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SONOGRAPHIC EVALUATION OF SPLENIC DIMENSIONS IN APPARENTLY HEALTHY PEDIATRICS IN KANO METROPOLIS, NIGERIA.

[1]**Mohammed Sidi** [*1]**Umar Mansur** [1]**Abubakar Shehu Barde**

[1]*Department of Medical Radiography, Faculty of Allied Health Sciences, Collage of Health Sciences, Bayero University Kano.*

Corresponding author: umansur.radg@buk.edu.ng +2348034280010

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ABSTRACT

Background: Variation of race, ethnic groups, and geographic locations of different communities necessitate each population to establish a normative value of each organ that will serve as reference guide for the diagnosis of the pathological conditions affecting splenic size in pediatrics.

Aim: This study was aimed at evaluating splenic dimensions of apparently health pediatrics in Kano metropolis Nigeria, using ultrasonography.

Methods: This study was a prospective, conducted in Kano metropolis, from May 2020 to October 2020. Four hundredth and twenty healthy pediatrics were conveniently recruited, involving; 210 males and 210 females within the age range of 0 - 17 years. The subjects were scanned in supine position. The splenic length and width were obtained in longitudinal plane whereas the anterior posterior diameter (APD) was obtained in transverse. Descriptive and inferential statistics were used for the data analysis. Statistical package for social sciences (IBM SPSS) version 23.0 was used for the data analysis and $p < 0.05$ was considered significant.

Results: The mean splenic length, width, and APD dimensions for male pediatric subjects were 62.2±26mm, 61.6±21.7mm, and 36.2±1.45mm, while that of female subjects were 31.2±17mm, 27.9±4.2mm, and 25.45±5.1mm. A statistical significance difference in splenic dimensions between pediatric age groups was observed ($p = 0.000$). The Spleen dimensions were positively correlated with age, BMI and BSA ($r > 0.5$).

Conclusion: Normative values for pediatric splenic dimensions were established in Kano metropolis. A statistical significant difference in splenic dimensions between pediatric age groups was observed. The splenic dimensions were positively correlated with BMI and BSA.

Introduction

Many international organizations have different classifications of pediatric age groups. The six standard classifications are; neonate (0 - > 28days), infant (>1month - <12months), toddler (12month - <24month), preschool age (24month – >60month), school age (5years – >13years), and teenager (13years – 17years). [1] Pediatrics are more vulnerable to infections and immune disorders. [2] The Spleen is the largest lymphoid organ in the human body and is situated in left hypochondriac region of the abdomen adjacent to the stomach and left kidney. [3] It is covered by an outer serous coat and an inner fibromuscular capsule. The spleen composed of white and red pulp, the white pulp is the primary site of immune and phagocytic action, while the red pulp is primary site of filtration. [4] It varies in size across different pediatric age groups and measures about 12cm × 7cm × 3cm in dimensions in adult subjects. [5] The spleen performed several vital functions which includes; hemopoietic function during intrauterine fetal life, destruction of blood cells, and play a vital rule in defense of the body. [3]

Measurement of splenic dimensions is essential because, many diseases can affect its size ranging from infective process to malignant disorders which present with either enlargement or reduction in of the spleen. [6] [5] Serial size measurements may be used in tracking the normal growth pattern of the spleen and in the follow-up known pathology of the spleen in pediatrics. [5] The spleen size can be evaluated by clinical and medical imaging procedures. The clinical assessment is usually the first step in detecting the abnormal size of the spleen. [7] The spleen is palpable only when its two to three time of its normal size, although it may be in 10% of health pediatric and 15% of neonates. [6] However, this clinical examination difficult and inaccurate. [8] Medical imaging techniques like; radiography, and computed tomography expose the patients to ionizing radiation, while magnetic resonance imaging in expensive, claustrophobic, time consumption and not readily available in developing countries. [6] [9] Ultrasonography is a non-invasive, established, safe, fast, readily available, low cost and reliable method for measurement of spleen sizes. [6] [10] However, it has the disadvantage of being operator dependent. Ultrasonography is essential in the evaluation of agenesis, atrophy, hypertrophy, and or identifying ectopic visceral organs. [5]

The sonographic indicators of moderate splenomegaly in adults includes anterior posterior diameter greater than two-thirds of the distance between the anterior and posterior abdominal wall, a cranio-caudal length of more than 11-14cm. [11] Interpolar diameter of more than 20cm was considered massive splenomegaly. [6] However, there is no consensus on the exact definition of splenomegaly by ultrasound measurement in pediatrics. [6] The exact evaluation is difficult because the normal dimension varies because of nutritional factors, body habitus, geographical location, genetic differences, race, physical activities and ethnicity. [12][13]

Various studies have been made to determine the splenic dimension among apparently healthy pediatric by ultrasound in different geographical location, race, populations and socio-economic background. Eze *et al.,* [5] conducted their study in south-eastern Nigeria involving 947 healthy school children within the age range of 6 - 17 years. they reported that, dimensions of the spleen were not statistical different in boys and girls ($p > 0.05$) and height correct best with splenic dimensions ($r > 0.5$). Nemati *et al.,* (2016) conducted their study among Iranian children involving 458 apparently health pediatrics. They reported no statistical significant difference in splenic dimension between genders ($p = 0.61$) and height correlate with splenic dimension ($r > 0.5$). In the standard practice, normative values of splenic sizes on healthy pediatric should be establish for references baseline in the diagnosis of splenic pathologies affecting the splenic size. Empirical study has shown that a normative value of splenic size on healthy pediatrics has not been documented in Kano. Intensive literature review showed that there are some published research articles on normative value of splenic size among apparently healthy paediatrics in south eastern Nigeria, but the studies were conducted on certain paediatric age groups (from 6 to 17years) which serves as missing gab. The findings of this study will serve as a guide to the sonographers, radiologists and physicians in the diagnosis and management of pathological conditions affecting the splenic size in pediatric. The study aimed at evaluating splenic dimensions in apparently healthy pediatric in Kano metropolis Nigeria using ultrasound.

Materials and methods

This study was cross-sectional conducted in Murtala Muhammad Specialist Hospital, Ja'en Primary Health Care Hospital and Unguwa Uku Primary Health Care Hospital in Kano Metropolis, Nigeria, from May 2020 to October 2020. An ethical approval was obtained from the Human Research and Ethics Committee of the Kano State, Ministry of Health and informed consent was obtained either directly from the subjects or from the subject's relatives. These were the subjects visiting the out- patient department either for routine immunization or asymptomatic children accompanying their families to radiology department. A convenient sampling method was employed and a sample size of 420 apparently healthy pediatric subjects within Kano metropolis were studied; involving 210 males and 210 females within the age range of 0 – 17years was used. The sample size was determined by the Cochran's formula as shown below;

$$n = \frac{z^2\ pq}{e^2}$$

Where:

n = minimum sample size
z = percentage point of distribution at 95% confidence interval (1.96)
p = prevalence from other previous study = 50% (0.5)
q = 1-p (complimentary probability) = 0.5
e = maximum sample size error = 5% (0.05)
$n = (1.96)^2*0.5*0.5/(0.5)^2$
n = 3.8416*0.25/0.0025
n = 0.9604/0.0025
n = 385.16
The sample size was upgraded to 420 subjects.

The exclusion criteria included pediatric subjects with malaria and typhoid fever, which could be known from the subject's history, subject with sickle cell disease, systematic diseases such as cardiovascular disease which can leads to congestion of the splenic veins and hence causing splenomegaly, congenital anomaly and pediatric subjects with HIV which could be obtained from the subject's history. Ultrasound scans were performed using Portable digital ultrasonic machine (G.E); model DP-8800Plus with 3.5Mhz transducer by a qualified sonographer.

The Subject lied supine on the scanning table, the sonographer was on the right side of the subject. In a situation where by subject cannot comply may be due to anxiety he/she was reassured or supported by his/her relatives. Ultrasound gel was applied on the epigastric and left upper quadrant of the abdomen. The coronal plane was obtained that includes the hilum, greatest longitudinal distance is measured which is the distance between the splenic dome and the tip as the splenic length. On transverse plane of the body, transverse view of the spleen was obtained, the splenic width is measured as the greatest dimension on the transverse image through the hilum. The thickness is measured as a distance between the hilum and the dome of the spleen. All measurements were recorded. Average reading was taken after three different measurements. The Body Mass Index (BMI) was obtained by expressing the weight in Kg over the square of the height in meters (kg/ m2) while the body surface area (BSA) was calculated using Mosteller formula. All the measurements were recorded into the data capture sheet.

Figure 1. Sonogram of anteroposterior and splenic length of apparently healthy male pediatric.

Statistical Analysis

The data passed normality test using Shapiro-Wilk test, therefore parametric method of data analysis was used. The mean and standard deviation and range of age, height, weight, BMI, BSA, and splenic dimensions were obtained using descriptive statistics. The independent two-sample *t*-test was used to compare male and female splenic dimensions. One-way ANOVA was used to compare the splenic dimensions between the six age groups. Furthermore, a Tukey Post-Hoc Test of multiple comparisons was used to compare the splenic dimensions between one group and the other groups. Pearson's correlation was used to correlate splenic dimension with the anthropometric variables. The data were analyzed using statistical package for social sciences (IBM SPSS) version 23.0. the statistical level of significance was set at $P<0.05$

Results

Table: 1: Anthropometrical variables of the male's subjects.

Age groups	Anthropometrical variables				
	AGE Mean± SD	**Height(m) Mean± SD**	**Weight(kg) Mean± SD**	**BMI(kg/m²) Mean± SD**	**BSA(m²) Mean± SD**
Neonate	13.17±7.6 (1-25)	.55±.03 (.5-.67)	4.0±.1.0 (2-6)	13.17±3.7 (6-21)	.23±.03 (.16-.3)
Infant >1m <12m n=35	5.9±2.9 (2-11)	.62±.045 (.5-.76)	7.5±1.3 (5-10)	19.3±3.2 (13-26)	.34±.04 (.26-.42)
Toddler 12 - <24m n=34	17.7±4.5 (12-23)	.76±.077 (.65-.89)	8.12±1.70 (4-10)	14.59±2.8 (9.5-20)	.40±.062 (.27-.50)
Preschool 24 - <60m n=35	3.23±.85 (3-5)	.88±.097 (.52-1.1)	13.0±2.0 (7-18)	16.7±5.3 (11-44.5)	.54±.07 (.36-.68)
School age 5 -<13y n=42	8±2.5 (5-12)	1.20±.13 (.9-1.45)	21.3±5.42 (13-32)	15.13±3.8 (7.5-27.5)	.84±.14 (.60-1.13)
Teenagers 13-17y n=35	14.3±1.8 (13-17)	1.53±.11 (1.3-1.76)	41.5±6.25 (12-24)	18.0±3.3 (12-24)	1.33±.11 (1.12-1.56)

Table 2: Anthropometrical variables of the female's subjects

Age groups	Anthropometrical variables				
	AGE Mean± SD	**Height(m) Mean± SD**	**Weight(kg) Mean± SD**	**BMI(kg/m²) Mean± SD**	**BSA(m²) Mean± SD**
Neonate	12.7±7.8 (1-26)	.59±.89 (.5-1.0)	3.57±.74 (2-5)	10.7±2.5 (5-16)	.23±0.03 (.16-.29)
Infant >1m <12m	5.9±2.9 (2-11)	.63±.046 (.5-.76)	8.1±1.7 (5-10)	14.59±2.8 (9.5-20)	.34±.04 (.26-.42)
Toddler 12 - <24m	17.4±4.47 (12-23)	.75±.078 (.65-.89)	8.12±1.72 (4-10)	14.59±1.9 (9.5-20)	.39-.06 (.27-.49)
Preschool 24 - <60m	3.25±.84 (3-5)	.87±.097 (.52-1.1)	12.5±1.99 (7-18)	16.7±5.3 (11-44.4)	.53±.069 (.36-.67)
School age 5 -<13y	8±2.45 (5-12)	1.20±.13 (.9-1.45)	21.3±5.42 (13-32)	15.13±3.8 (7.5-27.5)	.84±.14 (.60-1.13)
Teenagers 13-17y	14.4±1.8 (13 -17)	1.53±.11 (1.3-1.76)	41.4±6.25 (12-23.7)	17.95±3.3 (12-23.6)	1.33±.11 (1.13-1.57)

Table 3: Splenic dimension of the subjects

Age groups	Splenic Dimensions (cm)					
	Male (n=210)			Female (n=210)		
	Length Mean± SD	Width Mean± SD	APD Mean± SD	Length Mean± SD	Width Mean± SD	APD Mean± SD
Neonate	4.29±.54 (2.8-5.1)	2.6±.40 (1.98-3.50)	2.21±.30 (1.6-3.0)	4.02±.56 (3.0-1.86)	2.53±.29 (1.8-3.)	2.12±.24 (1.2-2.7)
Infant >1m <12m	5.13±.60 (4.2-6.5)	2.82±.58 (1.9-4.5)	2.9±.49 (2.0-23)	5.13±.60 (4.2-6.5)	2.82±.58 (1.9-4.5)	2.98±.81 (2.0-5)
Toddler 12 -<24m	4.95±2.84 (3.5-7.0)	3.01±.50 (2.1-3.9)	2.46±.78 (1.8-4.6)	4.96±.80 (3.5-7.0)	3.01±.50 (2.1-3.9)	2.46±.78 (1.8-4.6)
Preschool 24 - <60m	6.09±.93 (4.3-7.8)	3.0±.53 (1.9-3.9)	2.48±.52 (1.5-3.5)	6.01±.93 (4.3-7.8)	2.97±.53 (1.9-3.9)	2.48±.52 (1.5-3.5)
School age 5 - <13y	7.00±.95 (5.4-9.1)	3.57±.88 (2.0-6.1)	2.84±.58 (2.0-4.5)	6.9±.95 (5.4-9.1)	3.6±.84 (2.0-6.1)	2.8±.58 (2.0-5.3)
Teenagers 13 - 17y	9.42±2.79 (4.9-14.6)	3.72±.82 (2.5-5.6)	3.21±.74 (1.9-4.9)	9.41±2.79 (4.9-14.6)	3.72±.82 (2.5-5.6)	3.21±.74 (1.9-4.9)

Table 4: Comparison of splenic length between male and female subjects

Age groups	Male Mean (cm)	Female Mean (cm)	Means Difference	*p*-value
Neonate	4.29±.54 (2.8-5.1)	4.02±.56 (3.0-1.86)	-.27	.047
Infant >1m <12m	5.13±.60 (4.2-6.5)	5.13±.60 (4.2-6.5)	.183	.342
Toddler 12 - <24m	4.95±2.84 (3.5-7.0)	4.96±.80 (3.5-7.0)	-.601	.004
Preschool 24 - <60m	6.09±.93 (4.3-7.8)	6.01±.93 (4.3-7.8)	-1.02	.000
School age 5 -<13y	7.00±.95 (5.4-9.1)	6.9±.95 (5.4-9.1)	.363	.166
Teenagers 13-17y	9.42±2.79 (4.9-14.6)	9.41±2.79 (4.9-14.6)	1.694	.001

Table 5: Comparison of splenic width between male and female subjects

Age groups	Male Mean (cm)	Female Mean (cm)	Means Difference	*p*-value
Neonate	2.6±.40 (1.98-3.50)	2.53±.29 (1.8-3.)	-.065	.439
Infant >1m <12m	2.82±.58 (1.9-4.5)	2.82±.58 (1.9-4.5)	-.0129	.911
Toddler 12 - <24m	3.01±.50 (2.1-3.9)	3.01±.50 (2.1-3.9)	-.167	.251
Preschool 24 - <60m	3.0±.53 (1.9-3.9)	2.97±.53 (1.9-3.9)	.217	.062
School age 5 -<13y	3.57±.88 (2.0-6.1)	3.6±.84 (2.0-6.1)	.427	.053
Teenagers 13-17y	3.72±.82 (2.5-5.6)	3.72±.82 (2.5-5.6)	2.154	.000

Table 6: Comparison of splenic AP diameter between male and female subjects

Age groups	Male Mean (cm)	Female Mean (cm)	Means Difference	*p*-value
Neonate	2.21±.30 (1.6-3.0)	2.12±.24 (1.2-2.7)	-.091	.176
Infant >1m <12m	2.9±.49 (2.0-23)	2.98±.81 (2.0-5)	-.278	.651
Toddler 12 - <24m	2.46±.78 (1.8-4.6)	2.46±.78 (1.8-4.6)	-.537	.387
Preschool 24 - <60m	2.48±.52 (1.5-3.5)	2.48±.52 (1.5-3.5)	.195	.081
School age 5 -<13y	2.84±.58 (2.0-4.5)	2.8±.58 (2.0-5.3)	.256	.106
Teenagers 13-17y	3.21±.74 (1.9-4.9)	3.21±.74 (1.9-4.9)	1.014	.000

Table 7: Comparison of splenic dimensions between different age groups using one-way ANOVA

Splenic length			**Splenic width**			**Splenic AP diameter**		
Mean(cm)	**F***	***p*-value**	**Mean(cm)**	**F***	***p*-value**	**Mean(cm)**	**F***	***p*-value**
6.19 ± 2.39	235.9	0.000	3.36 ± 1.19	73.74	0.000	2.79±1.27	14.01	0.000

Table 8: Comparison of splenic length between different groups using Tukey Post-hoc test.

(Age Group)i	(Age Group)j	Mean Difference	*p*-value
<28days	>1month<12month	-1.04	0.000
	12month – <24month	-0.49	0.168
	24month – <60month	-1.40	0.000
	5 – <13years	-3.03	0.000
	13 – 17years	-6.10	0.000
>1 – <12months	<28days	1.04	0.000
	12month – <24month	0.54	0.100
	24month – <60month	-0.37	0.478
	5 – <13years	-1.99	0.000
	13 – 17years	-5.05	0.000
12 – <24month	<28days	0.49	0.168
	>1month<12month	-0.54	0.100
	24month – <60month	-0.91	0.001
	5 – <13years	-2.54	0.000
	13 – 17years	-5.60	0.000
24 – <60months	<28days	1.41	0.000
	>1month<12month	0.37	0.478
	12month – <24month	0.91	0.000
	5 – <13years	-1.62	0.000
	13 – 17years	-4.68	0.000
5 – <13years	<28days	3.03	0.000
	>1month<12month	1.99	0.000
	12month – <24month	2.54	0.000
	24month – <60month	1.62	0.000
	13 – 17years	-3.06	0.000
13 – 17years	<28days	6.10	0.000
	>1month<12month	5.05	0.000
	12month –< 24month	5.60	0.000
	24month – <60month	4.68	0.000
	5 – <13years	3.06	0.000

Table 9: Comparison of splenic width between different groups using Tukey Post-hoc test.

(Age Group)i	(Age Group)j	Mean Difference	*p*-value
<28days	>1month<12month	-0.27	0.424
	12month – <24month	-0.35	0.162
	24month – <60month	-0.52	0.007
	5 – <13years	-1.19	0.000
	13 – 17years	-2.43	0.000
>1 – <12months	<28days	0.28	0.424
	12month – <24month	-0.08	0.995
	24month – <60month	-0.24	0.587
	5 – <13years	-0.91	0.000
	13 – 18years	-2.16	0.000

(Age Group)i	(Age Group)j	Mean Difference	*p*-value
12 – <24month	<28days	0.35	0.162
	>1month<12month	-0.08	0.995
	24month – <60month	-0.16	0.882
	5 – <13years	-0.83	0.000
	13 – 17years	-2.07	0.000
24 – <60months	<28days	0.52	0.007
	>1month<12month	0.24	0.587
	12month – <24month	0.16	0.882
	5 – <13years	-0.67	0.000
	13 – 17years	-1.91	0.000
5 – <13years	<28days	1.18	0.000
	>1month<12month	0.91	0.000
	12month – <24month	0.83	0.000
	24month – <60month	0.67	0.000
	13 – 17years	-1.24	0.000
13 – 17years	<28days	2.43	0.000
	>1month<12month	2.16	0.000
	12month – <24month	2.07	0.000
	24month – <60month	1.91	0.000
	5 – 13years	1.24	0.000

Table 10: Comparison of splenic AP diameter between different groups using Tukey Post-hoc test.

(Age Group)i	(Age Group)j	Mean Difference	*p*-value
<28days	>1month<12month	-0.56	0.057
	12month – <24month	-0.42	0.284
	24month – <60month	-0.41	0.313
	5 – <13years	-0.78	0.001
	13 – 17years	-1.56	0.000
>1 – <12months	<28days	0.56	0.057
	12month – 24month	0.14	0.982
	24month – <60month	0.16	0.972
	5 – <13years	-0.21	0.893
	13 – 17years	-1.00	0.000
12 – <24month	<28days	0.42	0.284
	>1month<12month	-0.14	0.982
	24month – <60month	0.14	1.000
	5 – <13years	-0.36	0.480
	13 – 17years	-1.14	0.000
24 – <60months	<28days	0.41	0.313
	>1month<12month	-0.15	0.972
	12month – <24month	-0.14	1.000
	5 – <13years	-0.36	0.426
	13 – 17years	-1.16	0.000
5 –< 13years	<28days	0.78	0.001
	>1month<12month	0.21	0.893
	12month – <24month	0.36	0.480
	24month – <60month	0.37	0.426
	13 – 17years	-0.78	0.001

(Age Group)i	(Age Group)j	Mean Difference	*p*-value
13 – 17years	<28days	1.56	0.000
	>1month<12month	1.00	0.000
	12month – <24month	1.14	0.000
	24month – <60month	1.16	0.000
	5 – <13years	0.79	0.001

Table 11: Correlation of splenic length dimension and anthropometrical variables of male subjects

Age groups	Age (years)		Height (m)		Weight (kg)		BMI (kg^{2}m)		BSA (m^2)	
	r	P	r	p	R	P	r	p	r	p
Neonate	.575**	.000	.384	.023	.160	.360	.193	.268	.310	.070
Infant (1m-<12m)	.659**	.000	.334*	.050	.338*	.047	.102	.558	.370*	.029
Toddler (12-<24m)	.659**	.000	.334*	.050	.338*	.047	.102	.558	.370*	.029
Preschool (25-<60m)	.42**	.003	.22	.209	.43*	.010	.24	.169	.39*	.020
School age (5-<13y)	.42**	.003	.22	.209	.43*	.010	.24	.169	.39*	.020
Teenagers (13-17y)	.56**	.000	.59**	.000	.40*	.017	.31	.065	.55**	.001

** correlation is significant at 0.01 p-value

Table 12: Correlation of splenic length dimension and anthropometrical variables of female subjects

Age groups	Age (years)		Height (m)		Weight (kg)		BMI (kg^{2}m)		BSA (m^2)	
	r	P	r	p	r	P	r	p	r	p
Neonate	.492**	.003	.221	.201	.429*	.010	.238	.169	.392*	.020
Infant (1m<12m)	.57**	.000	.60**	.000	.40*	.017	.40*	.017	.55**	.001
Toddler(12-<24m)	.49**	.003	.22	.209	.43*	.010	.24	.169	.39*	.020
Preschool (25-<60m)	.64**	.000	.56**	.000	.58*	.025	.18	.219	.51**	.002
School age (5-<13y)	.64**	.000	.56**	.000	.58*	.025	.18	.219	.51**	.002
Teenagers (13-17y)	.56**	.000	.59**	.000	.40*	.017	.31	.065	.55**	.001

Table 13: Correlation of splenic width and anthropometrical variables of the male subjects

Age groups	Age (years)		Height (m)		Weight (kg)		BMI (kg^2m)		BSA (m^2)	
	r	P	r	p	r	P	r	p	r	p
Neonate	.255	.139	.509	.002	.276	.109	.172	.324	.454	.006
Infant (1m<12m)	.61**	.000	.52**	.001	.26	.212	.29	.085	.146	.401
Toddler(12-<24m)	-.091	.603	-.134	.442	-.127	.468	.069	.695	.146	.401
Preschool (25->60m)	.59**	.000	.42*	.012	.32	.066	.04	.82	.41*	.14
School age (5-<13y)	.077	.659	.322	.060	.050	.774	.219	.206	.197	.258
Teenagers (13-17y)	.49**	.002	.38*	.024	.11	.527	.31	.064	.27	.133

Table 14: Correlation of splenic width and anthropometrical variables of the female subjects

Age groups	Age (years)		Height (m)		Weight (kg)		BMI (kg^2m)		BSA (m^2)	
	r	P	r	p	r	P	r	p	r	p
Neonate	.077	.660	.322	.060	.05	.774	.219	.206	.197	.258
Infant (1m<12m)	.59**	.000	.42*	.012	.32	.066	.04	.820	.41*	.014
Toddler(12-<24m)	.49**	.002	.38*	.024	.11	.527	.32	.640	.27	.133
Preschool (25-<60m)	.08	.659	.32	.060	.05	.774	.21	.206	.19	.258
School age (5-<13y)	.43*	.011	.45**	.006	.49**	.003	.088	.621	.53**	.001
Teenagers (13-17y)	.49**	.002	.38*	.024	.11	.527	.31	.064	.27	.113

Table 15: Correlation of splenic AP diameter and anthropometrical variables of the male subjects

Age groups	Age (years)		Height (m)		Weight (kg)		BMI (kg^2m)		BSA (m^2)	
	r	P	r	p	r	P	r	p	r	p
Neonate	.443	.008	.580	0.00	.265	.124	.208	.231	.486	.003
Infant (1m<12m)	.280	.109	.298	.087	.303	.082	.039	.828	.331	.056

Age groups	Age (years)		Height (m)		Weight (kg)		BMI (kg²m)		BSA (m²)	
	r	*P*	r	*p*	r	*P*	r	*p*	r	*p*
Toddler (12-<24m)	.023	.896	-.283	.099	.083	.635	.302	.078	.045	.798
Preschool (25-<60m)	.43*	.011	.37*	.031	.39*	.020	.07	.680	.43*	.011
School age (5-<13y)	.088	.617	.226	.192	-.041	.816	.255	.139	.088	.614
Teenagers (13-17y)	.42	.399	-.03	.858	.07	.690	.11	.530	.02	.895

Table 16: Correlation of splenic AP diameter and anthropometrical variables of the female subjects

Age groups	Age (years)		Height (m)		Weight (kg)		BMI (kg²m)		BSA (m²)	
	r	*P*	r	*p*	R	*P*	r	*p*	r	*p*
Neonate	.088	.617	.226	.192	0.41	.816	.255	.139	.88	.614
Infant (1m<12m)	.59**	.000	.42*	.012	.32	.066	.04	.820	.41*	.014
Toddler (12-<24m)	.15	.400	-.03	.858	.07	.690	.11	.530	.02	.895
Preschool (25-<60m)	.49**	.003	.22	.209	.43*	.010	.24	.169	.39*	.020
School age (5-<13y)	.21	.233	.09	.593	.21	.230	.13	.435	.17	.322
Teenagers (13-17y)	.147	.399	-.031	.858	.070	.690	.110	.530	.023	.895

Discussion

The findings of this study as shown in **Tables 1 and 2** are lower than the findings of the previous studies conducted by Dhingra *et al.* [14], Eze *et al.* [5], Megrimis *et al.* [10], Thapa *et al.* [15], Werrakul *et al.* [16] and Umeh *et al.* [17]. The possible reasons for the differences might be, all the previous studies with the exception of Megrimis *et al* [10] did not sub-divide their study subjects in to different pediatric age groups and compute the anthropometric variables independently. Furthermore, studies by Dhingra *et al.* [14] Thapa *et al.* [15] and Werrakul *et al.* [16] reported higher anthropometrical values. The possible reasons might be due to environmental, racial, dietary and socioeconomic differences. However, Eze *et al.* [5] and Umeh *et al.* [17] conducted their studies in Nigeria, but, they only consider school age children within the age range of 6-17years, this might be the reason of the difference in anthropometric variables with the current study.

As shown in **Table 3**, the splenic length reported in this study was similar to what was reported by Megrimis *et al.* [10]. However, Megrimis *et al* [10] did not reported the measurements of the splenic width and anterior-posterior diameter (APD). Measuring all the three splenic dimensions are more accurate and reliable in defining splenomegaly. The similarities might be due to the fact that the studies adopted a similar research method and consider the same pediatric age range. Furthermore, the findings of the current study as shown in **Table 3** were contrary to the findings of the studies conducted by Dhingra et al [14], Thapa *et al.* [15] and

Werrakul *et al.* [16]. The possible reason might be due to environmental, racial, dietary and socioeconomic difference. However, Eze *et al.* [5] and Umeh *et al.* [17] conducted their studies in Nigeria, but, they only considered school age children within the age range of 6-17years. This might be the possible reason of the difference with the current study.

Table 4 shows there was a statistical significance difference in splenic length between male and female subjects among the neonates, toddler, preschool age and adolescence ($p<0.05$). However, there was no statistical significance difference in splenic length between males and females subject among infant and school age pediatric ($p>0.05$). This was contrary to the previous studies conducted by Megrimis *et al.* [10] and Eze *et al.* [5] that reported no statistical significant difference in splenic length between male and female subjects in all the pediatric age groups ($p>0.05$). The findings of the current study as shown in **Table 5 and 6** revealed no statistical significance difference in splenic width and anterior-posterior dimensions between male and female subjects among all the pediatric age groups ($p>0.05$) with the exception of adolescence group ($p<0.05$). With the exception of Eze *et al.* [5] the previous studies did not report the measurements of the splenic width and anterior-posterior dimensions. **Table 7** shows a statistical significant difference in splenic dimensions between the different pediatric age groups using One-way ANOVA. Furthermore, Tukey post-hoc test of multiple comparisons as shown in **Tables 8, 9 and 10** revealed there was a statistical significant difference in splenic dimensions between all age groups ($p=0.000$), except between >28days and 12month - 12month *(p=0.168),* >1- <12month and 12month - 12month *(p=0.100),* and between >1 <12month and 24month - 60month *(p=0.478)* for the splenic length, between <28days and 1month - <12month *(p=0.424),* <28days and 12month - 24months *(p=0.162),*>1- <12month and 12month - 24month *(p=0.995)*, >1- <12month and 24month - 60month *(p=0.587)* and between 12month – 24month and 24month - 60month *(p=0.882)* for the splenic width and between <28days and >1month<12month (p=0.057), <28days and 12month – 24month (p=0.284), <28days and 24month – 60moonth (p=0.313), >1month - <12month and 12month – 24month (p=0.982), >1month - <12month and 24month – 60month (p=0.972), >1month - <12month and 5 – 13years (p=0.893), 12month - 24month and 24month – 60month (p=1.00), 12month -24month and 5 – 13years (p=0.480), 24month – 60 month and <28days (p=0.313) and between 24month – 60 month and 5- 13years (p=0.426) for the splenic anterior-posterior dimension.

The findings of the current study as shown in **Table 11 & 12** was similar to the findings of the studies conducted by Eze *et al.* [5], Megrimis *et al.* [10] and Ozdikici [18] who reported a strong positive correlation in male and female subjects between splenic length and all the anthropometrical variables. The similarities might be due to the fact that both studies adopted the same scanning technique. However, Megrimis *et al.* [10] measured only splenic length and Eze *et al.* [5] considered only school age children. Furthermore, the findings of this study as shown in **Table 13 & 14** revealed a strong positive correlation in splenic width with age, height, weight, BMI and BSA in both male and female selected subjects. None of the previous studies correlate splenic width with the anthropometrical variables. **Table 15 & 16** revealed a strong positive correlation in splenic AP dimension with the age, height, weight, BMI, and BSA in both male and female selected subjects.

Conclusion

Normative values for the pediatrics splenic dimensions have been established in Kano metropolis. There was a statistical significance difference in splenic length between male and female subjects among all pediatric age groups with the exception of infant and school-age groups. A Strong positive correlation was observed between splenic length, width and AP dimensions with age, height, weight, BMI and BSA.

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