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Liver Span by Ultrasound in Healthy Adults in Zaria, North-Western Nigeria

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Abstract: Background*: Liver span may provide information concerning the diagnosis, treatment, and prognosis of various gastrointestinal and hematological diseases. Ultrasound has been found to be both accurate and reliable for these measurements.*
Aims of the study*: The present study was planned to establisha normative data for liver span by ultrasound and to study its correlation with some anthropometric variables in adults' Nigerian population in Zaria.*
Materials and Method*: Thestudy was conducted in the Department of Radiology and Human Anatomy, Ahmadu Bello University, Zaria between January and August 2016. Three hundred and fifty apparently healthy young adults (175 males and 175 females) resident in Zaria who gave their informed consent were randomly selected and recruited for the study. The study proocol was approved by the Ethical Committee of the University. The longitudinal dimension of the liver was obtained in the midclavicular plane with the subject in deep inspiration. In addition, the age, sex, height (Ht) and weight (Wt) of the subjects were recorded. The liver scan was done with a Mindray diagnostic ultrasound system (Model DC-3, 2010/2012, Nanshan, Shenzen, PR China) plus 2.5-6 MHZ curvilinear probe. Hard copy image was taken for documentation, and all the measurement was done by a single trained sonologist to reduce inter-observer errors.*
Results*: There was no significant sex related differences in the liver span (P>0.05) as such the mean liver span for the overall population was 14.15±1.46 cm.The liver span was significantly positively correlated with Ht (r=0.260), Wt (r=0.390), BMI (0.276) and BSA (0.393). The strongest correlation was observed between liver span and BSA.*
Conclusion*: TheNormal value of liversize in the adult Nigerian population in Zaria (North Western region) and model for predicting liver span hasbeen generated [Liver span=8.286+3.520 (BSA)].*
Keywords:*Sonography, Measurements, Liver span, Zaria*

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I. Introduction

Liver span determination can provide vital information concerning the diagnosis, treatment, and prognosis of various gastrointestinal and hematological diseases and malignancies[1]. Theclinical assessment method and diagnostic imaging technique are the two methods employed in the assessment of liver span. In the clinicalassessment method, liver examination is done at the bedside by palpation, percussion and ballottement. Some of the draw backs of this method is that the largest portion of the liver which is hidden in the thoracic cage makes it partially inaccessible for the examiner's hand. Another limitation is that some pathological condition such as pleural effusion and ascites may affect liver span estimation leading to either overestimation orunderestimation of the actual liver size[2, 3]. For these and other reasons not mentioned, this method is not a gold standard for accurate estimation of liver span. The diagnostic imaging modalities of liver include Ultrasound, Radionuclide Imaging, Computedtomography and Magnetic Resonance Imaging. These imaging modalities by and large, give more precise measurement of the liver span. However, magnetic resonance imaging is expensive and time consumingwhile computed tomography exposes the patient toundesirable amount of ionizing radiation, and radionuclide scan may underestimate the actual liver size[4]. Ultrasound is devoid of these disadvantages and as such it has nowbecome the imaging modality of choice in most of the clinical surveys of the liver span[5].

Ultrasound is cheap, accessible, portable, non-invasive, radiation free, requires little or no neither patient preparation, nor use of medication or routine injection of contrast agent.It has now become a fundamental part of the clinical assessment of healthy as well as pathologic liver[6]. Safaket al[7] has also identified ultrasound as a reproducible, repeatable and reliable technique of imaging.

Several studies have been documentedin international literature[5, 8-15] and a few in the local literature[16, 17] on the exact liver span by ultrasound and its correlation with several anthropometric variables. There is scarcity of information on the averagesonographic value of liver span among Nigerian adults in Zaria. Hence, the present study was planned to establisha normative data for liver span by ultrasound and to study its correlation with some anthropometric variables.

II. Materials and methods

Thestudy was conducted in the Radiology and Human Anatomy Department ofAhmadu Bello University, Zaria between January and August 2016. Three hundred and fifty apparently healthy young adults (175 males and 175 females) resident in Zaria who gave their informed consent were randomly selected and recruited for the study. The protocol for the study was approved by the Ethical Committee of the University and informed consent was obtained pre-participation. The subjects with any prior history of liver disease or any condition that could modify the liver structure or sonographic evidence of hepatic parenchymal lesion or cyst were excluded from the study. The demographic data,height (Ht), and weight (Wt) of the subjects were recorded and body mass index (BMI) and body surface area (BSA) were computed using the Mostelled[18]formula in the Department of Human Anatomy. Afterwards, the participants were taken to the Radiology Department for the scanning. Before the ultrasound examination, the participants were requested to fast overnight in order to reduce food residue and gas in the upper gastrointestinal tract, which may reduce image quality or preclude liver imaging. Alsogeneral physical examination was done prior to the ultrasound to exclude any clinically observable disease that could alter the liver dimensions.All the sonographic examinations were done by a single trained Sonologist in order to avoid inter-observer error. And all measurements were taken in duplicate with their mean values as the real measurement; this was in order to avoid intra-observer error.

III. Scanning technique

The liver ultrasound was done with a Mindray diagnostic ultrasound system (Model DC-3, 2010/2012, Nanshan, Shenzen, PR China) plus 2.5-6 MHZ curvilinear probe.Examinations were done with each subject lying supine according to the agreed scanning techniques described by American Institute of Ultrasound in Medicine Proceedings[19](AIUM). Following application of coupling gel on the area of interest, longitudinal scan image of the liver was done at deep arrested inspiration and with a relaxed abdominal wall.In order to have better access to the liver, subjects were instructed to raise their right hand behind their head, thus increasing the intercostal spaces and the distance from the lower costal margin to the iliac crest. The size of the liver was measured in the right mid- clavicular line (MCL) (with a measurement from the hepatic dome to the inferior hepatic tip) (Fig. 1).

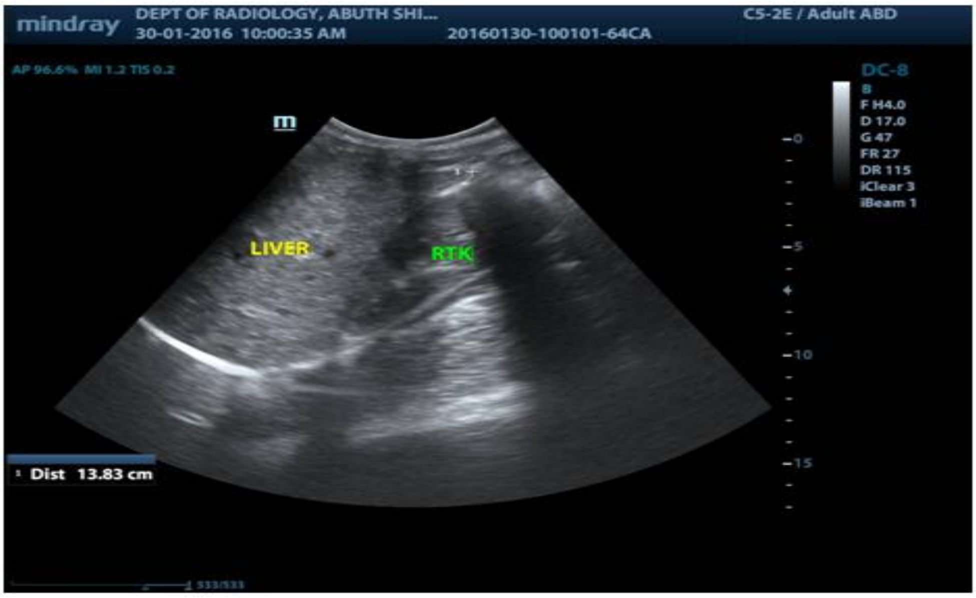

Figure 1: Sonogram showing measurement of liver span

IV. Statistical Analyses

Descriptive statistics was expressed as mean ± standard deviation.Independent sample t-test was used to investigate sexual dimorphism in the variables. The Pearson correlation was used examine the significance of linear associationbetween liver span and anthropometric variables. Stepwise linear regression analysis was used to develop model for the prediction of liver span. All statistical analyses were performed with Statistical Product and Service Solutions (SPSS) version 23.0 and the significance level was set at $p<0.05$.

V. Result

The age range for the general study population is 18 to 35 years with the mean ages for males and females as 22.83±3.29 and 21.54±3.28 years respectively. The mean liver span for the overall population is 14.15±1.46 cm (table 1). In table 2, there is no significant sex related differences in the liver span, however, mean Ht, Wt and BSA aresignificantly higher in males ($P<0.05$) except for the BMI which is higher in the females ($P<0.05$). In figures 2 and 3, liver span is significantly positively correlated with Ht (r=0.260), Wt (r=0.390), BMI (0.276) and BSA (0.393). The strongest correlation is observed between liver span and BSA.

The stepwise regression analysis included only one variable (BSA) for better prediction of liver span. The goodness of fit indicates that the independent variable (BSA) can predict liver span significantly more than by chance, $F(1, 348)=63.497$, $P<0.001$, $R^2=0.154$ (Table 3). The equation for the prediction of liver span has been generated.

Table 1: Descriptivestatistics of liver span and some anthropometric variables

	All Subjects (350)		Male (175)		Female (175)	
Parameters	**Mean±SD**	**Min±Max**	**Mean±SD**	**Min±Max**	**Mean±SD**	**Min±Max**
Age (years)	22.19±3.35	18.00±35.00	22.83±3.29	18.00±35.00	21.54±3.28	18.00±35.00
Weight (Kg)	60.67±10.54	40.00±97.00	61.12±8.73	46.00±86.00	60.23±12.09	40.00±97.00
Height (m)	1.65±0.08	1.46±1.91	1.69±0.07	1.57±1.91	1.62±0.07	1.46±1.77
BMI (kg/m^2)	22.17±3.50	15.8136.13	21.34±2.85	16.90±33.34	23.00±3.89	15.81±36.13
BSA	1.66±0.16	1.31±2.14	1.69±0.14	1.43±2.03	1.64±0.18	1.31±2.14
Liver span (cm)	14.15±1.46	10.41±18.80	14.22±1.20	11.67±17.00	14.07±1.67	10.41±18.80

BMI: Body mass Index; BSA: Body Surface Area

Table 2: Sexualdimorphism in liver span and some anthropometric variables

Parameters	N (male, female)	t-value
Age (years)	350 (175, 175)	3.674
Weight (Kg)	-	0.789^{a*}
Height (m)	-	10.944^{a*}
Body Mass Index (kg/m^2)	-	-4.564^{b*}
Body Surface Area	-	3.158^{a*}
Liver span (cm)	-	0.988

*p< 0.05; a: indicates greater mean values for the males; b: indicates greater mean values for the females

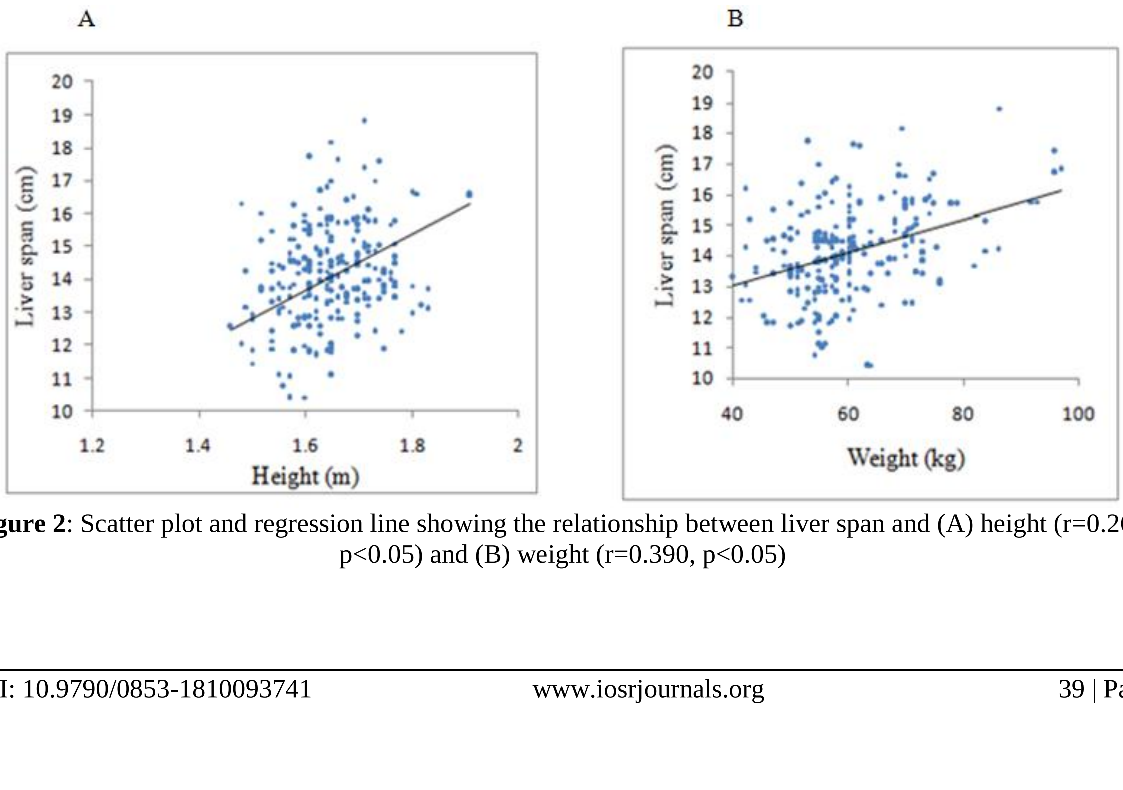

Figure 2: Scatter plot and regression line showing the relationship between liver span and (A) height (r=0.260, p<0.05) and (B) weight (r=0.390, p<0.05)

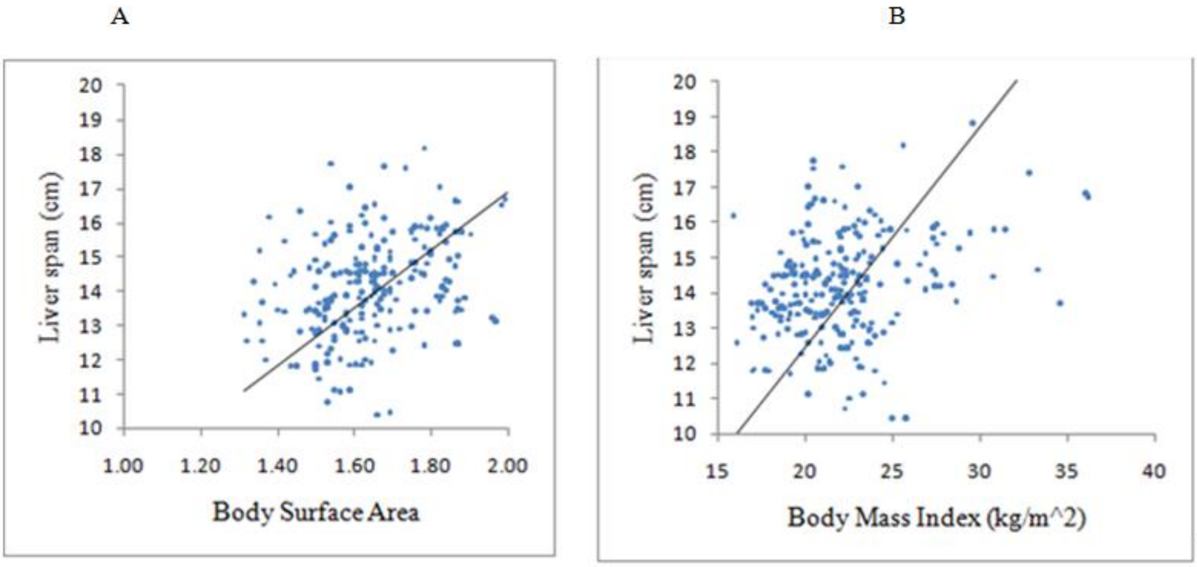

Figure 3: Scatter plot and regression line showing the relationship between liver span and (A) Body surface area (r=0.393, p<0.05) and (B) Body mass index (r=0.276, p<0.05).

Table 3: Stepwise linear regression analysis for the prediction of liver span

Step	Selected Variable	SEE	R	R^2	Df	F-value	P-value
1	Body surface area (BSA)	1.343	0.393	0.154	1, 384	63.497	0.001

SEE: Standard error of estimate; r= Pearson correlation coefficient; R^2= coefficient of determination; df: degree of freedom

Liver span=8.286+3.520 (BSA)

VI. Discussion

In the present study, liver span was not significantly different between the sexes such that the overall mean liver span was 14.15 cm. This result is similar to the reports of other earlier authors[7, 9, 20, 21]. Thus, in this population, sex is not an influential factor for liver span and as such, exceptional tables based on gender are not required. Contrastingly, Udoakaet al[16] found significant sexual dimorphism in the liver span of Southern Nigeria (12.8cm♀, 12.0cm♂) with the overall mean liver span to be 13.13cm. Also, Khereillaet al[5] on adult Saudi population (12.5cm♀, 11.9cm♂) and Tarawneh et al[12] on Jordanian adults (12.6cm♀, 12.1cm♂) observed significant sex related differences in the liver span with the overall span to be 12.5cm and 12.3cm respectively. These values are lower than the one in the present study. The discrepancies in the liver span could be explained by the influence of genetics, nutrition and environmental factors on the different populations. Also these results have shown that it is inappropriate to use the same normogram for the same race or different ethnicitieseven if they are from the same country.

With regards to the correlation of liver span with anthropometric parameters, several authors such as Kratzer et al[10], Konus et al[9], Gamerradin et al[6], Khereilla et al[5], Safak et al[7], Soyupak et al[20], Dhingra et al[13] and Da Silva et al[22]found positive correlations between liver span and Ht, Wt, BMI and BSA with the height or weight been the single best predictor of liver span in the populations. However, Niedarauet al[8] and Udoakaet al[16] did not find significant correlation between liver span and height, weight, BMI and BSA. In the present study similar positive correlations were observed but BSA was the single best predictor of liver span. These disparities with the current study could be explained by the influence of genetics, different ethnic origins or variations in race.

The prediction model of the liver span, in centimeters, was generated according to BSA in this study as a surrogate method for the sonographers. Hence, if the BSA is obtained in a busy practice or in remote settings where ultrasound facility is not readily accessible, the normal liver span for adults in Zaria (North Western Nigeria) aged 18−35 years can be predicted from these equations.

The differences seen in the anthropometric parameters of different populations, regions and races should be taken into cognizance by the Nigerian ultrasound community.Hence, it has become imperative for Nigerians to have their own population specific normograms of the liver span in the studied age group as Western or Asian derived population data cannot be used asgeneralstandard. Our results could be extrapolated to the wider international community where there is need for each country to set up their own specific normograms of liver span in young adults with reference to the body parameter that shows the best correlation with liver span dimensions as BSA might show variation in different ethnic origins or races.

The limitations of this study include the smaller sample size as larger sample size might improve the precision of the estimates and also the generalizability of the data. The nutritional status of the subjects was not recorded and liver function test (LFT) to assess the normal physiologic condition of the liver was not done. It is anticipated that further studies will tackle these limitations.

VII. Conclusion

Normal valuable baseline liver span nomorgram have been established for the study population taking into cognizance the body parameters. A multicentre study is recommended in other regions of the country as this might improve the exactness of the estimates and also the generalizability of the data.

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Conflicts of Interest
There are no conflicts of interest

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