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

ASSOCIAÇÃO ENTRE A COMPOSIÇÃO CORPORAL E A INFILTRAÇÃO DE GORDURA NOS MULTÍFIDOS LOMBARES EM ADULTOS JOVENS

ASOCIACIÓN ENTRE LA COMPOSICIÓN CORPORAL Y LA INFILTRACIÓN DE GRASA EN LOS MULTÍFIDOS LUMBARES EN ADULTOS JÓVENES

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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 (CSA_{total}) (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 (R^2=0.275; p=0.021; CI=0.364 – 3.925) and, in men, with lean abdominal mass (R^2=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 multífidos 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, musculoesqueléticos e grávidas. Avaliou-se a infiltração de gordura nos multífidos 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 (AST_{total}) (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 (R^2=0,275; p=0,021; IC=0,364 - 3,925) e, nos homens, com a massa magra abdominal (R^2=0,420; p=0,017; IC: -9,981- [-1,235]). Conclusão: Encontrou-se correlação entre o percentual de gordura nos multífidos e a AST, nas mulheres, e com a massa magra abdominal e IMC para os homens, além da associação entre o percentual de gordura e 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; Tecido 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 multífidos 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 multífidos 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 (AST_{total}) (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 (R^2 = 0,275; p = 0,021; IC = 0,364 - 3,925) y, en los hombres, con la masa magra abdominal (R^2 = 0,420; p = 0,017; IC: -9,981- [-1,235]). Conclusión: Se encontró correlación entre el porcentaje de grasa en los multífidos 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.*

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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 lumber multifidus (LM) shows higher predisposition for infiltration and like one of the main stabilization muscle of lumber spine it may result in lumbar pain[2,9].

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 Etic 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).

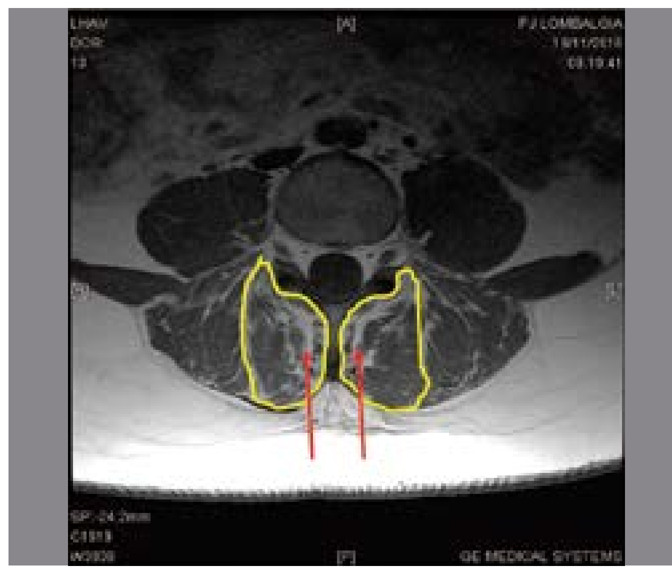

Figure 1. Axial T1-weighted image shows the lumbar multifidus in L5. The dashed line delimits the multifidus lumbar muscle, the arrows point to the fat infiltration.

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_{total}), that comprehends the muscle and the fat inlfiltration; b. the fat-free cross-sectional area ($CSA_{fatfree}$), with the muscular mass; c. the fat cross-sectional area (CSA_{fat}), muscle fat infiltration area. Them, it was quantified the multifidus fat percentage (Multifidus fat percentage = CSA_{fat}/CSA_{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].

History of lumbar pain. It was investigated the occurrence of lumbar pain in the last three months and applied the Oswestry Functional Index (IFO) to evaluate the pain and the intensity by the time of gathering[12].

Statistical Analysis

It was performed the *Shapiro-Wilk* test to verify the normality of variables. Then, to compare the averages between male and female was used the Independent Samples t-Test for the normal variables and *Mann-Whitney* for the outside normality, beside the exactly test of *Fisher* for categoric variables.

It was applied the *Pearson* Correlation, to normal variables and *Spearman*, to variables outside normality. The results of correlation were classifieds as weak (<0.4), moderate (0.4 – 0.7) and strong (>0.7)[13]. 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.

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, only 37.5% (n=12) reported lumbar pain with higher occurrence in women (75%; n=9) comparing to men (25%; n=3) and pain intensity average of 1,2 (±0.389) and 1, for women and men, respectively. 25% (n=8) of the volunteers showed musculoskeletal disfunction of the lumbar spine, more frequently in men (75%; n=6) comparing to women (25%; n=2).

For statistical analysis of correlation and association there was chosen the left multifidus. Regarding multifidus fat percentage there was noticed a positive moderate correlation (r=0.525; p=0.021) with CSA_{total} of the multifidus for women. A negative moderate correlation between the quantity of lean abdominal mass (r= -0.648; p=0.017) and the body mass index (BMI) (r= -0.644; p=0.018) (Table 2).

For men, the regression linear pattern correlated 42% of the data, with F test (F=7.967), used to check the model suitability, showed p-value of 0.017 and standard combings of 1.489 to 2.114 (Table 3).

For women, the regression linear pattern correlated 27.5% of data variability, with test F (F=6.456), showing p-value of 0.021 and standard combings of -1.428 to 2.484 (Table 4).

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

Variables	Multifidus fat percentage			
	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	-0.527	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				
Energy expenditure	-.120	.626	0.178	0.56
Caloric expenditure	-.141	.566	0.15	0.624
Pain intensity (0-5)	.439	.060	-0.095	0.758

r: Pearson correlation; BMI: Body Mass Index; WC: Waist circumference; WHR: Waist-hip ratio; CSA: Cross-sectional area; IPAQ: International Physical Activity Questionnaire; *p< 0.05

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

VARIABLES	Multifidus fat percentage			
	Coefficient	Standard error	CI	P-value
Intercept	38.188	7.558	21.552; 54.824	<0.001*
Lean abdominal mass	-5.608	1.987	-9.981; -1.235	0.017*

Adjusted R=0.420; P=0.017; *p<0.05; CI: Confidence Interval of 95%.

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

VARIABLES			Gender				
	Total sample (n=32)		Female (n=19)		Male (n=13)		
	Media	SD	Media	SD	Media	SD	P-value[a]
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	0.001*
Height (cm)	167.61	±8.582	162.45	±4.746	175.15	±7.255	<0.001*
BMI ($kg.m^{-2}$)	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	0.05
WHR	0.79	±0.715	0.76	±0.660	0.835	±0.553	0.002*
Body fat percentage (%)	32.9	±8.908	37.278	±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	±4.558	53.361	±7.055	<0.001*
Lean abdominal mass (Kg)	3.005	±0.778	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 (cm^2)							
Left	11.4781	±2.646	10.656	±2.276	12.679	±2.771	0.031*
Right	11.323	±2.400	10.551	±2.054	10.356	±1.931	0.025*
Multifidus fat-free CSA (cm^2)							
Left	8.947	±2.329	7.872	±1.515	10.519	±2.462	0.001*
Right	8.941	±2.121	7.972	±1.680	10.356	±1.931	0.001*
Multifidus fat CSA (cm^2)							
Left	2.53	±1.221	2.783	±1.415	2.159	±0.775	0.159
Right	2.382	±0.996	2.578	±1.015	2.096	±0.931	0.183
Multifidus fat percentage (%)							
Left	21,885	±8.839	25.134	±9.304	17.137	±5.555	0.009*
Right	21.085	±7.876	24.213	±7.866	16.512	±5.410	0.005*
IPAQ							
Energy expenditure (MET-min/sem)	1757.406	±1898.803	1550.789	±1243.702	2059.384	±2612.950	0.097
Caloric expenditure (Kcal/min-sem)	2014.187	±2443.223	1607.038	±1381.830	2609.251	±3451.164	0.94

[a]Independent Samples T-Test; BMI: Body Mass Index; WC: Waist circumference; WHR: Waist-hip ratio; CSA: Cross-sectional area; IPAQ: International Physical Activity Questionnaire; SD: Standard deviation; * p< 0.05.

Table 4. Regression between the multifidus fat percentage and the multifidus cross-sectional area in females.

Variables	Multifidus fat percentage			
	Coefficient	Standard error	CI	P-value
Intercept	2.284	9.185	-17.095; 21.664	0.807
CSA_{Total}	2.144	0.844	0.364; 3.925	0.021*

Adjusted R =0.275; P=0.021; *p<0.05; $CSA_{Total:}$ Total cross-sectional area; CI: Confidence Interval of 95%.

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 disfunction in lumbar spine.

Men got higher averages of anthropometric measures and higher values related to lean mass both body and abdominal and free-fat body mass as observed by another studies[14-17]. As well as muscle CSA was higher too[18,19]. In women, the percentage of superior body fat match the expected physiological result for this population[20,21] and showed in the *National Health and Nutrition Examination Survey* (NHANES) study with evaluation of body composition using DXA[19,22]. Like the fat percentage in multifidus that also follow the total body distribution in women[3,15].

In men, the fat percentage in lumbar multifidus negatively correlated with lean abdominal mass as showed by another studies[14,22-24], 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.

Although the lumbar multifidus fat (ML) has presented correlation with BMI in different thigh muscles[24,25] and none correlation for paravertebral muscles[25], 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_{total}, 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_{total}[26,27], however, this decrease can be due an natural reduction of muscular mass in elderly[5].

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.

CONCLUSION

It was evidente 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 golden pattern, magnetic resonance and DXA are high cost gadgets.

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

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