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INFLUENCE OF PHYSICAL ACTIVITY LEVEL AND BODY ADIPOSITY ON LUMBAR MULTIFIDUS MUSCLE FAT INFILTRATION OF LOW BACK PAIN INDIVIDUALS

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ABSTRACT

The stability of the spinal column is largely dependent on the integrity of the spinal muscles, especially the multifidus muscle. However, this important role of the multifidus muscle might be compromised due to both mechanical and non-mechanical causes leading to change in its contents, fat deposition and reduction in the cross-sectional area.This study was carried out to determine the influence of physical activity level and body adiposity indices on lumbar multifidus muscle (LMM) fatty infiltrationamong individuals with low back pain (LBP). This was a cross-sectional study in which 94 participants, male and female samples with non-specific LBP were recruited conveniently and assessed for LMM fat infiltration, pain intensity, functional disability, physical activity and socio-demographic variables. There were positive and moderate correlations between LMM fatty infiltration and body mass index (BMI) (r=0.575, p=0.001), waist circumference (WC) (r=0.514, p=0.001) and gender (r=0.409, p=0.001) for normally distributed data using Pearson moment correlation coefficient. For not normally distributed variables, LMM fatty infiltration was moderately and positively correlated with gender (r=0.422, p=0.001), %body fat (r=0.621, p=0.001), visceral fat (r=0.470, p=0.0001), Oswestry Disability Index (ODI) (r=0.238, p=0.021) and visual analogue scale (VAS) (r=0.232, p=0.024) respectively. However, there was a weak negative correlation between LMM fatty infiltration and occupation (r=-0.206, p=0.046). There were significant differences between male and female multifidus fat infiltration and body adiposity indices. There was a positive relationship between multifidus fatty infiltration and BMI, gender, %body fat, visceral mass, ODI and VAS, while we observed a negative relationship between lumbar multifidus fatty infiltration and occupation. Furthermore, the best correlate of lumbar multifidus fatty infiltration was %body fat.

Keywords: Multifidus, Muscle, fatty infiltration, low back pain, adiposity, physical activity

BACKGROUND

Low back pain (LBP) is an extremely common symptom experienced by people of all ages and a leading cause of disability worldwide (Hartvigsen *et al.,* 2018). In 2015, the global point prevalence of activity-limiting LBP was 7.3%, which implies that 540million people were affected at any one time (Hoy *et al.*, 2012). The largest increase in the disability caused by LBP in the last few decades have occurred in low income and middle income countries including Africa, Asia and the Middle East where health and social systems are not well equipped (Hoy *et al.*, 2015). In Africa, the lifetime prevalence of LBP has been estimated at around 28%–74%, which is almost comparable to the rates in Western societies (Louw et al., 2007). In Nigeria, one-year LBP prevalence has been reported between 33% and 74% among the adult population who are mainly workers (Bello and Adebayo, 2017).

LBP is a multifactorial disorder with many possible etiologiesand has been attributed to several biophysical factors while its maintenance associated with several psychosocial factors (Ramond-Roquin*et al.,* 2015). According to some researchers, large groups of the disorders of the lower back are predominantly mechanically induced and they lead to a maladaptive process that maintains the ongoing pain and can result in functional deficits (O'Sullivan*et al.*, 2003). There is evidence that individuals with LBP have altered motor control of specific muscles of the trunk particularly the transversus abdominis muscle and lumbar multifidus muscle (LMM) when the stability of the spine is challenged in dynamic tasks (i.e. perturbations) (Hodges and Richardson, 1998; Hodges & Richardson, 1999). Furthermore, studies have shown that abnormalities in the brain (altered brain structure and function) (Wand *et al.,* 2011), changes in lumbar tactile acuity (Luomajoki and Moseley, 2011), decreases in spinal mobility (Hodges*et al.,*2009), and compromises in postural control (Mok*et al.,*2007) were found to be present in patients' LBP compared to asymptomatic individuals.

Another important structural change linked with LBP is fat infiltration of the LMM. Fat infiltration of LMM is defined as the histological change in the distribution of fiber types and a reduction in the size of the muscle in patients with CLBP (Mannion, 1999) and intervertebral disc herniation (Cambell*et al,*1998). Lumbar muscle when degenerated may compromise spinal stability and jeopardize spinal health, potentially leading to further injury as described by Panjabi (1992). Fatty infiltrates arise because of atrophy of the skeletal musculature (Hides*et al.,*2008). A study by Kalichman*et al.*, (2010), suggested that altered paraspinal morphology such as fat penetration in the LMM might be related to increasing LBP and consequently low physical activity. In the same vein, Hides et al., (1996) reported that LMM with atrophy in the lower back on the painful side did not recover automatically following appropriate treatment protocols, which made them suggest that fatty infiltrates in the LMM have some correlation with persisting LBP. In contrast, Hultman *et al.*(1993) found no difference in paraspinal CSA or density, which is a substitute for fatty infiltration on CT during remission of intermittent LBP compared to healthy controls.

Morphological studies have shown an association between LMM fatty infiltration and LBP patients in high-income countries (Keller*et al.*, 2004; Le Huec*et al.,*2005). There is inconsistency in the relationship between high BMI, LMM fatty infiltration, and postural instability. Hence,Storheim, *et al.* (2017) advised on further prospective studies that will look into this relationship. Unfortunately, only a few studies on the multifidus fat infiltration have been conducted in sub-Saharan Africa bearing in mind that there is a high prevalence of excess weight and obesity among black Africans, especially Nigerians (Akindele*et al.*, 2016), such that slow learning among school children has been linked to obesity and overweight in Africa (Adom*et al.,*2017). A study was needed therefore to ascertain the influence of physical activity and body adiposity on LMM fatty infiltration among low back pain individuals from low resource African setting.

MATERIALS AND METHODS

The Ethics and Research Committee of Aminu Kano Teaching Hospital (AKTH) approved this cross-sectional study with number NHREC/21/08/2008/AKTH/EC/2631. The participants for this study were patients with non-specific low back pain attending general outpatient departments of Surgery and Physiotherapy Departments of AKTH using a purposive sampling technique. The setting for this study was a tertiary health institution with more than 700-bed spaces for admission and many outpatient specialty clinics. Participants with a previous history of spinal surgery, pregnancy, TB of the spine and those with a known cause of LBP were excluded from this study. Each participant was screened for NSLBP once referred for physiotherapy by a Physiotherapist who specializes in LBP management. A total number of 94 non-specific LBP individuals 18 years and above participated in this study, which formed 97.92% of the calculated sample size.

The instruments used for the collection of data for this study were Oswestry Disability Index (ODI) for low back pain disability, International Physical Activity Questionnaire (IPAQ) for physical activity level, diagnosticultra sound machine for LMM fat imaging, weighing scale to measure the weight and visceral fat of the participants and Stadiometer (Upsurge Medical Stadiometer ZT-120, Made in England)to measure the participants' height. Medison Accuvix V10 ultrasound scanner with a 3.7 MHz Curvilinear probe was used to determine the fat infiltration in the Lumbar Multifidus Muscle. Tanita Ironman electronic weighing scale (TANITA BC-549 plus IRONMAN^{R}, Tanita Corp., Tokyo, Japan), tape measure and Stadiometer were used.

Tanita Ironman electronic weighing scale was used to measure the participants' weight, %body fat and the visceral mass. Standard procedures as detailed in the manuals of the ultrasound machine, Tanita Ironman electronic weighing scale and Stadiometer were followed while collecting data.

Data analysis

Descriptive statistics of frequency, percentage, mean and standard deviation were used to reduce age, gender, and other sociodemographic details. Test of normality was carried out using Shapiro-Wilk and normally distributed variables were analysed using Pearson correlation coefficient while Spearman rho correlation coefficient was used for not normally distributed variables. Student's t-test was used to determine the differences between clinical variables among genders. Other variables were summarized with descriptive statistics. Multiple regression analysis was used to determine the predictor of lumbar multifidus fat infiltration using sociodemographic and body adiposity variables as independent variables while fat infiltration was used as a dependent variable. The data obtained was analyzed using the statistical package for social sciences (SPSS version 20.0) at a significant level of 0.05

RESULTS

A majority of the participants were male (55.3%), married (84%), had tertiary education (53.2%) whereas a significant number were self-employed (46.8%)and obese (37.2%). The socio-demographic characteristics of the participants are fully shown in Table 1 below.

Table1. Participants' socio-demographic characteristics

Variable	Frequency	Percentage (%)
Gender:		
Male	52	55.3
Female	42	44.7
Marital Status:		
Married	79	84
Single	12	12.8
Divorced	1	1.1
Widowed	2	2.1
Education Level:		
Not Educated	8	8.5
Primary	9	9.6
Secondary	27	28.7
Tertiary	50	53.2
Occupation		
Unemployed	13	13.8
Employed	34	36.2
Self Employed	44	46.8
Retired	3	3.2

Participants' clinical characteristics of pain, physical activity and disability distributions

Table 2 shows the participants' overall clinical characteristics in terms of pain at the lower back and physical activity levels. The table shows that more participants (47.9%) experienced severe pain, few (20.2%) experienced worst pain, while others (31.9%) had moderate pain based on the visual analogue scale measurement with 4.41±1.59 mean and standard deviation respectively. Based on the physical activity level, most of the participants (55.3%) recorded low MET minutes, few (25.5%) were moderately active, while very few (19.1%) were highly active and generally within 933.11±106.82 mean and standard deviations respectively.

The disability index measured indicated that some are minimally disabled (19.1%), moderately disabled (59.65), severely disabled (17.0%), while others (4.3%) were at the crippled stage.

The mean and standard deviation for the disability status was found to be 36.19±12.39. There were statistically significant differences between males and females when their lumbar multifidus %fat, BMI, WC, WHR and visceral fat were compared as shown in Table 2 below.

Table 2: Clinical Variables of the Participants

Variable	Male		Female		m±sd	t	p-value
	n	(%)	n	(%)			
Multifidus % fat					7.10±1.90	4.30	0.001*
Normal	43	45.7	25	26.6			
Slight	9	9.6	17	18.1			
Severe							
BMI					27.71±5.24	4.84	0.001*
Underweight	2	3.8	0	0			
Normal weight	22	42.3	4	9.5			
Overweight	16	30.8	15	35.7			
Obese	12	23.1	23	54.8			
WC					7.10±1.90	3.01	0.003*
Waist hip ratio					27.71±5.24	0.96	0.342
Low risk	45	86.5	10	23.8			
Moderate risk	6	11.5	3	7.1			
High risk	1	1.9	29	69.			
% body fat					7.10±1.90	13.35	0.001*
Visceral mass					27.71±5.24	2.57	0.013*
Healthy	45	86.5	37	88.1			
Excess	7	13.5	5	11.9			
Pain intensity					7.10±1.90	0.73	0.471
Mild pain	31	59.6	23	54.8			
Moderate pain	17	32.7	17	40.5			
Severe pain	4	7.7	2	4.8			
Disability index					27.71±5.24	0.59	0.554
Minimal disability	4	7.7	5	11.9			
Moderate disability	39	75	27	64.3			
Severe disability	7	13.5	7	16.7			
Crippling LBP	1	1.9	3	7.1			
Bedbound LBP	1	1.9	0	0			
PAL					7.10±1.90	0.07	0.943
Low PAL	30	57.7	22	52.4			
Moderate PAL	10	19.2	14	33.3			
High PAL	12	23.1	6	14.3			

Key: BMI=body mass index, WC=waist circumference, PAL=physical activity level,

There were positive and moderate correlations between LMM fatty infiltration and BMI (r=0.575, p=0.001), WC (r=0.514, p=0.001) and gender (r=0.409, p=0.001) for normally distributed data using Pearson moment correlation coefficient. For not normally distributed variables, LMM fatty infiltration was moderately and positively correlated with gender (r=0.422, p=0.001), %body fat (r=0.621, p=0.001), visceral fat (r=0.470, p=0.0001), ODI (r=0.238, p=0.021) and VAS (r=0.232, p=0.024) respectively. However, there was a weak negative correlation between LMM fatty infiltration and occupation (r=-0.206, p=0.046).

Table 3: Relationships between LMMF and Sociodemographic and clinical Variables

	LMMF	BMI	WC	%Body fat	Visceral fat	ODI	VAS	Gender	Occupation
LMMF									
r	1								
p									
BMI									
r	+0.575**	1							
p	0.000								
WC									
r	+0.514**	0.804**	1						
p	0.000	0.000							
%Body fat									
r	+0.621**	0.799**	0.681**	1					
p	0.000	0.000	0.000						
Visceral fat									
r	+0.470**	+0.736**	+0.705**	+0.643**	1				
p	0.000	0.000	0.000	0.000					
ODI									
r	+0.238*	0.065	+0.214*	0.100	0.140	1			
p	0.021	0.533	0.039	0.340	0.178				
VAS									
r	+0.232*	0.088	0.170	0.119	0.123	+0.691**	1		
p	0.024	0.398	0.102	0.253	0.239	0.000			
Gender									
r	0.422**	+0.444**	+0.380**	+0.799**	+0.302**	0.054	0.095	1	
p	0.000	0.000	0.000	0.000	0.003	0.605	0.360		
Occupation									
r	-0.206*	-0.128	-0.149	-0.299**	0.211**	-0.207*	-0.159	-0.345**	1
p	0.046	0.219	0.153	0.003	0.041	0.045	0.127	0.001	

Key:LMMF=lumbar multifidus muscle fat, BMI=body mass index, WC=waist circumference, ODI=Ostwestry disability index, VAS=visual analogue scale

The researchers ran a multiple regression to predict how PA (METs) and body adiposity (BMI, WHR, waist circumference, % body fat and visceral fat) influenced lumbar multifidus fatty infiltration among low back pain individuals. These variables statistically significantly predicted lumbar multifidus fatty, F(9,84)=15.96,p=0.000, R^2=0.426. Only %body fat statistically predicted lumbar muscle fatty infiltration (p=0.004) as shown in Table 4 below.

Table 4: Predictors of Lumbar Multifidus Fat Infiltration

Predictors	B	SEB	β	95% CI	p-value
PA	-9.478	0.000	-0.049	0.000-0.000	0.564
BMI	0.057	0.065	0.157	0.148-0.103	0.386
WHR	-0.078	3.322	-0.003	6.485-6.329	0.981
WC	0.025	0.027	0.166	0.027-0.078	0.341
%body fat	0.067	0.023	0.407	0.022-0.112	0.004**
Visceral fat	-0.023	0.063	-0.047	0.148-0.103	0.718
VAS	0.019	0.015	0.156	-0.010-0.048	0.207
AGE	0.003	0.018	0.021	-0.032-0.039	0.851

Key: PAL=physical activity level, BMI=body mass index, WHR= waist-hip ratio, WC=waist circumference, VAS= visual analogue scale

DISCUSSION

A majority of the participants were male, married, with half of them having tertiary education and less than halfself-employed. Most of the participants reported severe low back pain, low physical activity level and moderately disabled as a result of low back pain. There were significant differences between male and female multifidus fat infiltration, BMI, WC, %body fat and the visceral mass. There was a positive relationship between multifidus fatty infiltration and BMI, gender, %body fat, visceral mass, ODI and VAS, while the researchers observed a negative relationship between lumbar multifidus fatty infiltration and occupation. Furthermore, the best correlate of lumbar multifidus fatty infiltration was %body fat.

The researchers observed differences in the body adiposity indices between male and female participants. This has been reported in the literature earlier; female gender has a higher %body fat and deposition in different parts of the body (Karastergiou*et al.,*2012). This was earlier reported by Wu*et al.* (2001), that there was lower %body fat among adult men of all ages but this fat is usually located in the abdomen.

Lack of regular physical activity has been shown to confer various health hazards on the body. The outcome of this study shows that the participants had low physical activity level and some were moderately disabled. Alzahrani*et al.* (2019) reported an inverse relationship between low back pain and physical activity participation in a systematic review and meta-analysis of an observational study. Furthermore, LBP individuals with moderate/higher physical activity reported less pain and disability after 12 months of follow-up (Pinto *et al.,* 2014). The negative effects of pain on physical activity in low back pain patients has been attributed to the deconditioning model of low back pain which results from psychological effects (Storheim*et al.*, 2005), neuromuscular changes (Hammill*et al.,*2008) and physical functioning changes (Di Lorio et al., 2007) among others.

There was a positive relationship among multifidus fatty infiltration and BMI, %body fat, visceral mass, disability, pain andgender, whilethe researchers observed a negative relationship between lumbar multifidus fatty infiltration and occupation. A corresponding increase in BMI, gender, %body fat, visceral mass and disability leads to increase in the lumbar multifidus fatty infiltration as seen from this study. These findings are in line with the previous studies that show that multifidus fat infiltration is associated with BMI (Marcus*et al.,*2010; Hildebrandt*et al.,*2017), pain (Hides*et al.,*2008) and gender (Crawford et al., 2016).However, this is contrary to the findings of previous studies on patients with non-specific acute and CLBP and disc herniation (Kong*et al.,*2014). Furthermore, it was also found that significant relationship existed between severity of LMM fat infiltration and pain intensity (r=0.22,p=0.02), though weak, which was in line with the findings of Storheim*et al.* (2017) who found that fat infiltration correlated positively with pain intensity and disability patients with CLBP. Similarly, Kjaer*et al.*(2007) also reported that fatty infiltration in the LMM had a stronger correlation with LBP severity in the adult population than in adolescents.

Also, a study conducted by Poonam *et al.*(2016) on the role of MRI and Ultrasonography in the evaluation of multifidus muscle in CLBP patients found a positive correlation between pain severity and fat infiltration in the LMM. Although their study was strictly on CLBP patients, the findings of this study can be explained in terms of small sample size and a combination of both acute and chronic low back pain patients which is why the strength of the correlation was low (r=0.22,p=0.03).Percentage body fat, among other body adiposity indices measured was the only predictor of the lumbar multifidus fat infiltration among low back pain individuals.

This study also shows that there is a positive correlation between percentage body fat and pain intensity (r=0.73, p=0.001). In a large cross-sectional study on the relationship between body composition and LBP intensity and disability, a strong relationship between BMI and LBP intensity was found among the general population(Hussain et al., 2017), which is in harmony with the findings of the current study.

The outcome of this study should be interpreted with caution due to its limitations. The duration of the LBP was not taken into consideration while recruiting the participants for this study. Also, since this was a cross-sectional study, the causative effects of covariate and predictors of lumbar multifidus cannot be upheld.

CONCLUSION

The outcome of this study shows that there were gender differences in the body adiposities of the study participants. In addition, an increase in BMI, gender, %body fat, visceral mass, ODI and VAS leads to a corresponding increase in the lumbar multifidus fatty infiltration while the best correlate of lumbar multifidus fatty infiltration was %body fat.

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Authors' contribution

Study concept and design: MukadasAkindele, YamsatNandom Aaron

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Data entry, cleaning and analysis: YamsatNandom Aaron, MukadasAkindele, Musa Yusuf Dambele

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