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EVALUATION OF THE EFFECTS OF THE VOLUMES OF THE POSTERIOR AND ANTERIOR VERTEBRAL MUSCLES ESTAMAIATED FROM THE COMPUTED TOMOGRAPHY IMAGES ON THE LUMBAR LORDOSIS

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ABSTRACT

Aim: This study aims to analyze the relationship between prevertebral and postvertebral muscle volumes comparatively with PAL technique, (projection area per length squared) which is used to calculate the excessive curvature in lumbar region (lumbar lordosis) with quantitative (numerical) data, on radiological images of both genders, and the follow-up of the disease course before and after treatment with numerical data. **Material and Methods:** CT scan images were collected from Archival System of the Radiological Department of Ondokuz Mayis University Hospital in Samsun, Turkey, and used in this investigation. The data collecting procedure, 62 CT scan images for patients aged from (19 to 84) were obtained in supine position. Two different software are used to in this study, “Osiri X” which enables viewing the files in our image bank. With this software, the images in the files will be displayed in a single window in sagittal, coronal and transverse planes, oriented images were exported to DICOM file, the other application were used called (Image J), by this software the measurements of anterior (psoas major) and posterior (Para spinal, multifidus) muscles volume calculated, furthermore measuring the value of PAL it's also calculated. **Results:** findings indicated that there is no significant correlation between variables regardless of (Total): anterior volume, posterior volume and PAL. Moreover, there are no statistically significant correlations between anterior volume, posterior volume, and PAL in both genders, according to Pearson test. **Conclusion:** In line with findings, we think that knowing body mass index, height and weight, activity status and physical conditions, low back pain history and age-related fat changes in muscles volume due to the importance of these factors, and their direct relationship to muscles volume, in subsequent study they will be taken into account to include them with the data.

KEYWORDS: Lumbar lordosis, projection area length squared,psoas major, Para spinal, multifidus.

INTRODUCTION

The functional and clinical significance of lumbar lordosis has been increasingly recognized in research investigations.[1,2] It is well understood that lumbar lordosis, or the degree of lumbar curvature, plays a crucial role in maintaining spinal equilibrium.[3] Understanding the development of the human spinal column and the specific anatomical characteristics that enable lumbar lordosis may give insight into spine health and its degeneration, based on the distinctive upright posture and lordotic lumbar curvature of the human spine.[4] Researchers have concentrated their efforts on the back's bones, discs, and joints in the past. Nonetheless, the role of the muscular system in lumbar spine stabilization cannot be overstated.[5]The degree of lumbar lordosis is influenced by vertebral body wedging and disc shape, but it is also influenced by spinal muscle strength[6] and volume.[7] The lumbar spine muscles are divided into two groups depending on their location from the spine, the anterior (prevertebral) and posterior (postvertebral), the psoas major muscle represent the prevertebral group whereas postvertebral comprises transversospinalis (multifidus, rotatores, interspinales and intertransversarii) and erector spinae (iliocostalis and longissimus).[8] The psoas is widely known for its role as a major flexor of the hip joint[9], also it may function as a lumbar spine stabilizer[10], as well when bearing severe lumbar loads, it also acts as a controller of the lumbar lordosis.[11] In the same context, postvertebral muscles are crucial in regulating movement, providing mechanical stability, and determining the degree of lumbar lordosis.[7]

Fortunately, computer tomography (CT) can provide non-invasive morphologic information about these muscles with minimum radiation.[12,13] Like a reduction in the size of the muscles and an increase in the quantity of fat deposits by this advantage macroscopic indicators of muscle degeneration that may be clearly identified on CT scans.[14]

The projection area per length squared (PAL), which was employed to measure the degree of lumbar lordosis in this study; by Utilizing direct lateral roentgenograms is a unique and simple approach that may provide more representative findings than prior methods for lumbar lordosis evaluation. this technique discovered by Sahin and Kaplan (2008).[15] Therefore this study was planned to compare the changes in prevertebral and postvertebral muscle volumes between genders with the PAL technique, which enables the diagnosis of lumbar lordosis to be calculated quantitatively with radiological images, to establish the diagnosis and to follow the course of this disorder.

MATERIALS AND METHOD

The radiological department of Ondokuz Mayıs University Hospital provided the samples for this research. CT scan pictures of the spine, in particular, were obtained through ethical authorization from the Radiological Department's archive system, the medical research ethics committee approval was obtained with the official document numbered 14.09.2018, B.30.2.ODM.0.20.08 / 1873 (APPENDIX 1).. A total of 70 images were collected, however, eight of them were rejected owing to low resolution and therefore could not be processed by Image J. As a result, the final sample size was 62 (n = 62) of 31 women and 31 men aged 19-84 years (mean 45.5). The taken images ware in Computer Disk (CD) was first opened using Osiri X, which is a DICOM medical image viewer.

To clarify, this approach was utilized for image processing by selecting one picture from an already prepared file, copying it into the Osiri X database folder, and then selecting 3DMPR from the 3D Viewer tab. The pictures in the files were presented in a single window using the 3D MPR tool in sagittal, coronal, and transverse planes, and the CT image was brought to the orthogonal plan. To locate the umbilicus, the midline was shifted up and down significantly; the sternum and spinal column were in the same plane, which is known as the sagittal plane. One picture had been prepared and was ready to use (Figure 1).

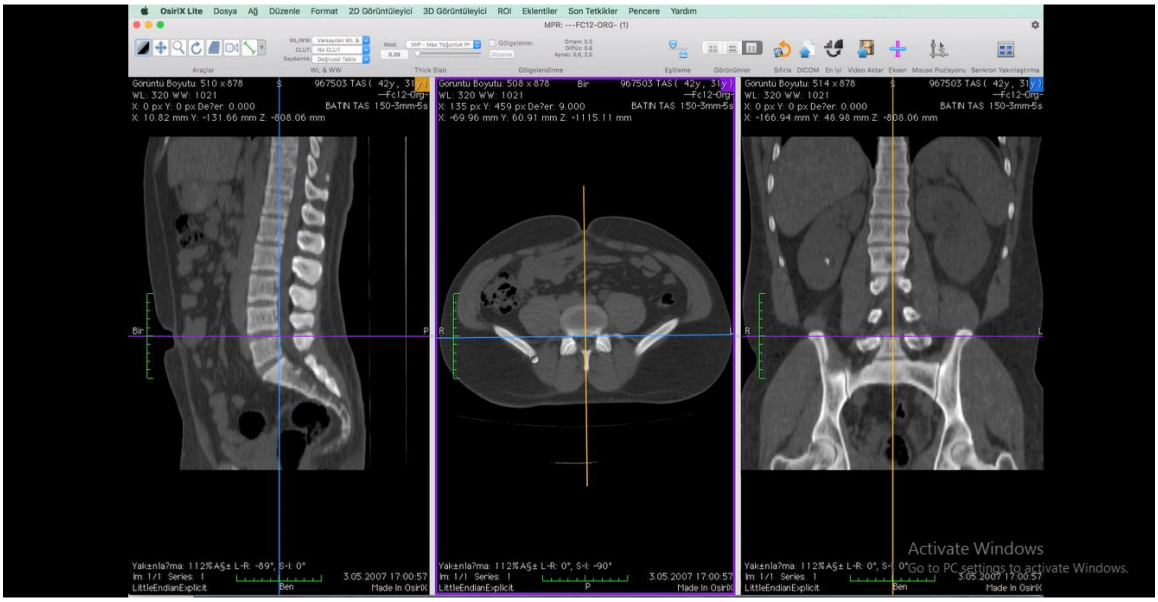

Figure 1: Osiris X program calibrated images.

Only the axial sections of the images brought to the orthogonal plane corresponding to the region between the upper edge of the lumbar 1st vertebra and the lower edge of the lumbar 5th vertebra were exported using the

OsiriX software. The sagittal image was opened in Image J, an image processing software developed by the National Institutes of Health in the United States. to calculate Pal, the region behind the Lumbar vertebra was estimated. A line has been drawn from the rear edge of L5 to the posterior edge of L1 using the (straight) feature in picture J, and the first calculation has been done by clicking on analyze measure or (Ctrl+m) (Figure 2).

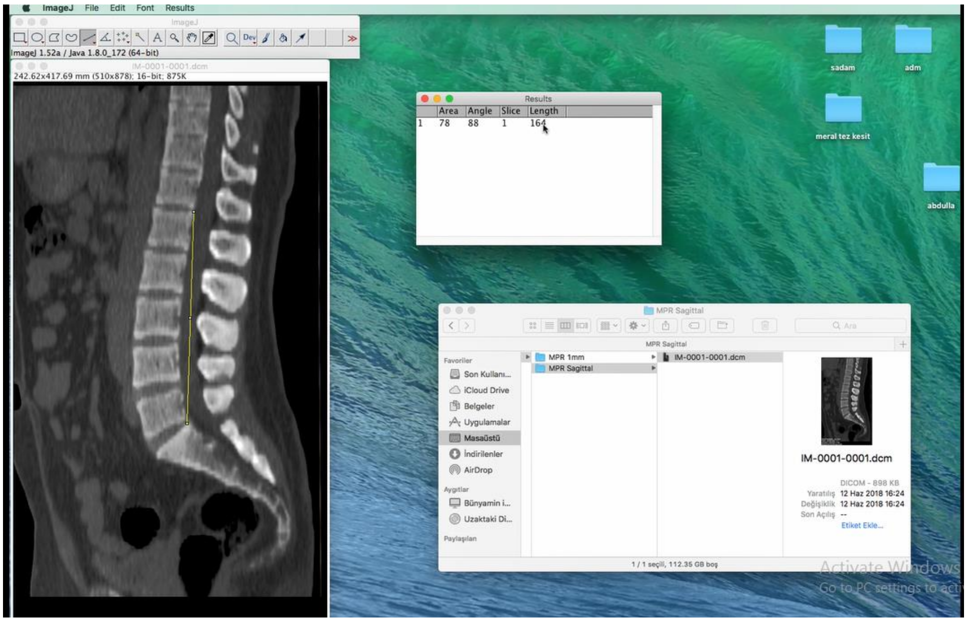

Figure 2: First calculation in sagittal view within image J software.

The second computation is done with the help of polygons (feature in image J) After drawing a line between the first and fifth lumbar vertebral bodies, the pointer was carried over the bodies (in the middle of the vertebrae bodies) (Figure 3). These two masurmeants were copied and pasted into a Microsoft Excel sheet.

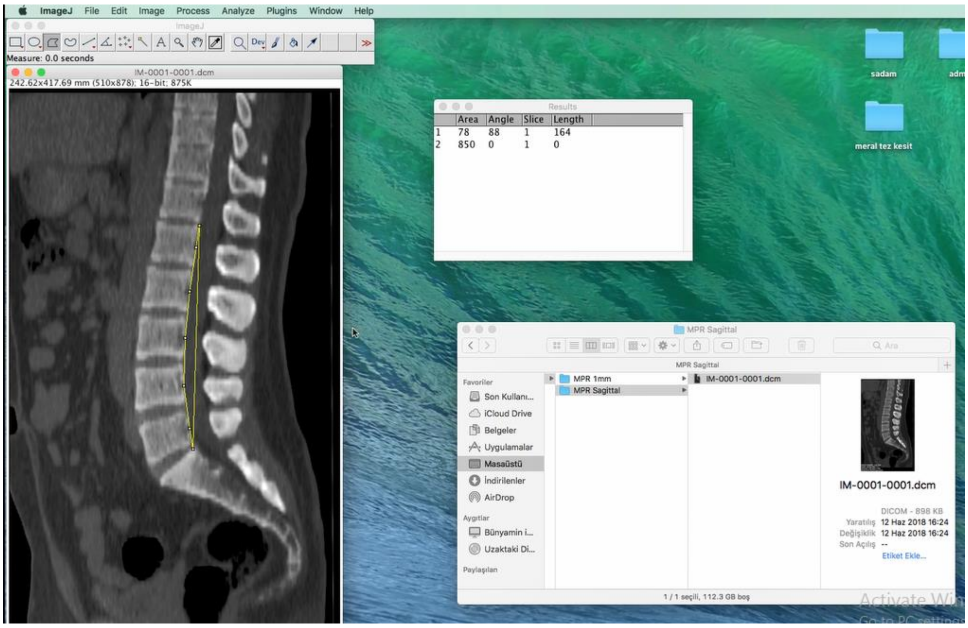

Figure 3: The second calculation proccess in sagittal veiw within.

İmage J software

The image in the axial plane from the image series fixed to the orthogonal plan was exported as a new file named (MPR 1mm), the section thickness had already been set to 1mm, and there was also an option to determine the thickness of the area (FROM – TARGET), FROM L1 to L5 which is the TARGET, with folder name (MPR 1mm). The pictures were then exported and saved as DICOM files (Figure 4).

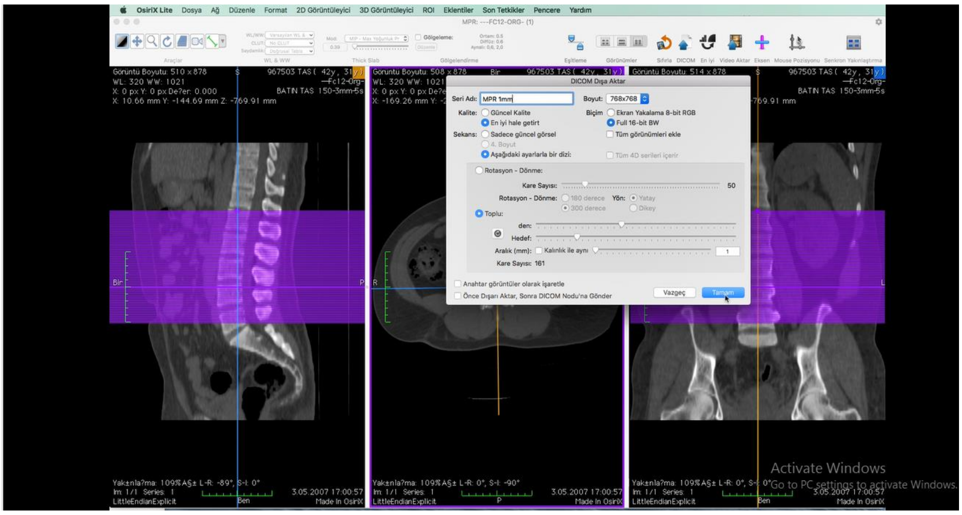

Figure 4: Exporting images as DICOM files.

In image J software, the axial image was opened; the number of radiography image sections between L1- L5 was so hight so they decreased by increasing the reduction facture to 10 mm, to get a reasoable number of images to be measured. The muscles volume was calculated in Image J using the (Polygon and freehand) feature, which is a Selection feature. In each part utilized in the volume computation, the information of each individual's psoas major muscle and erectile spine muscle for each patient, the number og image sections in which muscle volumes were calculated ranged from 13 to 17 imeges, according to the length of the distance between the L1 and L5, which varies from one patient to other. (Figure 5).

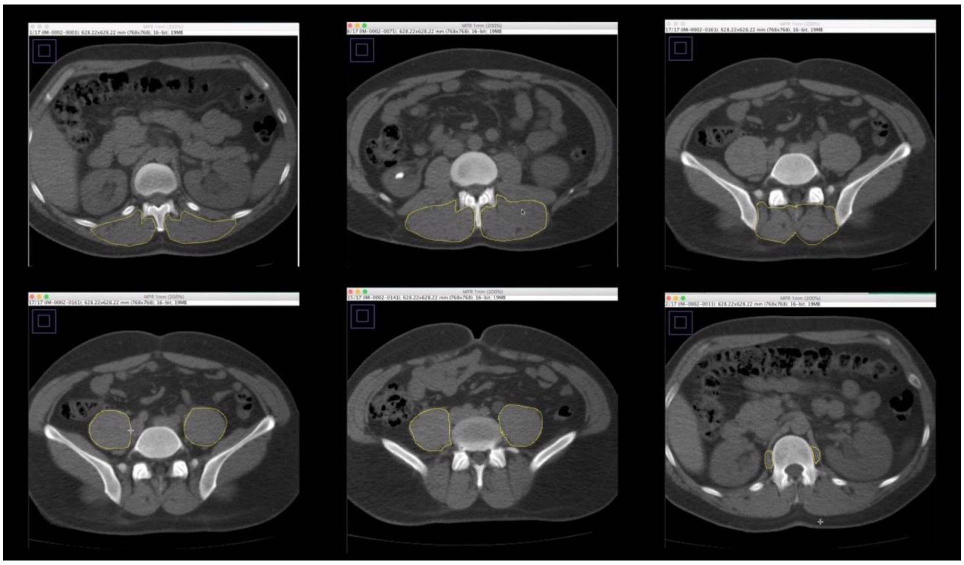

Figure 5: The different measurment stages of anterior and posterior muscle volumes in image J software.

Statistical Analaysis

SPSS 22 was used to analyze the data (IBM SPSS Statistics 22, SPSS inc., an IBM Co., Somers, NY). The study's inclusion criteria were met by a total of 62 CT scan pictures (n = 62).[31] of the 62 roentgenograms belonged to females, while the others[31] were in the hands of male backdated patients. The mean, standard deviation, or frequency and percent are used to express the data. Gender was provided as a count and percentage for categorical factors. As indicated in the following table 1.

Table 1: Distribution of Quantitative Variables.

Variables		n	%
Gender	Male	31	50
	Female	31	50

RESULTS

It's worth noting that this study based its findings on the anterior and posterior volume variables, comparing them to the PAL value for both sexes; as a result, other variables that were measured in this study were excluded; as a result, the excluded variables were not used to arrive at the study's results. The Mean±SD of the variables of age, pal, anterior volume cm3. Posterior volume cm3, anterior CE, Ant post fraction, posterior CE, L (length) and A (Area) providing the assumptions of normal distribution were analyzed,as shown in the table 2 below.

Table 2: Distribution of Quantitative Variables.

Variables	Mean±SD	Minimum	Maximum
age	45.58±15.99	19.00	84.00
PAL	4.08±1.86	0.11	8.89
Anterior_Volume_cm3	230.34±91.45	55.22	415.93
Posterior_Volume_cm3	598.03±154.69	187.93	1033.36
Anterior_CE	0.67±0.20	0.40	1.98
Ant_Post_Fraction	27.06±5.57	12.26	38.89
Posterior_CE	0.47±0.13	0.37	1.39
L	153.48±9.04	127.00	169.00
A	942,12 ± 415,94	10.00	1997.00

The retrospective patients (participants) varied in age from 19 to 84 years old, with a mean age (M) of 45.58 years and a standard deviation of 15.99, indicating that only adults were included in this study. After confirming the normality of the test variables, Pearson's coefficient was used to do a correlational analysis.

Firstlly, the association between total anterior volume (psoas major muscle anterior volume) and PAL TOTAL was determined, and it was revealed that there is no significant link between the two variables (r= -0,055; n=62; p=0,669). A significant association was evaluated in this example at a significance level of 0.05. The mean (M) of the total anterior volume was 230.34 with a SD of 91.45.

The second person correlation was between total posterior volume (erector spine muscle volume) and PAL TOTAL; the findings showed that there is no statistically significant association between the two variables, (r= 0,046; n=62; p=0,720). Finally, a Pearson correlation between Ant Post Fraction (total) and PAL TOTAL was calculated (r= -0,160; n=62; p=0,213). There is no substantial association between these variables, as suggested by this correlation as shown in table 3.

Table 3: Bivariate Correlation of TOTAL PAL, Anterior Volume, Posterior Volume, And Ant_Post_Fraction Variables In TOTAL.

	TOTAL PAL_Anterior volume	TOTAL PAL_Posterior volume	TOTAL PAL_Ant_Post_Fraction
r	-0,055	0,046	-0,160
p	0,669	0,720	0,213

* Correlation is statistically significant at the 0.05 level.

Gender Differences

Additionally, it was required to detect gender differences after Pearson correlation coefficients for the different variables that were not gender-specific had been obtained PAL and anterior volume, posterior volume, and Ant Post Fraction have been correlated in this case. This test is based on the premise that data are normal, thus it was required to check gender distribution before conducting the Pearson correlation test. Table 4 shows the broad range of variables by gender.

Table 4: Distribution of Variables By Sex.

Variables	Sex		t	p
	Male	Female		
	Mean±SD	Mean±SD		
age	45.83±15.33	45.32±16.87	0.12	0.900
PAL	3.78±1.73	4.39±1.96	1.300	0.198
Anterior_Volume_cm3	303.18±55.64	157.50±54.26	10.43	P<0.0001
Posterior_Volume_cm3	694.93±139.36	501.13±99.14	6.30	P<0.0001
Ant_Post_Fraction	30.52±3.54	23.59±5.08	6.23	P<0.0001
Anterior_CE	0.61±0.80	0.72±0.27	2.10	0.039
Posterior_CE	0.43±0.04	0.50±0.17	2.11	0.039
L	158.90±5.96	148.06±8.37	5.86	P<0.0001
A	950.58±434.73	933.67±403.29	0.15	0.874

*Independent samples t test was used.

The data in table 4 demonstrates that, Females' PAL value (M=4.39; SD= 16.87) is more that of males (M= 3.78; SD=1.73), the T value=1.300; p=0.198 (more than 0.05), reveals that there are no statistically significant variations in PAL between males and females. Males' anterior volume (M=303.18; SD=55.64) is more that of females (M=157.50; SD=54.26), T=10.43; p=0.0001 that demonstrate statistically significant differences in anterior volume between males and females, likewise males posterior volume (M=694.93; SD=139.36), are seen to be more than of females (M=501.13; SD=99.14) T=6.30; p=0.0001, It also indicates that there are statistically significant differences between two groups.

Similarly, the Ant_Post_Fraction variable, shows a significant statistical difference between males (M=30.52; SD=3.54) and females (M=23.59; SD=5.08) T=6.23; p=0.0001. It's also worth noting that the length (L) is more in males (M= 158.90; SD=5.96) than females (M=148.06; SD=8.37), T= 5.86; p=0.0001, that demonstrate substantial differences. To calculate the males Pearson correlation coefficients, the results of PAL/ anterior volume, PAL/ posterior volume, and PAL/Ant Post Fraction, as given in table 5, do not indicate a substantial correlation.

Table 5: Bivariate correlation of PAL, Anterior volume, Posterior Volume, and Ant_Post_Fraction variables by male.

	Pal_Anterior volume	Pal_Posterior volume	Pal_Ant_Post_Fraction
r	0,350	0,288	0,027
p	0,054	0.116	0,887

* Correlation is statistically significant at the 0.05 level.

On the other hand, In females, the Pearson correlation coefficients between the same variables show a negative weak non significant correlation between PAL and anterior volume (r=-0.064; n=31; p=0.731), a positive weak non significant correlation between PAL and posterior volume (r=0.097; n=31; p=0.604), and a negative weak non significant correlation between PAL and Ant Post_ Fraction (r=-0.136; n=31; p=0.464) Table 6.

Table 6: Bivariate Correlation of PAL, Anterior Volume, Posterior Volume, and Ant_Post_Fraction Variables by Female.

	Pal_Anterior volume	Pal_Posterior volume	Pal_Ant_Post_Fraction
r	-0.064	0.097	-0.136
p	0.731	0.604	0.464

* Correlation is statistically significant at the 0.05 level.

DISCUSSION

The purpose of this work, to analyze and evaluate the prevertebral and postvertebral muscles volume**,** and discover if there a relationship with lumber lordosis which was calculated with PAL technique. CT images for 62 participants (31 male and 31 female) collected from Ondokuz Mayis University hospital in Samsun, Turkey, Regardless of gender differences, The data indicated that there are no statistically significant correlations between PAL TOTAL and anterior muscle volumes, posterior muscle volumes and Ant_Post_Fraction r= (-0,055, 0,046, -0,160) respectively. Observations of evolutionary changes in spinal musculature, the mechanical role of spinal muscles, and correlations between muscle volume and lumbar spinal curvature changes convincingly demonstrate the involvement of musculature in maintaining lumbar lordosis.

Its not secret there is a presence of relationship between the degree of lumbar lordosis and the prevertebral muscle volume.[16] Statistically significant positive correlation between the angle of lumbar curvature and muscle volume was founded.[7] Conversly Copaver has been said that there is a relationship between the morphology of the psoas major and the spinal curvature, that muscle morphology influences its surface, and that Lumbar Lordosis has an impact on muscle structure. He discovered that there are no connections between lumbar lordosis and the psoas muscle's volume.[17]

Furthermore, regardless of gender, gender differences were found in muscle volume that may be important, there is positive poor but not significant correlations between PAL for male and anterior volume, posterior volume r was (0.350, 0,288), as well the anterior and posterior volume in males is mor than in females. Similarly, it was also discovered that there very weak negative correlations between Pal /anterior volume in females r= -0.064 and pal/ posterior volume r=0.097. In this case it can also be argued that the reason for the absence of significant correlations between muscle volumes for both genders with PAL is to presence of several individual and environmental factors that may influence on the anterior and posterior volumes of the muscles regarded to the lumbar lordosis this includes age[18] and gender[19] which is already taken in consideration In this study.

Other factors that were not taken into account which are considered as one of limitations of this study, these factors had a direct or indirect influence on volume of muscles concerned. The factors or influences includes (age related fatty changes in muscles[20], height, weight, and body mass index (BMI)[21], training and sports[22], and low back pain (LBP) situation.[23]

The age of participants ranged between 19-84 the mean was 45.58 with a standard deviation of 15.99 In this case, considering the broad age range and the broad standard deviation, it was expected that there would be fat changes in the muscular structures regarded to the aging , it has been noticed in an older population, females had smaller volume of multifidi, erector spinae, psoas[20] In addition, the fat component of the erector spinae in females was greater than in males.[24] Morevere there is an association between gender and age with psoas fat infiltration and change in volume.[25] males generally lose more muscle by aging, but women have better functional consequences.[26] Muscle volumes shown a modest association with anthropometric parameters (height, weight, and BMI)[25], the height and weight significantly influence the volume of the erector spine muscles.[27] A higher cross sectional volume of the psoas major muscles was related with taller height, heavier weight, BMI, and lean body mass, and more years of sport and exercise activities (age adjusted).[21] Parkkola and Korman[28] found that People with a greater fat content (obesity) are also more likely to have more intramuscular fat in the erector muscle mass than in the other muscles. Regular strength training is typically predicted to result in an increase in lumbar spine muscles volume in cross-sectional area since volume is a major predictor of a muscle's ability to generate force[22], Cross-sectional images were obtained using CT or magnetic resonance imaging (MRI). Greater trunk force was related with larger muscles volume. Finally, According to two investigations, patients with persistent LBP had lower paraspinal muscles volume.[13,28] Furthermore, Smaller muscle volumes have also been linked to more disk deterioration.[28] On the other hand the effect of spinal pathology on psoas size is paradoxical; there is no difference in psoas volume in patients with LBP compared to controls, yet there is a substantial decrease in multifidus volume.[14] However A decreasing in spinal muscle volumes on MRI and CT, with or without reduced muscle density on CT, may be found in patients with acute and chronic LBP, as well as LBP after surgery.[29,30] due to the importance of these factors, and their direct relationship to muscles volume, in the subsequent study they will be taken into account to include them with the data.

There is another limitation of this study. The CT scans were all performed in a supine position. Images acquired in this position may not correctly show the relations of the muscles contributing to lumbar lordosis and may not reflect the real tissue interactions. Also while the repeated measures testing showed good repeatability for the method of measuring the volumes of the muscles, there was a possibility for error in constructing the polygons in image J software around the borders of each muscle. Lastly Muscle degeneration can be detected by reduced muscle volumes and by increased fatty deposit within the muscle. The approach we employed only provided a gross measurement of muscle volumes and did not allow for calculation of replacement of muscle by adipose or connective tissues.

CONCLUSIONS

This anthropometric study was planned to compare the changes in prevertebral and postvertebral muscle volumes with the Pal technique between genders, which enables the diagnosis of lumbar lordosis to be calculated quantitatively with radiological images, to establish the diagnosis and to follow the course of the disease. CT scan images were collected from the Archival System of the Radiological Department of Ondokuz Mayıs University Hospital in Samsun, Turkey, and used in this investigation. The findings revealed that there is no significant correlation between the variables regardless of total anterior volume, total posterior volume and the total of PAL. Moreover, there are no statistically significant correlations between anterior volume, posterior volume, and PAL in both genders, according to the Pearson test. We think that knowing, height, weight, BMI, activity status and physical conditions, low back pain history and age-related fat changes in muscles volume due to the importance of these factors, and their direct relationship to muscles volume, in the subsequent study they will be taken into account to include them with the data.

Conflicts of Interest

No Conflicts of Interest.

Funding Statement

No Funding Statement.

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