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## Sonographic Evaluation of Liver Dimensions among Apparently Healthy Adult Subjects in Kano Metropolis

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### ABSTRACT

The ability to ascertain the human liver by a sonographer allows for the diagnosis of various liver pathologies, establishing normal liver size aids in determining the treatment method for the underlying liver pathology. The study was aimed at evaluating normal liver size among apparently healthy adult subjects and to establish a reference value in Kano Metropolis. The study design was prospective and cross-sectional conducted in Kano Metropolis from June 2019 to September 2019. Using simple random sampling, a total of 384 subjects were recruited in the study. An EDAN ultrasound machine with a 3.5MHz curvilinear probe was used as the instrument for data collection. Age, height, weight, BMI and BSA were recorded on a data capture sheet. Data was analyzed by SPSS version 23.0. The mean ( $\pm$ SD) for cranio-caudal dimension of the right lobe was found to be 14.99 $\pm$ 0.74cm in males and 14.38 $\pm$ 0.72cm in females, mean left lobe 5.76 $\pm$ 0.85cm in males and 5.39 $\pm$ 0.81cm in females. The mean AP diameter of the right lobe was 13.02 $\pm$ 1.12cm in males and 12.34 $\pm$ 0.95cm in females. Liver dimension in males was greater than that of females ( $p < 0.001$ ). Age and weight show significant moderate correlations with liver dimensions. ( $r = 0.52$ ,  $p < 0.001$  and  $r = 0.44$ ,  $p < 0.001$ ) in both males and females respectively. In Kano Metropolitan population, liver size was greater in males than females. It correlates significantly with age and weight in both males and females.

**Keywords:** Sonographic, liver dimension, Mid-clavicular Line, Kano Metropolis

### Introduction

The liver is the largest abdominal organ in the human body. It weighs approximately 1500 g and is located in the right upper quadrant of the abdomen (Moore, 2013). The liver performs various essential functions which include; metabolism of carbohydrates, proteins and lipid, production of bile that help in the digestion process, detoxification function and storage of vitamins (Barrett, 2012). Various pathological processes may result in either alterations in the size or shape of the liver (Odegaard, 2005). An increased in size beyond normal is termed

hepatomegaly which is linked with various disease conditions which includes inflammatory conditions, fatty infiltration, neoplasms, polycystic liver diseases (Ahmad and Tahir, 2012) high venous pressure causing congestion metabolic diseases and dilated hepatic sinusoids (Childs, 2014). On the other hand reduced liver size may be associated to liver cirrhosis and acute fulminant hepatitis (Singh, 2017). Ultrasound is a real-time, rapid, available and inexpensive technique to evaluate the size of the adult liver and the patient is not exposed to

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ionizing radiation (Singla *et al.*, 2017). Doppler ultrasound can provide important information on the hemodynamics of the portal venous system (Kok *et al.*, 1999). The variations in anthropometric feature of a diverse population, geography, race and region are established fact (Mittal, 2010). In a study conducted by Ozmen *et al.* (2018) in Turkey, liver sizes were found to be (150.04 ± 14.84mm) in males and (147.57 ± 18.32mm) in females. A study conducted by Singh, (2017) in India, the mean liver span in males to be (14.16 cm ± 1.32 cm) and (12.79 cm ± 1.40 cm) in females. In another study conducted by Kratzer *et al.* (2003) in Germany, the average liver length in male subjects was (14.5 ± 1.6 cm) and (13.5 ± 1.7 cm) in female subjects. There is a paucity of data on normal measurement of liver dimension by ultrasonography in Kano Metropolis. The ranged values of AP diameter of right and left lobes and cranio-caudal dimension of 10.58-15.72 cm, 3.57-7.60 cm and 13.10-16.49 cm for males and 9.66-14.95 cm, 3.28-7.72 cm and 12.65-15.94 cm for females will serve as a guide for sonographers, radiologists and physician in patient diagnosis and management. The study was aimed at evaluating sonographic liver dimensions in apparently normal adult subjects in Kano metropolis.

### Materials and Methods

The study design was cross sectional and prospective carried out at some selected hospitals including Murtala Muhammad Specialist Hospital, Aisami Primary Health care and Sheka primary Health care located at different areas of Kano Metropolis from June 2019 to September 2019. The study was approved by the research and ethics committee, Ministry of Health, Kano State and informed consent was obtained from all the subjects. Using a random sampling, a total of 384 subjects were recruited for the study obtained using Cochran formula. Thus;

$$n = \frac{Z^2 pq}{d^2}$$

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

d=maximum sample error = 5 % (0.05) using the above data the sample size was

$$n = (1.96)^2 * 0.5 * 0.5 / (0.05)^2$$

$$n = 3.8416 * 0.25 / 0.0025$$

$$n = 0.9604 / 0.0025$$

$$n = 384$$

Ages ranged 18-65 years. All the selected subjects do not have any history of alcohol consumption, diabetes, liver related abnormality such as cardiac failure, inflammatory disease and neoplasms and pregnant women because of the physiological hypertrophy associated with pregnancy. The age, height, weight, Body Mass Index (BMI) and Body Surface Area (BSA) were recorded on a data capture sheet, sonographic evaluation was done using EDAN D3/DUS3 and ZONECARE ZQ-6602 ultrasound machines each having a convex array probe with 3.5MHz frequency. The liver dimensions were measured from the dome of the diaphragm to the tip of the right hepatic lobe as described by (Kratzer *et al.*, 2003), the Antero-posterior diameter was measured as described by (Niederau *et al.*, 1983) and the left lobe was also measured based on the method adopted by (Mittal, 2010). Data was analysed using statistical package for social sciences (SPSS version 23.0). The pre-set p value was (≤ 0.05) that is, at 95% confidence interval.

### Results

Data from 384 subjects was assessed of which 50% (n= 192) were male subjects, remaining 50% (n= 192) were female subjects, the

(Mean±Standard deviation and range) values of the anthropometric variables (Height, weight, BMI and BSA) for both genders are shown in Table 1. It shows the mean age, height, weight, BMI, BSA and the standard deviation of the male selected subjects was 36.65 ± 12.55 years, 168.08±7.79 cm, 69.32 ±12.23 Kg, 24.53±3.99 Kg/m<sup>2</sup> and 1.79 ± 0.17 m<sup>2</sup>, while that of the female subjects were 26.90 ± 8.17 years, 159.84 ± 5.86 cm, 60.61±14.65 Kg, 23.66 ± 6.10 Kg/m<sup>2</sup> and 1.62 ± 0.23 m<sup>2</sup>. Mean values of all the variables are greater among males than females. The mean dimensions of the liver (cranio-caudal, AP diameter of the right lobe and AP diameter of the left lobe) are greater in male subjects than female subjects as shown in Table 2. The mean AP

diameter of the right and left liver lobes and cranio-caudal dimension and the standard deviation of the male selected subjects were 13.02±1.12 cm, 5.76±0.85 cm and 14.99±0.74 cm, while that of the female subjects were 12.34 ± 0.95 cm, 5.39±0.81 and 14.38±0.72 cm.

There are statistically significant differences in all the liver measurements between genders (p<0. 05) as shown in Table 3. The Correlation between liver dimensions and anthropometric variables in male and female subjects are shown in Table 4 and 5 respectively, age and weight in both genders showed significant positive correlation than height, BMI and BSA.

**Table 1:** Demographic information of the selected subjects, the Mean ± SD and range

Gender	Demographic Variables				
	Age (years)	Height(cm)	Weight(Kg)	BMI(Kg/m <sup>2</sup> )	BSA(m <sup>2</sup> )
<b>Males</b>	36.65 ± 12.55 (18-65)	168.08±7.79 (114-190)	69.32 ±12.23 (40-110)	24.53±3.99 (15.70-38.57)	1.79 ± 0.17 (1.13-2.40)
<b>Females</b>	26.90 ± 8.17 (18-55)	159.84 ± 5.86 (147-175)	60.61±14.65 (32-107)	23.66 ± 6.10 (0.0-44.3)	1.62 ± 0.23 (0.0-2.18)

**Table 2:** Mean, Standard Deviation and range values of the AP diameter of the right and left lobes and cranio-caudal dimensions in male and female selected subjects

Gender	Liver dimensions		
	Right lobe(cm)	Left lobe(cm)	Cranio-caudal(cm)
<b>Males</b>	13.02±1.12 (10.58-15.72)	5.76±0.85 (3.57-7.60)	14.99±0.74 (13.10-16.49)
<b>Females</b>	12.34 ± 0.95 (9.66-14.95)	5.39±0.81 (3.28-7.72)	14.38±0.72 (12.65-15.94)

**Table 3:** Differences in liver dimensions between males and females

Liver lobes	Statistical output	
	Mean difference	$\rho$ -value
Right lobe	11.68	0.000
Left lobe	4.57	0.000
Cranio-caudal	13.68	0.000

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**Table 4:** Correlation of liver dimension with anthropometric variables in male subjects  
r: correlation coefficient,  $\rho$ : significance

Liver variables	Demographic variables									
	Age		Height		Weight		BMI		BSA	
	r	$\rho$	r	$\rho$	r	$\rho$	r	$\rho$	r	$\rho$
Right lobe	0.45	0.000	0.82	0.25	0.23	0.001	0.20	0.004	0.23	0.001
Left lobe	0.08	0.27	-0.001	0.98	0.44	0.000	0.47	0.000	0.38	0.000
Cranio-caudal	0.52	0.000	0.14	0.048	0.35	0.000	0.29	0.000	0.35	0.000

**Table 5:** Correlation of liver dimensions with anthropometric variables in female subjects  
r: correlation coefficient,  $\rho$ : significance

Liver variables	Age		Height		Weight		BMI		BSA	
	r	$\rho$	r	$\rho$	r	$\rho$	r	$\rho$	r	$\rho$
Right lobe	0.49	0.000	0.65	0.37	0.40	0.000	0.38	0.000	0.40	0.000
Left lobe	0.18	0.01	0.15	0.03	0.33	0.000	0.27	0.000	0.34	0.000
Cranio-caudal	0.50	0.000	0.09	0.20	0.37	0.000	0.34	0.000	0.37	0.000

## Discussion

The findings of the current study as shown in Table 1 are almost similar to the findings of the studies conducted by Tarawneh *et al.* (2010) and Kheiralla *et al.* (2016) that reported a mean value of  $41.1 \pm 16.1$  years for males'  $37.8 \pm 13.7$  years in females and 32.5 years for males and 38.8 years in females. The findings of the study as shown in Table 1 are similar to the findings of the studies conducted by Kheiralla *et al.* (2016); Singh *et al.*, (2017) that showed male subjects have greater height compared to females despite the differences in the study locations (Saudi and India). The findings of the study as shown in table 1 are also similar to the findings of the study conducted Kheiralla *et al.* (2016) that reported a mean weight of 65.5Kg for males and 64.4Kg for females. The findings of the study as shown in table 1 are similar to the findings of the study conducted by Tarawneh *et al.* (2010) that reported BMI of 24.30 in males and 23.4 in females. However, the findings of the study as shown in Table 1 are contrary to the findings of the study conducted by Singla *et al.* (2017) that reported the BMI to be 18.5 kg/m<sup>2</sup> - 24.9 kg/m<sup>2</sup>. Furthermore, the findings of the study as shown in Table 1 are similar to the findings of the studies conducted by Tarawneh *et al.* (2010); Ozmen *et al.*, (2018) that reported BSA values slightly higher than the current study. The possible reason may be as a result of the heights in the two studies greater than the current finding. The AP diameter of the right lobe shown in Table 2 from the current study finding is higher than those reported by Niederau *et al.* (1983), differences in the findings might be due to geography and duration at which the research was conducted. The mean cranio-caudal dimensions of the right liver lobe as shown by this study are  $14.99 \pm 0.74$ cm in males and  $14.38 \pm 0.72$ cm in females as shown in Table 2, the findings were close to the findings reported by Kratzer *et al.* (2003), who reported the mean size to be  $14.5 \pm 1.6$  cm in males and  $13.5 \pm 1.7$

cm in female subjects, the methods used in the two studies were the same, this might be the possible reason for the agreement, while study population and design might be the possible reasons for disagreement with other studies. The findings of the study are contrary to the findings of the study conducted by Mittal *et al.* (2010) who reported the left liver lobe to be  $9.28 \pm 0.85$ cm for male subjects and  $9.17 \pm 1.03$ cm in female subjects, the differences might be attributed to the right lobe dimension recorded by Mittal *et al.* (2010) which was also less than what was reported by the current finding. The findings of the current study show significant differences between AP diameters of the right lobe, Cranio-caudal dimensions of the right liver lobe and AP diameters of the left lobe in males and females ( $p < 0.05$ ) as shown in Table 3, this is in agreement with the findings of the study reported by (Kratzer *et al.* 2003; Udoaka *et al.* 2013; Patzak *et al.*, 2014; Ozmen *et al.*, 2018). However, a study conducted by Kangasa *et al.* (2018) found that there was no statistical significant difference between liver sizes in males and female. Furthermore, the findings of this study showed a significant weak positive correlation between Cranio-caudal dimension and height in males ( $r=0.14$ ,  $p=0.048$ ) as shown in Table 4. This was similar to findings by Kheiralla *et al.* (2016). However, the findings show no significant weak correlation between the height the right lobe ( $r=0.092$ ,  $p=0.204$ ) as shown in table 4, this was contrary to the findings of the study reported by Kheiralla *et al.* (2016), this might be due to differences in mean height between the two studies. Age in females showed a significant moderate positive correlation with the right lobe and Cranio-caudal dimensions ( $r=0.49$ ,  $p < 0.05$ ) and ( $r=0.50$ ,  $p < 0.05$ ) respectively as shown in table 5. In the male a moderate positive significant correlation is shown between the age and cranio-caudal size of the liver ( $r=0.52$ ,  $p < 0.05$ ), as shown in Table 4, this finding differs from those reported by

Ozmen *et al.* (2018) who showed that there was no significant correlation between liver size and age among males ( $r = 0.034$ ,  $\rho = 0.535$ ). The findings of the study show moderate positive correlation between Cranio-caudal size and AP diameters of the right liver lobe and weight in males ( $r=0.40$ ,  $\rho < 0.05$ ) and ( $r=0.45$ ,  $\rho < 0.05$ ) respectively as shown in Table 4. This is in line with the studies conducted by (Tarawneh *et al.* 2010; Ozmen *et al.* 2018). BMI showed a moderate but significant correlation with a left liver lobe in males ( $r=0.47$ ,  $\rho < 0.05$ ) as shown in Table 4, this is almost close to findings of the study conducted by Ozmen *et al.* (2018) and contrary to the findings of the study conducted by (Udoaka *et al.*, 2013). BSA on the other hand showed a moderate significant correlation with a right lobe in female subjects in the order ( $r=0.40$ ,  $\rho < 0.05$ ) and showed a positive, but weaker and significant correlation with other liver measurements in both males and females ( $\rho < 0.05$ ) as shown in Table 5. This is in agreement with the findings of (Tarawneh *et al.*, 2010).

### Conclusions

Liver size is affected by many variables depending on geographical location, race and ethnicity. Our study has provided a reference value to evaluate liver sizes during assessment for any counterintuitive enlargement, liver dimensions were significantly higher in males compared to females, also age and weight in both genders show a significant positive correlation with liver dimensions.

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### Competing interests

Authors have declared that no competing interests exist.

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