Sonographic Evaluation of Psoas Major Muscle Thickness in Apparently Healthy Nigerian Population.

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ABSTRACT

Background: The psoas major muscle (PMM) is the only muscle that connects the lumbar spine and the lower limb making it very relevant during physical activities and everyday living. **Objectives:** To assess the psoas major muscle thickness (PMMT) in apparently healthy adults in order to establish a reference value for the population and also to determine the relationship between age, gender, ethnicity, and PMMT. **Materials and Methods**: The psoas major muscle thickness of two hundred and ten apparently healthy volunteers was measured using an ultrasound machine with a high frequency (7.0 MHz) linear transducer. Measurements were taken+ at the point of maximum thickness with the subject in the supine position. Data were analyzed using SPSS 21 and Pearson correlation analysis. Inferential statistics were also performed. **Results:** The mean PMMT was 34.28 ± 5.15mm. The majority of the subjects (19.5%) were within the age range of 40-59 years and their mean PMMT was 36.69 ± 4.568mm. There were more females, n =112 (53.3%) than the males, n =96 (46.7%). The mean PMMT of the males varied significantly from that of the females (p =0.001). A statistically significant difference existed between the Igbo and Hausa ethnic groups (p = 0.027). There were statistically significant positive correlations between PMMT and age (r= 0.0304, p< 0.001), Height (r = 0.234, p= 0.001) and BMI (r= 0.541, p< 0.001) and correlated with age, height, weight, and BMI. **Conclusion:** Psoas major muscle thickness varies significantly with age, gender, and anthropometric variables like body mass index, height, and weight.

Keywords: Apparently healthy, Psoas muscle thickness, Sonography.

INTRODUCTION

The psoas major muscle is located along the vertebrae, deep in the body and at the brim of the lesser pelvis. It connects the appendicular and axial skeleton to each other. Psoas major muscle is a long, thick, spindle-shaped and one of the muscular components of the posterior abdominal wall, which lies lateral to the lumbar vertebrae. [1] This muscle is the only muscle that connects the lumbar spine and the lower limb making it very relevant during physical activities and everyday living. [2]

In the early days, the measurement of size, dimension and/or cross-sectional

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area of the psoas major muscle were achieved by the dissection of cadaver. Embalmment of cadaver makes the muscular architecture to be shrunken in size and this may make its dissection not to be reliable for the purpose of evaluating muscular dimensions. [3] Currently, there are several imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound which can be used to evaluate the psoas major muscle dimensions and which may have the ability to produce reliable measurements.[4 - 6] Despite the fact that CT and MRI are highly sophisticated modalities, they are very expensive and not readily available. Also, CT involves ionizing radiations while MRI does not involve ionizing radiations but is contraindicated to subjects with metallic implants. Ultrasound is readily available, portable, provides real-time imaging, does not make use of ionizing radiation, non-invasive and has no known health hazard at the medical exposure level. [7, 8] These features therefore make ultrasound a better imaging modality that can be used to evaluate the thickness of the psoas major muscle.

Muscles can easily be differentiated from other structures using ultrasound and this makes it adequate for ultrasound evaluation [9] and ultrasound has also been utilized to study age related muscle atrophy.[10, 11] Previous studies have shown that muscle thickness measured by ultrasound can be used for estimating the cross-sectional area and/or volume of limb muscles. [12, 13] Takai *et al*, [14] reported measurements obtained while measuring the thickness of the psoas major muscle using ultrasound correlated with the findings of the cross sectional area using MRI. The evaluation of psoas muscle thickness or size is important because it can be used to predict total lean muscle, [15] Sarcopenia [16] and surgical outcomes in elderly patients. In men, PMMT has been demonstrated to be a potential marker for cardio-respiratory fitness as it can be used to predict maximal oxygen uptake (VO2 max). [2]

To the best of our knowledge, no reference values of the psoas major muscle thickness has been established and no ultrasound-based evaluation of the thickness of the psoas major muscle among the study population has been reported in literature, hence the need to carry out this study.

MATERIALS AND METHODS

This was a cross-sectional study, which involved 210 apparently healthy subjects purposively selected at a private diagnostic centre in Port Harcourt, Rivers State, Nigeria. Ethical approval for the study was obtained from the Human Research Ethical Committee of the Faculty of Health Sciences and Technology, Nnamdi Azikiwe University, Nnewi Campus, Anambra State, Nigeria. The study procedure was explained to the subjects and their consent was duly sought and obtained using written informed consent form. Participants were within the age range of 18 to 80 years and were those that came for ultrasound investigation during the study. Volunteers were included in the study based on being apparently healthy, being a Nigerian and living in the study area. Subjects with the following conditions were excluded from this study; history of trauma, surgery or inflammatory diseases involving the psoas major muscle, pregnant women, marked increased abdominal fat (obese), which could due to poor visualization. The sample size for this study was determined using the formula for a known population formula by Yamane cited by Ogolodom *et al* [17] and Ukaji *et al* [18] below

n= N/1+N(e)2

Where: n is the required sample size from the population under study

N=(442) is the whole population that had undergone abdominopelvic ultrasound from September 2020 to December 2020 at this study centre as obtained from the ultrasound reports archive and e is the sampling error, which is 0.05

n= 442/1+442(0.05) 2

n =210

The study was conducted from January 2021 to May 2021.

The ultrasound scan was performed by a certified sonographer with about ten years sonographic experience using 7.0MHZ transducer of a 4D LOGIQ P6 (General Electric Medical System) Ultrasound machine. The subjects were laid supine on the couch and acoustic gel was then applied at their epigastric, umbilical, and hypogastric regions. The scan was done in a superior-inferior approach along the path of the psoas major muscle on real time. The transducer was placed in the transverse plane while the transverse view of the psoas major muscle was obtained. The measurements were taken at the point where the psoas major muscle has its thickest measurement at the level of L4-L5 of the lumbar vertebrae (Figure 1) which corresponds to the level of anterior-superior iliac spine as described by Egwu et al. [19] The right and left psoas muscles were measured and an average taken. Previous studies have demonstrated that single measurement of either the left or right side can be taken or both sides can be taken and an average found.[19, 21] Three measurements were made, and the average taken to ensure reliability. The subjects' age, gender, weight, height, and body mass index (BMI) were determined and recorded on data capture sheet.

The obtained data was analyzed using a statistical package for social sciences (SPSS) version 21 (IBM Corp, Amornk, NY, 2012). Both descriptive statistics (mean, standard deviation, percentage, frequency and tables) and inferential statistical (Pearson's correlation, ANOVA and Independent T-test) tools were used. The level of statistical significance was set at $p < 0.05$.

FIG1

RESULTS

Table 1 shows that majority, 31.4% (n=66) with mean PMMT of 36.69 ± 4.568mm were within the age group of 40-59 years and the least 8.6% (n=18) with mean PMMT of 34.93 ± 3.965mm were within the age group of 60 years and above. Most subjects 53.3% (n=112) were females with mean PMMT 32.83 ± 4.796mm.

Out of 210 participants, majority 19.5% (n= 41) were professionals with mean value of PMMT 36.77 ± 5.01mm, followed by service and sales staff 14.8% (n=31) with mean value of PMMT 33.69 ± 4.67mm and the least 3.8% (n=8) were retirees with mean value of PMMT 35.21 ± 2.83mm as demonstrated in table 2.

The results of ANOVA in table 3 shows that there were no statistically significant mean differences in the PMMT between the Igbo ethnic group with Yoruba (p = 0.991) and other minor ethnic group (p= 0.967), but there was statistically significant mean difference in the PMMT between the Igbo ethic group and the Hausa (p = 0.027). No significant mean difference in the PMMT between Hausa ethnic group and Yoruba (p= 0.131) and the other minor ethic group (p= 0.076). There were statistically significant positive correlations between PMMT and age(r= 0.0304, p= 0.00), Height (r = 0.234, p= 0.001) and BMI (r= 0.541, p= 0.000) as shown in table 4.

Table 1: Socio-demographic characteristics of the subjects and Independent t test for males and females

Characteristics	Frequency (%)	Mean PMMT	Range	P value
Age (years)				
18-39	126(60)	32.82 ± 4.959	20.15 - 43.65	
40-59	66(31.4)	36.69 ± 4.568	26.45 -49.90	
60 & above	18(8.6)	34.93 ± 3.965	27.70 -44.70	
Gender				
Male	98(46.7)	35.92 ± 5.045	21.98 - 49.90	
Female	112(53.3)	32.83 ± 4.796	20.15 -42.90	0.0010

Table 2: PMMT mean, frequency and percentage distributions of occupation

Occupation	Frequency (%)	Mean ± SD
Managers	**15 (7.1)**	35.08 ± 5.063
Professionals	41 (19.5)	36.77 ± 5.01
Technicians & assistants	18 (8.6)	35.93 ± 3.25
Clerical Support staff	**22 (10.5)**	30.35 ± 4.50
Service and sales staff	31 (14.8)	33.69 ± 4.67
Craft and related trade staff	16 (7.6)	33.60 ± 6.08
Plant and machine operators/assemblers	11 (5.2)	36.55 ± 3.01
Elementary occupations	18 (8.6)	31.53 ± 4.89
Armed forces	11 (5.2)	35.18 ± 4.73
Retirees	8 (3.8)	35.21 ± 2.83
Students	19 (9.0)	32.73 ± 5.09

Table 3: Analysis of variance (ANOVA) of PMMT according to various Ethnic groups

Characteristics		Frequency (%)	Mean Thickness	Mean Difference	P value
Igbo		95 (45.2)	34.7± 4.51		
	Yoruba			-42357	.991
	Hausa			3.1670	.027
	Others			36383	.967
Yoruba		15 (7.1)	35.18 ± 6.37		
	Igbo			42351	.991
	Hausa			3.59051	.131
	Others			.78734	.947
Hausa		26 (12.4)	31.51 ± 6.47		
	Igbo			-3.16700	.027
	Yoruba			-3.59051	.131
	Others			-2.80317	.076
Others		74 (35.2)	34.39± 4.91		
	Igbo			-36383	.967
	Yoruba			-78734	.947
	Hausa			2.80317	.076

Table 4. Relationship of PMMT with age and a Anthropometric parameters

Parameters	correlation coefficient(r)	P value
Age (Yrs)	0.304	<0.001
Height (m)	0.234	0.001
Weight (Kg)	0.535	<0.001
BMI (Kg/m ^{2}	0.451	<0.001

DISCUSSION

The psoas major muscle is functional when the body is moving and at rest. It is also found useful in metabolism used in clinical assessment of some diseases [22] as well as mood and stress disorders as a cause of low back pain. [23]

This study revealed that age affects the size of the Psoas major muscle thickness and is highest among subjects between the age range of 40-59 years with a mean thickness of 36.69mm and a range of 49.90-26.45mm. At this age range many people tend to be more muscular but as one grows older there is the likelihood of muscle wasting which may explain the reason for this our observation. At old age the muscles also become less elastic and shortens. The physical activity of individuals and quality of life are also high at this age range and may have contributed to the age difference in the muscle thickness. Previous study by Imamura et al [24] noted that age influences the dimensions of the psoas major muscle significantly. The age difference in this study is however, not significant. The observed relationship between age and psoas major muscle thickness in this study may also be associated with occupational activity of the subjects as the study considered subjects with various occupations, which include but not limited to; professionals, plants and machine operators and assemblers, force men, service and sales workers and craft and related trade workers (welders and mechanic).

The mean psoas major muscle thickness is higher in males than females in this present study. This agrees with other previous studies, which revealed that men have more skeletal muscle mass than women even after adjustment for body weight and height. [25, 26] A previous study [27] stated that the reasons for this sex differences are unknown but greater functional requirement of trunk

musculature might be associated with a greater development of muscles in men who perform physical activities than women. During growth, women experience lower increase in waist circumference than men. This morphological difference in the abdominal region had been associated with differences in psoas muscle between the sexes. [28]

Findings from the study show that the mean psoas major muscle thickness is 34.28 ± 5.15 mm (range; 20.15- 49.90mm). The mean PMMT obtained from the present study is within the range of PMMT obtained by Egwu *et al*. [17] in adult male subjects when they evaluated occupation based related difference.

In this study, the mean PMMT of the various ethnic groups revealed differences among the groups. A significant difference in mean psoas major muscle thickness however, existed between the Igbo and Hausa showing that ethnicity may affect mean psoas major muscle thickness. The findings of this study on the relationship between psoas major muscle thickness and ethnicity are in accordance with the study done by Hanson et al., [29] on anatomical differences in the psoas muscles in young black and white men using forty-four (44) fresh male cadavers of similar age, weight and height.

There is a significant difference ($p \leq 0.05$) between psoas major muscle thickness and other anthropometric parameters such as body mass index, height and weight in this study. This finding is in tandem with the study done by Springer et al. [30] The sample size used for this study may be small to generalize for the entire population studied.Psoas major muscle is involved in various physical activities of daily living like running, dancing, sitting and walking. The information on participants' involvement in the following activities and other physical performance were not ascertained.

CONCLUSION

Our study has provided a normal reference range for psoas muscle thickness in healthy subjects and may be used for timely decision of age related atrophy or shortened psoas major muscle.This study has shown that psoas major muscle thickness varies significantly with ethnicity, age, gender and anthropometric variables like body mass index, height, and weight.

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Author contributions

All authors have read and consented that the manuscript be sent out for publication. The roles of the author include; JCE, OMN and ACU were the originators of the concept, drafted the manuscript and designed the research, CCO, DCU, MPO were responsible for the analysis, literature review and revised the work for publication.

Data availability

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

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