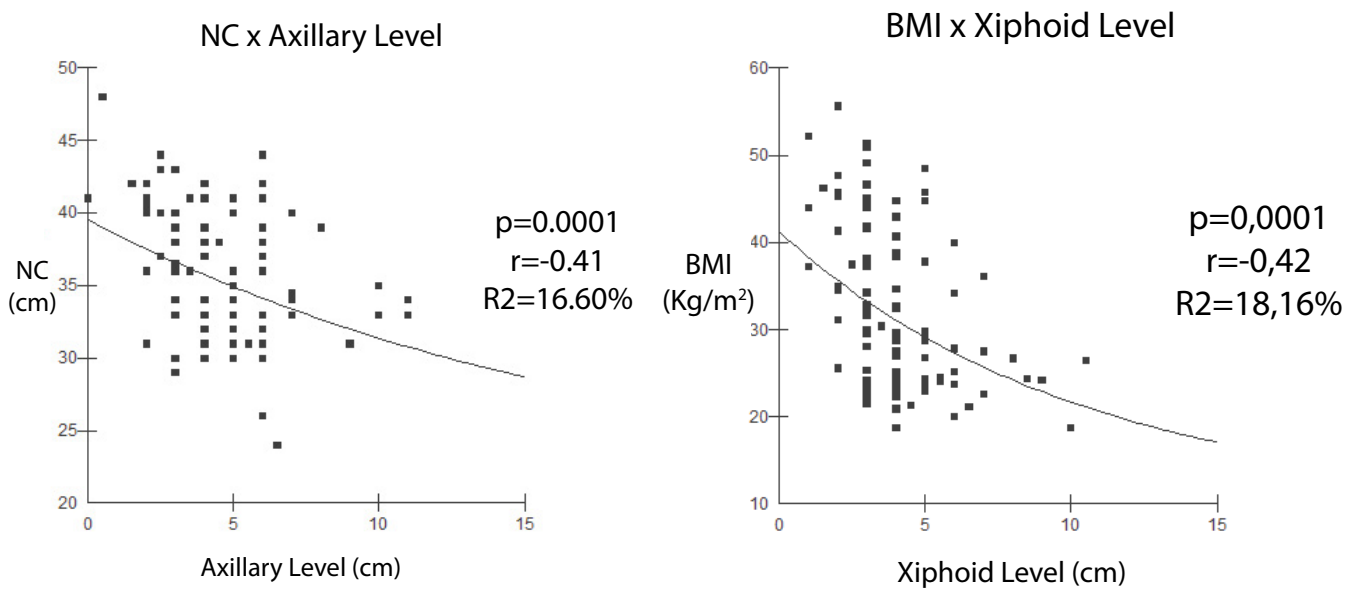

Figure 1. Results of the multiple regression analysis. Influence of NC on the axillary level of TM and BMI of TM in the xiphoid level. NC: neck circumference; TM: thoracic mobility; BMI: body mass index; kg/m^2: kilogram per square meter; cm: centimeters

DISCUSSION

In this study, it was found that the age, anthropometric characteristics and the distribution of body fat can influence the TM, i.e., with aging and with obesity, TM decreases. These results were found through significant, negative and moderate correlations, among the analyzed variables.

The reduction of TM, in obesity, found in this study, was also observed by Costa et al.[14], who found that individuals with a BMI >30 kg/m^2 presented TM reduction when compared with eutrophic individuals, suggesting that this reduction is caused by the mechanical effect of deposition of fat in the thoracic and abdominal cavity.

Similarly, Ladosky et al.[15], when assessing 77 morbidly obese, noted that with the increasing of BMI and consequent mass increase in the chest wall and abdominal cavity, these people presented a chest expansion decrease. Sue[16] also reported that the increased abdominal content in obese individuals may favor abdomen and thorax compressions, therefore, constraining the mobility.

In the study of Costa et al.[17], the authors concluded that morbidly obese women who underwent bariatric surgery presented best dynamics of respiratory muscles and consequent improvement of the TM in the post-surgery. The authors suggest that this improvement is a result of the natural decompression that the thorax and abdomen receive with the decrease of the adipose tissue after bariatric surgery.

In this study it was also observed that with aging, TM reduces. This fact was also reported in the study of Pettenon et al.[8], in which 16 seniors between 65 to 75 years showed reduction of TM. The authors reported that postural changes arising from the aging process were important factors for the decrease of the TM in this population.

In another study, Itokazu et al.[19] also observed that after stretching sessions by the global postural reeducation, seniors with hyperkyphosis presented improved TM, suggesting an association between posture and TM.

Cury and Yoshizaki[20] conducted a comparative analysis of TM between young adults and elderly people, in the age group ranging from 20 to 64 years, and confirmed the decrease in elderly's TM when compared to juveniles. They also found a connection between TM and a decrease of lung volumes in the studied population. The level of TM under normal parameters was also evidenced in the elderly evaluated by Guimarães et al.[21], corroborating the results of our study.

Thus, TM evaluation is a parameter for the diagnosis and monitoring of diseases progression[22]. So, from their evaluation, it is possible to draw up proposals for physiotherapeutic treatments seeking the preservation and/or improvement of these populations' quality of life.

Study limitations

This study was based with the classification of BMI to define eutrophic, overweight, obese and morbidly obese volunteers. Although BMI is considered to be one of the means to define excess weight, we cannot rule out the contribution of an evaluation through bioimpedance, to quantify exactly the values of lean and fat mass.

Another limitation of the study was the absence of men, since the results are limited to the female gender.

CONCLUSION

Confirming the hypothesis of the study, it can be concluded that age, anthropometric characteristics and distribution of body fat influence the behavior of the thoracic mobility in women from 25 to 75 years. Therefore, it is concluded that the TM reduces with age and with obesity. In addition, the deposition of fat in the neck and the increase of BMI are the most important factors in the commitment of women's TM, influencing the movements of the rib cage and restricting their capacity.

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