Relationship between abdominal and neck fat with sleep disorders in obese patients

Relação entre gordura abdominal e do pescoço com distúrbios do sono em pacientes obesas

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Abstract

Introduction: Obesity is one of the main public health problem worldwide and it has a negative short- and long-term relationship with women's health. Assessment of this disorder is essential, as is a body composition assessed by dual-energy X-ray absorptiometry (DXA) with the new region of interest as the neck. **Objective:** To verify the association between abdominal and neck fat with sleep quality in obese women. **Methods:** The sample, obtained from a Biomedical Engineering and Health Program database, was characterized by being obese female aged between 20 and 65 years. The tests performed were anthropometric assessment, sleep quality questionnaire, physical activity level, nutritional assessment, and body composition by dual-energy X-ray absorptiometry (DXA). For statistical analysis, the Shapiro-Wilk test, t test for independent samples, Kendall's Tau, linear and multiple regression and ROC curve were used. **Results:** The sample consisted of 15 individuals with a mean age of 45 ± 11.10 years, neck circumference of 41.50 ± 2.61 and abdominal circumference of 128.20 ± 11.62. We found no correlation between the regions of interest and the sleep quality questionnaire. Regression analysis shows non-significant statistical values for abdominal fat. The statistical test proved that the new region of interest in abdominal fat is closer to better sensitivity and has a greater relationship with sleep quality. **Conclusion:** there was no statistically significant correlation between the regions of interest and the sleep quality questionnaire. However, the abdominal fat region of interest was the point that presented the best association with sleep quality assessed by the Pittsburgh questionnaire.

Keywords: Body composition. Obesity. Quality of life. Sleep quality.

Resumo

Introdução: *A obesidade é um dos principais problemas de saúde pública em todo o mundo e tem uma relação negativa de curto e longo prazo com a saúde da mulher. A avaliação desse distúrbio é essencial, assim como a composição corporal avaliada por absorciometria de raios X de dupla energia (DXA), com a nova região de interesse como o pescoço.* ***Objetivo:*** *Verificar a associação da gordura abdominal e cervical com a qualidade de sono em mulheres obesas.* ***Métodos:*** *A amostra, obtida de um banco de dados do Programa de Engenharia Biomédica e Saúde, caracterizou-se por mulheres obesas com idade entre 20 e 65 anos. Os testes realizados foram avaliação antropométrica, questionário de qualidade do sono, nível de atividade física, avaliação nutricional e composição corporal por* dual-energy X-ray absorptiometry *(DXA). Para análise estatística, foram utilizados o teste de Shapiro-Wilk, teste t para amostras independentes, Tau de Kendall, regressão linear e múltipla, e curva ROC.* ***Resultados:*** *A amostra foi composta por 15 indivíduos com idade média de 45 ± 11,10 anos, circunferência do pescoço de 41,50 ± 2,61 e circunferência abdominal de 128,20 ± 11,62. Não encontrou-se correlação entre as regiões de interesse e o questionário de qualidade do sono. A análise de regressão mostrou valores estatísticos não significativos para a gordura abdominal. O teste estatístico comprovou que a nova região de interesse na gordura abdominal está mais próxima de melhor sensibilidade e tem maior relação com a qualidade do sono.* ***Conclusão:*** *Não houve correlação estatisticamente significativa entre as regiões de interesse e o questionário de qualidade do sono. A região de gordura abdominal de interesse, no entanto, foi o ponto que apresentou melhor associação com a qualidade do sono avaliada pelo questionário de Pittsburgh.*

Palavras-chave: *Composição corporal. Obesidade. Qualidade de vida. Qualidade do sono.*

Introduction

Obesity is one of the main public health problems worldwide, considered very important for social, psychological and metabolic reasons,[1] being associated with a high degree of comorbidities and high risk of mortality.[2] Among obesity-associated comorbidities are heart diseases, diabetes, some cancer types, arterial hypertension, locomotors disturbance, dyslipidemias, in addition to psychological disorders such as depression and binge eating.[3] The sleep apnea is the other respiratory problem caused by obesity, affecting 2% of women and 4% of men worldwide, being characterized by obstruction in airways and respiratory pause.[4] In relation to this topic, this phenomenon can cause an increase in intra-abdominal pressure and transfer this pressure to the thoracic region, resulting in changes in pressure/volume curves, decreasing lung volume and making breathing difficult.[5]

The evaluation of sleep quality and duration is essential to identify causes associated with obesity, including nutritional disturbances and poor physical activity. The recommendation of sleep for adults is seven hours minimum per night and for adolescents, eight hours.[6] Some studies show that there is a relationship between dissatisfaction with the quality of sleep and obesity.[7] Thus, the duration and quality of sleep are important for controlling the risk of developing obesity and metabolic diseases.[8]

Regarding the distribution of body fat, to assess the influence of android fat and neck fat on sleep quality, dual-energy X-ray absorptiometry (DXA) has been used to assess all total body composition and specific regions of interest such as neck or abdominal region, at a low cost compared to magnetic resonance or computed tomography.[9] Neck circumference is an accessible and practical body fat distribution index that can be used as a reference for detecting overweight and obesity.[10] However, it is very important to check if the low quality of sleep is associated with an increase in the percentage and distribution of body fat, and how poor quality of sleep can influence obesity or vice versa.

Methods

This retrospective study was realized in the Biomedical Engineering and Health Laboratory at Universidade Tecnológica Federal do Paraná (UTFPR). The sample was composed by analysis in a database between 2019 to 2020, and included 15 women with median age 45.0 ± 11.10 years. Endorsements from the ethics committee and institutional review board of Centro Universitário UniDomBosco (No. 4.108.194) were obtained prior to data collection. Patients were informed of risks and benefits, having individually signed an informed consent form and a research privacy form before being submitted to the testing protocol.

The participants were women aged 20 to 65 years, with a body mass index (BMI) classified between overweight and obesity, and weight limit of 150 kg, with sleep disorders. Participants who underwent any radiation examination at least seven days before the DXA analysis and/or missed one of the scheduled examinations were excluded.

For the analysis of sleep quality, the Pittsburgh Sleep Quality Index (PSQI) and the excessive sleepiness scale were applied. The Pittsburgh questionnaire has seven components, above five points, and the subject is classified as having poor quality sleep. For the excessive sleepiness scale, the subject who scored above 10 points out of the total was classified as positive.

The circumference evaluation of the neck and abdomen was performed with a brand tape measure WISO (WCS®). For the neck circumference was used the above thyroid cartilage and perpendicular along the neck axis. For the abdominal area it was used in the largest abdominal perimeter between the last rib and iliac crest. The body composition was performed by a Hologic model Discovery A densitometer was used. The total body composition and the region of interest for the neck and abdominal area were analyzed and the total fat mass and the fat mass index for each region were measured, as well as lean mass according to International Society for Clinical Densitometry.

The statistical analysis was performed by Microsoft version 2015 and software SPSS version 21.0. Shapiro-Wilk test was used for sample characterization, and to correlation test was performed the Kendall's Tau for linear multiple regression analysis. ROC curve was used to obtain the sensitivity and specification between participants with and without sleep disorders. Descriptive analysis was described through the table with median, standard deviation, minimum, maximum and quartile. Along with a descriptive table we used the t-test for an independent sample to verify the differences between each variable. Significance was established at $p < 0.05$.

Results

The sample was composed of 15 participants aged median 45.0 years old. The Pittsburgh scale was 6.00 (bad sleep quality), with 75% above 10 points. Table 1 shows that the body composition presented median neck fat of 39.5%, BMI of 42.3 kg/m^2 being that 75% was classified with grade III obesity, with neck circumference greater than 40 cm (sleep disturbance classification).

Table 1 - Clinic and body composition characteristics for total sample

Variables	Median	SD	Minimum	Maximum	Pct. 25	Pct. 50	Pct. 75	p-value
Age	45.00	11.10	20.00	62.00	34.00	45.00	50.00	0.00*
BMI (kg/m^2)	42.30	3.82	38.16	50.00	38.70	42.30	45.06	0.00*
Total mass (g)	106,338.20	15,365.12	89,217.90	152,038.70	102,448.90	106,338.20	115,883.40	0.00*
Height (m)	1.60	0.06	1.50	1.67	1.53	1.60	1.65	0.00*
Neck circ. (cm)	41.50	2.61	38.00	46.00	40.00	41.50	43.00	0.00*
Abdominal circ. (cm)	128.20	11.62	111.00	155.00	119.50	128.20	137.00	0.00*
Pittsburgh Score	6.00	3.89	3.00	14.00	4.00	6.00	12.00	0.00*
Abdominal fat (g)	5,702.20	480,662.70	3,453.00	150,2245.00	4,457.60	5,702.20	11,024.70	0.09
Neck fat (g)	858.40	308.43	401.30	1,430.40	548.50	858.40	1137,10	0.00*
Abdominal lean mass (g)	6,277.90	851,904.50	5,042.90	2,842,014.00	5,909.70	6,277.90	1,068,396.00	0.04**
Neck lean mass (g)	1514,30	410.87	607.60	1825,70	1078,70	1514,30	1682,40	0.00*
Visceral fat (g)	3,770.80	510,797.27	2,583.00	1,707,754.00	2,962.90	3,770.80	6,207.70	0.11
Abdominal fat (%)	46.90	5.59	32.20	55.80	44.60	46.90	49.80	0.00*
Visceral fat (%)	41.60	6.11	26.00	53.60	38.40	41.60	45.30	0.00*
Neck fat (%)	39.50	5.60	26.10	45.60	33.90	39.50	42.90	0.00*

Note: SD = standard deviation; Pct. = percentile; BMI = body mass index; circ. = circunference. *$p < 0.01$; **$p < 0.05$.

There was no correlation between Pittsburgh and the regions analyzed, nor a significant difference between the variables (Table 2). The regression analysis presented more influence between Pittsburgh scale and visceral fat, with values above neck fat, but both showed no statistically significant differences (Table 3). The ROC curve analysis showed that abdominal and visceral fat presented values nearest for sensibility and positive outcomes.

Table 2 - Correlation between Kendall's Tau and regions of interest and Pittsburgh scale

Pittsburgh Scale	Regions of interest		
	Abdominal fat	Neck fat	Visceral fat
Correlation coefficient	0.08	-0.20	0.08
Signficant (2 extremity)	0.69	0.32	0.69

Table 3 - Regression analysis for regions of interest with Pittsburgh scale

Region of interest	R2	Adjusted R2	Influence %	p-value
Neck fat	0.05	-0.02	5.00	0.41
Abdominal fat	0.00	-0.08	0.00	0.96
Visceral fat	0.08	0.01	8.00	0.29

Discussion

Sleep is an essential physiological need. Sleep quality assessment is necessary to analyze the presence of disorders, which can cause health consequences, such as appetite deregulation, stress, fatigue and obstructive sleep apnea syndrome.[11] During the phases of sleep, neurobiological processes such as changes in body temperature, maintenance of cardiac work and the production of anabolic hormones occur, leading to an essential state of restoration for the proper functioning of the organism.[12]

The study included 753 participants aged between 35 and 65, who were assessed using the PSQI. Weight, height and waist circumference were measured and there was a significant association of low quality of sleep with general obesity and high body fat in adults, this association being mainly driven by increased sleep latency, sleep disorders and daytime dysfunction.[13] In our study applying the PSQI in 15 participants aged 45.0 years old, the results shows that the Pittsburgh scale was 6.00 (bad sleep quality), with 75% above 10 points. In another study carried out by meta-analysis there was a strong correlation between obesity and insufficient hours of sleep.[14]

The present study demonstrated that the body composition obtained a median of fat in the neck of 39.5%, BMI of 42.3 kg/m^2, being that 75% were classified as grade III obesity, with neck circumference greater than 40 cm (sleep disturbance classification). The accumulation of fat can cause a decrease in lung capacity and alteration of the respiratory muscles, causing an increase in respiratory work. Thus, obese patients tend to compensate it by using more of the upper airways and less of the lower airways, which leads to a change in ventilation-perfusion and consequently to a clinical picture of hypoxemia.[15] In the same line, lack of adequate sleep time can cause excessive daytime sleepiness and naturally affect the performance of activities of daily living, what leads to a reduction in physical activities, resulting in decreased energy expenditure and, consequently, greater risk of developing obesity.[16]

In our study, the regression analysis showed a greater influence between the Pittsburgh scale and visceral fat, with values above those presented for the neck region, but both showed not statistically significant. However, other study with 303 patients (151 women and 152 men, aged 55 ± 17 years) with successfully treated malignant diseases or benign etiologies presented that neck fat expands differently with the increase in adiposity and correlates with factors of risk of cardiovascular diseases, being associated with metabolic syndrome.[17] The study also reports that neck circumference is a useful indicator of metabolic risk, although it is not independent of BMI.[17]

In our results the ROC curve analysis showed that abdominal and visceral fat presented values nearest for sensibility and positive outcomes. In a survey of 3,995 participants who were 18 years of age or older and were free from cardiovascular disease, cancer, emphysema, chronic pulmonary disease and depression, sleep disorders were associated with larger body size and higher measurements of body composition assessed by DXA, and this result was largely motivated by sleep apnea.[18]

Conclusion

The present study concluded that although the statistical data do not indicate a statistical correlation between neck and abdomen measurements analyzed by DXA with sleep quality, these measurements are of great importance as complementary measures for this purpose. The small sample used for the analysis together with the use of only a specific questionnaire without the technological resource of polysomnography for diagnostic definition were the main limitations of this investigation. Therefore, there is still a great need for new researches on the topic and mainly for new resources and diagnostic techniques.

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Authors' contributions

EMPR and OM were responsible for the coordination and design of the work, data analysis and, along with BCCL, CAP, KV and ABAJ, for writing the manuscript. KV, as a specialist in polysomnography and sleep disorders, reviewed the manuscript. All authors approved the final version.

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