ASSOCIATION BETWEEN BODY COMPOSITION AND FAT INFILTRATION IN THE LUMBAR MULTIFIDUS IN YOUNG ADULTS

ABSTRACT

Introduction: The increase in body fat is a natural and progressive process with aging, allowing fat infiltration in ectopic sites, such as skeletal muscle, which disrupts its function. Objective: To evaluate the association between body composition, fat infiltration into the low back multifidus muscles, and history of low back pain. Methods: This is a transversal and qualitative study that included young adult subjects of both sexes, and excluded individuals with neurological and musculoskeletal disorders and pregnant women. Fat infiltration into the multifidus and cross section area by magnetic resonance imaging; body composition by Dual-energy X-ray absorptiometry (DXA), and physical activity level determined by the International Physical Activity Questionnaire (IPAQ) were evaluated. The sample was divided by sex and. Pearson and Spearman’s correlation and stepwise linear regression were performed. For this study, a p<0.05, a level of significance of 5% and confidence interval of 95% were adopted. Results: Thirty-two individuals were evaluated (59.37% women; 40.63% men). There was a correlation between fat percentage and total cross-sectional area (CSAtotal, r=0.525; p=0.021), in women, and with lean abdominal mass (r=-0.648; p=0.017) and Body Mass Index (BMI) (r=-0.644; p=0.018) in men. There was also an association, in women, between fat percentage and cross section area (R²=0.275; p=0.021; CI: 0.364 – 3.925) and, in men, with lean abdominal mass (R²=0.420; p=0.017; CI: -9.981 - [-1.235]). Conclusion: There was correlation between fat percentage in the multifidus and CSA in women, and lean abdominal mass and BMI in men. There was also an association between fat percentage and cross section area in women, and lean abdominal mass in men. However, there was no evidence of any correlation between pain and low back dysfunction. Level of evidence I; Diagnostic studies - Investigating a diagnostic test.

Keywords: Body composition; Adipose tissue; Paraspinal muscles; Magnetic resonance imaging.

RESUMO

Introdução: O aumento da gordura corporal é um processo natural e progressivo com a idade, propiciando a infiltração de gordura em locais ectópicos, como por exemplo, na musculatura esquelética, o que prejudica sua função. Objetivo: Avaliar a associação entre a composição corporal e a infiltração de gordura nos músculos multifídos lombares e o histórico de dores lombares. Métodos: Estudo transversal e quantitativo em que foram incluídos adultos jovens de ambos os sexos e excluídos indivíduos com distúrbios neurológicos, musculosqueléticos e grávidas. Avaliou-se a infiltração de gordura nos multifídos e a área de secção transversa por meio de ressonância magnética; a composição corporal por meio de Absorciometria com raios-X de Dupla Energia (DXA), e o nível de atividade física através do Questionário Internacional de Atividade Física (IPAQ). A amostra foi dividida por sexo e feita sua respectiva caracterização, correlação de Pearson e Spearman e regressão linear stepwise. Foi adotado o valor de p<0.05, nível de significância de 5% e intervalo de confiança de 95%. Resultados: Foram avaliados 32 indivíduos (59,37% mulheres; 40,63% homens). Houve correlação entre o percentual de gordura e a área de secção transversa total (ASTtotal, r=0,525; p=0,021), nas mulheres, e com a massa magra abdominal (r=-0,648; p=0,017) e Índice de Massa Corporal (IMC) (r=-0,644; p=0,018) nos homens. E associação, nas mulheres, entre o percentual de gordura e a área de secção transversa (R²=0,275; p=0,021; IC: 0,364 – 3,925) e, nos homens, com a massa magra abdominal (R²=0,420; p=0,017; IC: -9,981 - [-1,235]). Conclusão: Encontrou-se correlação entre o percentual de gordura nos multifídos e a AST, nas mulheres, e com a massa magra abdominal e IMC para as mulheres, além da associação entre o percentual de gordura a área de secção transversa, para as mulheres, e com a massa magra abdominal para os homens. Entretanto, não foi evidenciada nenhuma correlação com dor e disfunções na coluna lombar. Nível de evidência I; Estudos diagnósticos - Investigação de um exame para diagnóstico.

Descritores: Composição corporal; Téciado adiposo; Músculos paraespinais; Ressonância magnética.

RESUMEN

Introducción: El aumento de la grasa corporal es un proceso natural y progresivo con la edad, propiciando la infiltración de grasa en lugares ectópicos, como, por ejemplo, en la musculatura esquelética, lo que perjudica su función. Objetivo: Evaluar la asociación entre la composición corporal y la infiltración de grasa en los músculos multifídos lombares en adultos jovens.

Keywords: Composición corporal; Téciado adiposo; Músculos paraespinales; Ressonância magnética.

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RESUMEN

INTRODUCTION: The increase in body fat is a natural and progressive process with aging, allowing fat infiltration in ectopic sites, such as skeletal muscle, which disrupts its function. Object: To evaluate the association between body composition, fat infiltration into the low back multifidus muscles, and history of low back pain. Methods: This is a transversal and qualitative study that included young adult subjects of both sexes, and excluded individuals with neurological and musculoskeletal disorders and pregnant women. Fat infiltration into the multifidus and cross section area by magnetic resonance imaging; body composition by Dual-energy X-ray absorptiometry (DXA), and physical activity level determined by the International Physical Activity Questionnaire (IPAQ) were evaluated. The sample was divided by sex. Pearson and Spearman’s correlation and stepwise linear regression were performed. For this study, a p<0.05, a level of significance of 5% and confidence interval of 95% were adopted. Results: Thirty-two individuals were evaluated (59.37% women; 40.63% men). There was a correlation between fat percentage and total cross-sectional area (CSAtotal, r=0.525; p=0.021), in women, and with lean abdominal mass (r=-0.648; p=0.017) and Body Mass Index (BMI) (r=-0.644; p=0.018) in men. There was also an association, in women, between fat percentage and cross section area (R²=0.275; p=0.021; CI: 0.364 – 3.925) and, in men, with lean abdominal mass (R²=0.420; p=0.017; CI: -9.981 - [-1.235]). Conclusion: There was correlation between fat percentage in the multifidus and CSA in women, and lean abdominal mass and BMI in men. There was also an association between fat percentage and cross section area in women, and lean abdominal mass in men. However, there was no evidence of any correlation between pain and low back dysfunction. Level of evidence I; Diagnostic studies - Investigating a diagnostic test.

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INTRODUCTION: El aumento de la grasa corporal es un proceso natural y progresivo con la edad, propiciando la infiltración de grasa en lugares ectópicos, como, por ejemplo, en la musculatura esquelética, lo que perjudica su función. Objetivo: Evaluar la asociación entre la composición corporal y la infiltración de grasa en los músculos multifídos lombares en adultos jovens.

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lumbares y el historial de dolores lumbares. Métodos: Estudio transversal y cuantitativo en el que fueron incluidos adultos jóvenes de ambos sexos, y excluidos individuos con disturbios neurológicos, musculoesqueléticos y gestantes. Se evaluó la infiltración de grasa en los múltiplos y el área de sección transversa por medio de resonancia magnética; la composición corporal por medio de Absorciometría con rayos X de Doble Energía (DXA) y el nivel de actividad física a través del Cuestionario Internacional de Actividad Física (IPAQ). La muestra fue dividida por sexo y fue hecha su respectiva caracterización, correlación de Pearson y Spearman y regresión lineal stepwise. Fue adoptado el valor de p <0,05, nivel de significancia de 5% e intervalo de confianza de 95%. Resultados: Se evaluaron 32 individuos (59,37% mujeres, 40,63% hombres). Hubo correlación entre el porcentaje de grasa y el área de sección transversa (ASTtotal) (r = 0,525, p = 0,021), en las mujeres, y con la masa magra abdominal (r = -0,648, p = 0,017) e Índice de Masa Corporal (IMC) (r = -0,644, p = 0,018) en los hombres, y asociación, en las mujeres, entre el porcentaje de grasa y el área de sección transversa (R² = 0,275; p = 0,021; IC = 0,364 - 3,925) y, en los hombres, con la masa magra abdominal (R² = 0,420; p = 0,017; IC = -9,981 - 1,235). Conclusión: Se encontró correlación entre el porcentaje de grasa en los múltiplos y la AST en las mujeres, y masa magra abdominal e IMC para los hombres, además de la asociación entre el porcentaje de grasa y el área de sección transversa, para las mujeres, y con la masa magra abdominal para los hombres. Entretanto, no fue evidenciada ninguna correlación con dolor y disfunciones en la columna lumbar. Nivel de evidencia I; Estudios diagnósticos – Investigación de un examen para diagnóstico.

Descriptores: Composición corporal; Tejido adiposo; Músculos paraespinales; Resonancia magnética.

INTRODUCTION

The fat deposition in interleaved adipocyte among the muscular fiber feature the fat infiltration, the intramuscular adipose tissue (TAI)\(^{1,2}\). Among the factor that can lead to TAI, may be female, because they have a physiological higher percentage of fat; age, because the misfunction of lipidic metabolism; and the body composition, because the excess of free floating fat\(^{1,3–6}\).

The TAI results in decrease of strength production and muscular mass, consequently, function decrease\(^{1,3}\), as relation of a transverse section area decrease, although there are controversial researches these alterations are commonly reported in this musculature\(^{1,3,7,8}\). At lumbar spine musculature, the lumbar multifidus (LM) shows higher predisposition for infiltration and like one of the main stabilization muscle of lumbar spine it may result in lumbar pain\(^{7,9}\).

The studies focus in female elderly, rare among adult population. In this sense, this study aims to evaluate the association between fat infiltration percentage in lumbar muscles, the body composition and history of pain and lumbar spine misfunction in young adults of both sexes.

METHODS

Study type and Sample

Transversal and quantitative study, developed at Recife/PE-Brazil, from September of 2016 to march of 2017, attached to Universidade Federal de Pernambuco (UFPE) and with the approval of this university Committee of Ethic and Research (Advice Number: 1.479.824). The participation of the study was ensured by reading and signing an Informed Consent (IC)

There was included subjects young adults from both genders, with and without lumbar pain and excluded the subjects with neurological, musculoskeletal (fractures, abnormalities, trauma history or spine surgery), pregnant, body with metal pieces and claustrophobic history. The sample was composed by 32 volunteers stratified by gender.

Observational Desing:

The evaluation was performed over two days and all of them made over the first day, except the fat infiltration evaluation, performed at the same week of the first gathering.

Fat infiltration and Multifidus CSA: through magnetic resonance (Signa HDxt 1.5T - GE Healthcare, Wisconsin, United States), in axial T1, with cutting thickness of 5mm (Figure 1).

Figure 1. Axial T1-weighted image shows the lumbar multifidus in L5. The dashed line delimits the multifidus lumbar muscle, the arrows point to the fat infiltration.

It was standardized for analysis the images that correspond with the superior edge of L5 and observed with software ImageJ 1.50i (National Institute of Health, USA). It was measured a. the total cross-sectional area (CSA\(_{\text{total}}\)), that comprehends the muscle and the fat infiltration; b. the fat-free cross-sectional area (CSA\(_{\text{fatfree}}\)), with the muscular mass; c. the fat cross-sectional area (CSA\(_{\text{fat}}\)), muscle fat infiltration area. Them, it was quantified the multifidus fat percentage (Multifidus fat percentage = CSA\(_{\text{fat}}\)/CSA\(_{\text{total}}\) x 100) by Color Threshold\(^{7}\) method.

Body Composition. It was evaluated the percentage of body and abdominal fat, lean body and abdominal mass and free-fat mass through Double Energy Radiologic Absormetry (DXA) - Lunar Prodigy Primo (GE Medical Systems Lunar, Wisconsin, United States).

Physical activity level. It was used the International Physics Activity Questionnaire (IPAQ), short way, self-applied and referring to the last week\(^{10}\). To determine the weekly energy expenditure, it was attributed the value of Metabolic Equivalent Estimate (MET) for each activity (Walk: 3.3 MET; moderate: 4 MET; vigorous: 8 MET) and multiplied by the frequency and duration in minutes\(^{11}\). For the weekly caloric expenditure the MET weekly value was multiplied by the weight and divided by 60 min\(^{11}\).
RESULTS

The research was made with 32 volunteers of which 59.37% women (n=19), 40.63% men, with characterization between groups for anthropometric measures, body composition, multifidus CSA and physical activity level presented in Table 1.

Regarding lumbar pain, 65.6% (n=21) of the volunteers reported any episode in last three months, more frequently between women (71.43%; n=15), comparing to men (28.57%; n=6). However, at the gathering time, 22.0% (n=7) of the volunteers noticed a positive moderate correlation (r=0.525; p=0.021) with CSAtotal of 1,2 (±0.389) and 1, for women and men, respectively. 25% (n=8) of the volunteers noticed a positive moderate correlation between multifidus fat percentage and the predicted variables. The collected data were tabulated and processed by the software Statistical Package for the Social Sciences (SPSS), 22.0 version. It was adopted the p-value < 0.05 for all analysis.

For statistical analysis of correlation and association there was chosen the Pearson Correlation, to normal variables and Spearman, to variables outside normality. The results of correlation were classified as weak (<0.4), moderate (0.4 – 0.7) and strong (>0.7)11. Then, it was applied the stepwise multiple linear regression between multifidus fat percentage and the predicted variables. The collected data were tabulated and processed by the software Statistical Package for the Social Sciences (SPSS), 22.0 version. It was adopted the p-value < 0.05 for all analysis.

Table 1. Baseline participant characteristics related to anthropometric measurements, body composition, multifidus CSA and physical activity.

| VARIABLES                        | Total sample (n=32) | Gender |            |            |            |            |            |            |
|----------------------------------|---------------------|--------|-----------|-----------|-----------|-----------|-----------|-----------|
|                                  | Media               | SD     | Male (n=13) |           | Female (n=19) |           |           |           |
| Age (yr)                         | 25.97 ±2.148        |        | 25.74 ±2.377 |          | 26.31 ±1.797 |          | 0.469     |           |
| Weight (kg)                      | 66.775 ±14.941      |        | 60.026 ±11.166 |        | 76.638 ±14.566 |        | 0.017*    |           |
| Height (cm)                      | 167.61 ±68.582      |        | 162.45 ±4.746 |          | 175.15 ±7.235 |          | <0.001*   |           |
| BMI (kg/m²)                      | 23.554 ±4.122       |        | 22.716 ±4.048 |          | 24.779 ±4.071 |          | 0.168     |           |
| WC (cm)                          | 80.453 ±12.993      |        | 76.763 ±11.802 |        | 85.846 ±13.196 |        | 0.06      |           |
| WHR                              | 0.79 ±0.715         |        | 0.76 ±0.660 |          | 0.835 ±0.553 |          | 0.002*    |           |
| Body fat percentage (%)          | 32.9 ±8.908         |        | 37.287 ±7.141 |          | 26.5 ±7.333 |          | <0.001*   |           |
| Abdominal fat percentage (%)     | 32.221 ±11.748      |        | 34.926 ±11.412 |        | 28.269 ±11.520 |        | 0.117     |           |
| Lean body mass (Kg)              | 42.886 ±10.432      |        | 35.718 ±4.538 |          | 53.361 ±7.055 |          | <0.001*   |           |
| Lean abdominal mass (Kg)         | 3.005 ±0.770        |        | 2.493 ±0.295 |          | 3.753 ±0.642 |          | <0.001*   |           |
| Fat-free mass (Kg)               | 45.243 ±10.711      |        | 37.903 ±4.710 |          | 55.97 ±7.293 |          | <0.001*   |           |
| Multifidus total CSA (cm²)       | 21.085 ±7.876       |        | 21.234 ±7.866 |          | 24.566 ±7.981 |          | 0.183     |           |
| Multifidus fat-free CSA (cm²)    | 2.382 ±0.996        |        | 2.576 ±1.015 |          | 2.096 ±0.931 |          | 0.168     |           |
| Multifidus fat percentage (%)    | 8.947 ±2.329        |        | 7.812 ±1.515 |          | 10.519 ±2.462 |          | 0.001*    |           |
| Multifidus fat CSA (cm²)         | 2.841 ±2.121        |        | 2.972 ±1.680 |          | 3.106 ±1.931 |          | 0.001*    |           |
| Energy expenditure (MET-min/sem) | 1757.406 ±1898.803  |        | 1500.789 ±1243.702 |        | 2059.384 ±2612.950 |        | 0.007     |           |
| Caloric expenditure (Kcal/min/sem) | 2014.187 ±2443.223 |        | 1607.038 ±1381.830 |        | 2609.251 ±3451.164 |        | 0.94      |           |

Table 2. Correlation between the multifidus fat percentage and anthropometric measurements, body composition, multifidus CSA and physical activity.

| VARIABLES                        | Female (n=19) | Male (n=13) | r P-value | r P-value |
|----------------------------------|--------------|-------------|-----------|-----------|
| Age                              | 0.097        | 0.692       | -0.096   | 0.754     |
| Weight                           | 0.329        | 0.17        | -0.538   | 0.058     |
| Height                           | 0.316        | 0.187       | -0.006   | 0.985     |
| BMI                              | 0.225        | 0.353       | -0.644   | 0.018*    |
| WC                               | 0.23         | 0.344       | -0.327   | 0.065     |
| WHR                              | 0.072        | 0.769       | -0.362   | 0.224     |
| Body fat                         | 0.232        | 0.339       | -0.45    | 0.123     |
| Abdominal fat                    | 0.287        | 0.234       | -0.405   | 0.169     |
| Lean body mass                   | 0.216        | 0.374       | -0.385   | 0.194     |
| Lean abdominal mass              | 0.294        | 0.222       | -0.648   | 0.017*    |
| Fat-free mass                    | 0.214        | 0.38        | -0.369   | 0.214     |
| Multifidus total CSA             | 0.525        | 0.021*      | -0.092   | 0.764     |
| Multifidus fat-free CSA          | -0.09        | 0.714       | 0.354    | 0.235     |
| IPAQ                             | -1.20        | 0.626       | 0.178    | 0.56      |
| Energy expenditure               | -1.49        | 0.060       | 0.099    | 0.758     |

Table 3. Regression between the multifidus fat percentage and the abdominal lean mass in males.

| VARIABLES                        | Coefficient | Standard error | CI                  | P-value |
|----------------------------------|-------------|----------------|---------------------|---------|
| Intercept                        | 38.188      | 7.558          | 21.552–54.824       | <0.001* |
| Lean abdominal mass              | -6.608      | 1.987          | -9.981 to -3.235    | 0.001*  |

4 Independent Samples T-Test; BMI: Body Mass Index; WC: Waist circumference; WHR: Waist-hip ratio; CSA: Cross-sectional area; IPAQ: International Physical Activity Questionnaire; * p< 0.05.
DISCUSSION

There was noticed a moderate correlation and positive association between multifidus fat percentage and CSA in women and negative moderate correlation among BMI and lean abdominal mass in men. However, was not found correlation between pain and dysfunction in lumbar spine. Men got higher averages of anthropometric measures and higher values related to lean mass body both abdominal and free-fat body mass as observed by another studies. As well as muscle CSA was higher too. In women, the percentage of superior body fat match the expected physiological result for this population and showed in the National Health and Nutrition Examination Survey (NHANES) study with evaluation of body composition using DXA. Like the fat percentage in multifidus that also follow the total body distribution in women.

In men, the fat percentage in lumbar multifidus negatively correlated with lean abdominal mass as showed by another studies. Therefore we estimate the lean circumscribed mass to the lumbar multifidus practice higher influence over the fat percentage than the fat related measures and we should evaluate it to investigate fat infiltration.

CONCLUSION

It was evident association between LM fat percentage and CSA in women, suggesting that CSA may increase due the fat infiltration present in LM. In men the LM fat percentage was inversely associated with lean mass, leading to consider it as main factor in young adults fat infiltration presence. It is suggested that investigations may be performed to make the findings more accessible like adipometer and bioimpedance and ultrasound, even gold pattern, magnetic resonance and DXA are high cost gadgets.

Although the lumbar multifidus fat (ML) has presented correlation with BMI in different thigh muscles and none correlation for paravertebral muscles, in LM we found negative and moderate correlation. As the measure of BMI includes lean mass, we presume it influences the relation between these too variables.

In women there was correlation and association between fat multifidus percentage and CSA, estimating this relation with the multifidus area is due the higher space available for intramuscular fat deposition. These findings diverge from a study made in elderly that showed decrease of CSA, however, this decrease can be due an natural reduction of muscular mass in elderly.

The limitations of this study refer to the absence of investigation of others factors as protein supplementation and vitamin D concentration, directly attached to adipocyte deposition and muscle function evaluation.

All authors declare no potential conflict of interest related to this article.

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