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Original Article

Relationship between Spleen dimensions and Anthropometric parameters: A case study of Nnewi People in Nigeria.

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Abstract

Introduction: Several studies have been done on the spleen and anthropometric parameters in various tribes and nationalities but there is dearth of literature of such studies among the Igbo tribe of Nigeria hence this study is to establish the correlation between the spleen morphometry and anthropometric parameters of Igbo people using Nnewi as a reference point. Method: Three hundred and twenty one consented and healthy Igbo subjects (164 males, and 157 females) from Nnewi were used for this one-year study conducted at the ultrasound unit of Nnamdi Azikiwe University Teaching Hospital Nnewi Campus. A 2-dimensional ultrasound machine with a 3.5MHz probe was placed along the left lower costal margin from the ninth to eleventh ribs at the anterior, mid and posterior axillary lines. Splenic length was measured as the maximum distance between the dome of the spleen and the splenic tip and width as the maximum distance between the medial and lateral borders of the spleen. The heights and weights of the subjects were measured by stadiometer and weighing scale. All measurements were taken twice and average reading was taken to avoid observer error. Result: The weight, height, and BSA, did not significantly differ with spleen dimensions. This showed that the spleen dimensions are not at variance with anthropometric measurements. Conclusion: There is no correlation between the spleen dimensions and the anthropometric parameters.

Keywords: Spleen, Anthropometry, Nnewi, Ultrasound Scan, Weight, Height.

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Introduction

Body organ weight and its morphometric parameters bear potential significance in detecting the possible organ defects or diseases¹. Spleen is the largest and mobile lymphoid organ in a human body and it is located in the left upper quadrant of the abdomen between the fundus of the stomach and left dome of the diaphragm². Spleen is a highly vascular intraperitoneal organ, with various sizes and shapes and has two borders (medial and lateral) and two surfaces (diaphragmatic and visceral). The spleen develops as a lobulated mass from the mesoderm of the upper part of the dorsal mesogastrium under the cover of its left layer. The average dimensions of a spleen are approximately13cm in length, 8cm in breadth and 4cm in thickness. The average weight in an adult is about 80-150 gm³. One important factor in establishing the identity of a person is his stature. Spleen has been reported to vary in size and shape based on age, race and nationality^{4,5,6}. There has been previous documentation about the anthropometric correlation of an individual and spleen dimensions ^{6,7,8}. Splenic enlargement can occur as a result of various clinical conditions which include infections, malaria, hematological cancer, infiltrative diseases, immunologic, and malignant conditions⁹

Various radiological machines can be used to assess several parameters of the body organs such includes Ultrasound, X-ray, and Computed Tomographic machines among others. The estimation of splenic size in vivo is often important in the diagnosis, treatment and prognosis of a variety of disorders. Palpation and percussion are the standard bedside techniques to estimate splenic size but are far from being accurate because it cannot detect small increase in size ^{10, 11}. The spleen has to be two to three times bigger than its normal size before it can be clinically palpable¹².

Scanning of the body viscera is usually carried out to know the normal dimensions, echo patterns and deviations from normal and this has led to the diagnosis or prediction of pathological conditions ¹³. Ultrasound being a safe, non-invasive and inexpensive non-ionizing radiation machine that can measure dimensions and detect various anomaly in shape and size has been preferred in estimating internal organs dimensions^{14, 15}.

Several studies have been done on the spleen and anthropometric parameters in various tribes and nationalities but there is dearth of literature of such studies among the Igbo tribe of Nigeria. This present study is to establish the relationship between the splenic dimensions and anthropometric parameters of adult Igbo people using Nnewi as a reference because of its vibrant auto industry.

Materials and Methods

This study was a prospective study carried out from July 2015 to June 2016 at Nnewi city, Anambra State.

Study Area:

Nnewi is a commercial and industrial city in Anambra, South-eastern, Nigeria, It is the second largest city in Anambra about 22km south east of Onitsha and has population of about 958,000. Geographically its latitude and longitude coordinates are: 6.010519; 6.910345 and it falls within the tropical rain forest of the World and as such it suffers from soil leaching and soil erosion. The main occupation of Nnewi people is trading, production and farming ¹⁶. The city spans over 1,076.9 square miles (2,789 km²) in Anambra State

Ethical Consideration

Ethical approval was sought and obtained for this study from the Ethical Committee of Faculty of Basic Medical Sciences, Nnamdi Azikiwe University, Nnewi Campus.

Sample Size

The sample size was determined by Yamane formula $n = \frac{n}{1+N(e)^2}$ ¹⁷

Where: n = sample size; N = population of study; e = margin of error (0.05).

The number of registered population in Nnewi was used as the sampling frame to determine the sample size. According to Anambra State Statistical book 2011, the registered population was 79925¹⁸. According to Uzoagulu, the level of significance used was 0.056¹⁹. Inserting these figures in the formula above, we have: $n = \frac{79925}{1+79925(0.056)^2} = 398$.

(77 accounted for questionnaires with problems)

Recruitment of Subjects

This prospective study involving 321 apparently healthy subjects (164 males, and 157 females) recruited randomly from the sampling frame of Nnewi community was conducted at the ultrasound unit of Nnamdi Azikiwe University Teaching Hospital Nnewi Campus, Nigeria for a period of one year from July, 2015- June, 2016, after explaining the procedure including transporting them at no cost to the Ultrasound unit of Nnamdi Azikwe Teaching Hospital, Nnewi campus. Informed consent was obtained from all the subjects who were healthy and willing to participate in the study.

All consenting subjects were from age 18 - 35years and were transported to the radiology unit of Nnamdi Azikiwe University Teaching Hospital, Nnewi campus for the study. This age range was chosen because they would comply with study requirements and are likely to have stable body anatomy.

Those excluded from the study were subjects younger than 18 years and greater than 35 years, subjects with prolonged febrile illness, splenic trauma, recurrent/chronic illness, hematological disorder, sickle cell disease, chronic renal disease, and pregnant women while those included were subjects whose grandparents were Igbo and living in Nnewi within the age bracket of 18-35 years that did not have any of the excluded condition. The procedure was explained to all the subjects and to ensure compliance with inclusion and exclusion criteria, brief clinical history and physical examination of the patients were taken.

The heights and weights of the subjects were measured twice independently by the researcher and assistant using the standard anthropometric technique, height was recorded in meters, and weight was recorded in kilograms.

Spleen Scanning Technique

Ultrasound scan of the patients were done using a 2-dimensional ultrasound machine, Siemens Sonoline Prima model which was made in Japan for Siemens Medical System Incorporated, Issaquah, WA, 98029 – 7002, US.

A 3.5 Mega Hertz (MHz) probe was used to scan the subjects, the subjects were asked to lie supine on the examination couch, exposing their chest. Scanning was done after the application of adequate amount of coupling gel on the transducer, the probe was placed in the left upper quadrant along the left lower costal margin from the ninth to eleventh ribs at the anterior, mid and posterior axillary lines. The spleen was identified as a homogenous echotexture, and measurement of the spleen dimensions was done with the patient in the supine position and

also in the right lateral decubitus position on deep inspiration so that the spleen descends downward.

All measurements were taken by the radiologist on sections through the splenic hilum to create a constant reference point for repeated measurements. Splenic length was defined as the maximum distance between the dome of the spleen and the splenic tip and splenic width is defined as the maximum distance between the medial and lateral borders of the spleen, and was measured on a plane perpendicular to the length. Each measurements was done twice and average reading was taken as the measurements to avoid observer error.

The anthropometric parameters for correlation include: age, gender, height, weight, Body Surface Area (BSA) and Body Mass Index (BMI).

Body Mass Index: This was calculated using the formula: $BMI = W/H^2$.

Where W = Weight of the Subjects in Kilograms (Kg); H = Height of the Subjects in Meters (M)

Body Surface Area: This was calculated using BSA= square root of the product of Height in centimeters (cm) x Weight in Kilograms (kg)/ 3600^{20} .

Statistical analysis

All collected data were subjected to statistical analysis using Statistical Package for Social Sciences (SPSS) version 20.0. The mean and standard deviation of the collected data were calculated. Pearson's correlation bivariate test was used to correlate the relationship between splenic dimensions and anthropometric parameters. Analysis of variance (ANOVA) was used to compare the measured parameters between various age groups. The level of significance was fixed at 5% and the difference between them was considered significant at p<0.05.

Result

A total of 321 apparently healthy subjects (164 males, and 157 females) were recruited for this study. The age range of the subjects were 18-35 years with a mean age of 24.36 ± 4.26 and there was significant difference in the age of the subjects studied. The mean weight and height of the subjects studied were 68.28 ± 38.37 kg and 1.69 ± 10.82 m respectively while the mean splenic length and width of the subjects were 100.53 ± 12.67 mm and 55.02 ± 40.08 mm respectively. The mean BMI and BSA of the subjects were 24 ± 0.0014 kg/m² and 1.78 ± 3.093 m² respectively, (Table 4.2). Even though there was no significant difference in the height and weight of the subjects studied there was significant difference in the BMI of the male and female subjects (Table 4.1).

Table 4.3, showed a steady increase in the mean splenic length, weight and BMI in the age range of 30-35 years even though it was not statistically significant. Analysis of Variance (ANOVA) showed that there was significant difference in height (p<0.05), weight and BSA (p<0.05) between the age groups.

As observed in the male in Table 4.3, the result is almost the same in female subjects as seen in Table 4.4, there was an increase in mean weight, BMI and BSA of age group 30-35 years.

There was a significant difference in weight (p<0.05), BMI (p<0.05) and BSA. Other parameters remained insignificant (p>0.05) when compared between groups.

Independent sample t-test showed that the males had significantly higher age (p<0.05) and BMI (p<0.05) than their female counterparts. The weight, height, BSA, spleen length and spleen width did not significantly differ with gender (p>0.05) as shown in Table 4.1 below.

Pearson's correlation test showed that there was no significant relationship between the splenic dimensions and anthropometric parameters in the male and female subjects as shown in Table 4.5 and 4.6 below

Table 4.1: Age, anthropometric parameters, and splenic dimensions (mean \pm SD) according to gender

Parameters	Males (n=164)	Females (n=157)	P-Value
Age	25.53±4.16	22.82±3.62	0.034*
Weight	72.38 ± 50.57	63.66±12.51	0.390*
Height	1.67±0.13	1.72±0.07	0.198*
BMI	26.66±19.58	21.59±4.39	0.043*
BSA	1.80± <mark>0</mark> .34	1.74±0.17	0.694*
Splenic Length	101.16±11.95	100.00 ± 13.51	0.739*
Splenic Width	52.84±7.67	57.67±58.63	0.216*

*Significant at P < 0.05

Table 4.2: Splenic dimension and anthropometric parameters mean in the subject population

Parameters	Ν	ALL	
Age (years)	321	24.26±4.26	
Weight (kg)	321	68.28±38.37	
Height (m)	321	1.69 ± 10.82	
Splenic Length	321	100.53±12.67	
Splenic Width	321	55.02 ± 40.08	
BMI (kg/m ²)	321	24.00±0.0014	
BSA (m ²)	321	1.78 ± 3.093	

Table 4.3: Anthropometric parameters and splenic dimension	ons (mean \pm SD) grouped by age
group in the males (n=164)	

Parameters	18-23 years	24-29years	30-35 years	P-Value
Weight	68.62±12.62	68.51±10.36	95.21±130.48	0.050*
Height	1.67 ± 0.07	1.66 ± 0.15	1.73±0.10	0.025*
BMI	24.80 ± 5.11	26.24±12.47	32.32 ± 45.40	0.270*
BSA	1.78±0.16	1.77±0.17	1.98 ± 0.81	0.017*
Splenic Length	98.84 ± 9.98	101.86 ± 10.42	103.63±19.07	0.177*
Splenic Width	51.15±7.16	53.21±7.40	55.17±9.15	0.073*

*Significant at P < 0.05

Table 4.4: Mean and Standard deviation of anthropometric parameters and splenic dimensions grouped by age group in the females (n=157) (mean \pm SD).

Parameters	18-23 years	24-29years	30-35 years	P-Value
Weight	62.06±11.05	65.13±11.50	74.46 ± 20.45	0.003*
Height	1.72 ± 0.08	1.71 ± 0.07	1.74 ± 0.04	0.438
BMI	21.05 ± 3.85	22.33 ± 4.26	24.65 ± 7.34	0.015*
BSA	1.72 ± 0.16	1.75 ± 0.176	1.88 ± 0.24	0.005*
Splenic Length	99.44±14.25	100.69 ± 10.22	103.24±13.94	0.613
Splenic Width	59.48±68.63	53.09 ± 5.94	52.25 ± 5.18	0.831

*Significant at P < 0.05

Table 4.5: Correlation of splenic dimensions with age and anthropometric parameters in the male subjects (n=164)

	Age	Weight	Height	BMI	BSA	
Coefficient	0.094	0.059	0.017	0.042	0.111	
P-Value	0.215	0.438	0.827	0.582	0.146	
Coefficient	0.135	0.023	0.036	0.001	0.055	
P-Value	0.076	0.763	0.683	0.993	0.468	
	Coefficient P-Value Coefficient P-Value	AgeCoefficient0.094P-Value0.215Coefficient0.135P-Value0.076	Age Weight Coefficient 0.094 0.059 P-Value 0.215 0.438 Coefficient 0.135 0.023 P-Value 0.076 0.763	Age Weight Height Coefficient 0.094 0.059 0.017 P-Value 0.215 0.438 0.827 Coefficient 0.135 0.023 0.036 P-Value 0.076 0.763 0.683	Age Weight Height BMI Coefficient 0.094 0.059 0.017 0.042 P-Value 0.215 0.438 0.827 0.582 Coefficient 0.135 0.023 0.036 0.001 P-Value 0.076 0.763 0.683 0.993	AgeWeightHeightBMIBSACoefficient0.0940.0590.0170.0420.111P-Value0.2150.4380.8270.5820.146Coefficient0.1350.0230.0360.0010.055P-Value0.0760.7630.6830.9930.468

Pearson's correlation test showed that there was no significant relationship between the splenic dimensions and anthropometric parameters in the female subjects as shown in Table 4.6 below.

Table 4.6: Correlation of splenic dimensions with age and anthropometric parameters in the female subjects (n=157)

		Age	Weight	Height	BMI	BSA	
Spleen Length	Coefficient	0.125	0.141	0.049	0.107	0.151	
	P-Value	0.333	0.133	0.089	0.559	0.197	
Spleen Width	Coefficient	-0.114	-0.059	-0.036	-0.047	-0.067	
	P-Value	0.563	0.169	0.476	0.663	0.569	

Discussion

Evaluation of the splenic size by percussion and palpation is inaccurate, the spleen has to be enlarged two to three times its normal size to be clinically palpable². Ultrasonography is a cheap, safe and non-invasive, diagnostic machine that uses high frequency sound waves to produce dynamic images (sonograms) of organs, tissues and blood flow inside the body ^{14, 15}. Scanning of the viscera are carried out to know the normal dimensions, echo patterns and deviations from normal- which has led to diagnosis or prediction of pathological condition¹³. The result of our study showed that the mean BMI for males was statistically higher than the mean BMI for females (p<0.05) with males having a mean BMI of 26.66kg/m² (±19.58) and females with mean BMI of 21.59 kg/m² (±4.39). This agrees with the study done at University

of Kentucky on 631 collegiate athletes where the authors reported that the mean BMI for males was greater than the mean BMI for females(mean BMI for males 25.85kg/m² (± 4.26) and the mean BMI for females was 22.31kg/m² (± 2.68)²¹. Our work did not agree with the study done on 200 Nigeria adults at University of Benin Teaching Hospital which reported that the mean BMI of males was less than that of females (23.6kg/m² (± 2.8) for males and 24.9kg/m² (± 1.4) for females)^{22.} The variations in the above findings could be as a result of sampling bias, heredity, stature and environment.

The mean height for the males was lower compared to females while the weight of the males was higher than the females [(1.67m (\pm 0.13) and 72.38kg (\pm 50.57)] for males and [(1.72m (\pm 0.07) and 63.66kg (\pm 12.57)] for females respectively. These results are at variance with the reported results in adult Nigerian people where the mean height and weight for males were higher than females [(1.75mand 72.5kg (\pm 10.1) and 1.64m (\pm 5.8) and 64.1kg (\pm 12.9)] respectively²³. However, the mean weight of the males (72.38kg) in the present study is higher than that of females 63.66kg (\pm 12.51).

The mean height of the subjects in this present study which was 1.69m (± 10.82) is similar to the mean height of the subjects studied at Aminu Kano Teaching Hospital (AKTH), Nigeria which was 1.64m (± 0.77) but the mean weight of the subjects studied in the present study which was 68.28kg (± 38.37) is at variance with subjects from Aminu Kano subjects which was 61.40kg (± 10.97)²⁴.

Previous study on adult Nigeria population reported that the mean height and weight of the subjects were 1.65m (\pm 1.4) and 69kg (\pm 5.4) which is in tandem with the findings of the mean total height and weight of the present study^{23,25}. The mean total height and weight of the study done on college athletes in Canada were 1.72m (\pm 0.58) and 76.3kg (\pm 8.7)²¹, and this is at variance with what was obtained in our study. Another study done in Ethiopia also supported that there are morphometric differences between the male and females with the males having higher splenic dimensions than the females ²⁶. However, the dissimilarities in the mean total height and weight of the subjects could be as a result of sampling bias and differences in body habitus.

Also, the mean splenic length and width of our study were 101.16mm (±11.95); 52.84mm (±7.67) for males and 100.00mm (±13.51); 57.67mm (±58.63) for females respectively. The values in this present study vary with those obtained at the Northern Nigerian which were 103.9mm (±13.5); 48.0mm (±8.4) for males and 97.8mm (±15.8); 45.5mm (±7.7) for females' respectively^{24.} This variation was further corroborated by the study done at University of Kentucky on 632 collegiate athletes in which they revealed that the mean splenic length and width of females were 99.1mm (±1.27); 47.4mm (±0.91) and 112.9mm (±1.49); 55.4mm (±1.28) for males respectively^{21.}The results obtained in that study have slight variations with the results of our study.

Also, the result of our study which showed the mean splenic length and width of males and females as 101.16mm (\pm 11.95) ; 52.84mm (\pm 7.67) and 100.00mm (\pm 13.51) ; 57.67mm (\pm 58.63) respectively does not tally with the result obtained on 200 Nigerian adults at the University of Benin Teaching Hospital²². This could probably be due to the environment and nutrition.

A steady increase in the mean splenic length with an increase in age was observed in our present study with age group 30-35 having the highest (103.63mm (±19.07). The reason for the above findings may be explained by the fact that the subjects studied were in their active age which caused the values in between the age groups to remain statistically insignificant (>0.05). This observation with the previous reports on adult Nigerian population is similar^{23, 25}. There was no significant difference (p>0.05) in the mean splenic length between the age groups of both males and females on the studied 632 collegiate athletes from the University of Kentucky.^{21, 27}

In this study, independent sample t-test showed that the splenic dimensions did not significantly differ with genders (p>0.05). This corroborates the earlier findings of previous study ^{24, 28, 29}.

Contrarily, some reported studies in Jordan and Maiduguri, Nigeria showed that there was variation (p<0.05) in the splenic dimensions and gender $^{30, 31}$. The reason for the difference may be due to the difference in anatomical structures of different individuals within different geographic locations. Again, it may be that sex certainly is not a determining factor for variations of splenic dimensions in the studied subjects.

In this research work, when the splenic dimensions were correlated with age, weight, height, body mass index and body surface area, the results of the Pearson's correlation coefficient (r) test showed that splenic dimensions had no significant relationship with age, weight, height, body mass index and body surface area (p>0.05) in males and females respectively. In the study done on collegiate students of Kentucky University there was a moderate correlation of both height and weight with splenic length, and the correlation coefficient @ of 0.48 and 0.47, respectively was observed.

A reported study from Maiduguri, Nigeria also observed that there was no correlation between spleen volume, age, weight, height and BMI among 374 Africans adults studied^{29, 32} this further supported our findings.

The results of the Pearson's correlation coefficient of the present study are in line with the findings of the study done in Maiduguri, Nigeria ^{29, 32, 33} but vary with the results obtained from the collegiate students of the University of Kentucky²¹ the difference might probably be due to different geographical location.

This study suggests that anthropometric parameters do not have correlation with splenic dimensions and its variation with other studies could be as a result of heredity, geographical location, and variation in the anatomic structure of the body.

Conclusion: This study has established that there was no correlation between the splenic dimensions and anthropometric parameters in both sexes of Nnewi.

Conflict of Interest: The authors declare no conflict of interest.

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