IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 5 Ver. III (May. 2016), PP 27-34
www.iosrjournals.org

Sonographic Average Value Of Normal Liver Span Among Saudi Adults Referred To Najran University Hospital

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Abstract :-*Liver size estimation can be used as an indicator for evaluation of various hepatic or systemic pathological conditions like inflammatory diseases, metabolic diseases and malignancies. There are two main methods of liver size estimation, clinical assessment and diagnostic imaging technique of liver. Clinical assessment includes bedside examination of liver by palpation, percussion and ballottement. There are many limitations for bedside assessment of liver. The first limitation is that the majority of the liver mass is concealed by the thoracic cage away from the examiner's hand. The second limitation is that some pathological condition may affect liver size estimation like pleural effusion, ascites and tympany, leading to overestimation or underestimation of actual liver size. This is why percussion and palpation may not give the precise estimation of liver size. Diagnostic imaging techniques of liver which include Ultrasound, Radionuclide Imaging, Computed tomography and Magnetic Resonance Imaging, can generally give more accurate measurement of liver size, but magnetic resonance imaging is expensive and time consuming, computed tomography exposes the patient to undesirable amount of ionizing radiation, and radionuclide scan may underestimate the actual liver size. Ultrasonography remains the best investigation for accurate and rapid assessment of liver, because it is not harmful, easily applicable and evaluates the size and consistency of liver precisely by real time images. That is why sonographic evaluation of liver size became very popular and represents a large portion of sonographic examination requests in the majority of imaging departments.*

Keywords - *Normal liver span, Ultrasound in Midclavicular Line, Anthropometric variables, Height, Weight and Body Mass Index.*

I. INTRODUCTION

Liver is the largest gland in human body, its weight can reach up to 1500 g in the adult male and up to 1400 g in the adult female., it performs many vital and essential functions like building up of body proteins, formation of bile, processing of nutritional materials, storing some vitamins, iron and simple sugars, purification of human body from toxic substances, conversion of ammonia to urea. Destruction of old red blood cells and hemoglobin. Liver is pyramidal shape located in the right hypochondrium under the right hemidiaphragm, it has three smooth surfaces; superior, inferior and posterior surface. The superior surface is convex and the inferior surface concave with the gallbladder projecting below it. Liver is divided into four main lobes, the right lobe which contains most of the liver's mass, a left lobe, and two small caudate and quadrate lobes. According to Couinaud classification liver can be further divided into eight functionally distinctive segments, each segment has its own branch of the hepatic artery, portal vein and bile duct centrally located and a branch of hepatic vein in the periphery.

Enlargement of liver is associated with different hepatic and systemic diseases which include inflammatory conditions, metabolic diseases, fatty liver, autoimmune diseases, primary and secondary neoplasms, anemias and cardiac failure. On the other hand, reduced liver size may be associated liver cirrhosis. Changing in liver size needs to be evaluated accurately and rapidly. Ultrasound is considered the best imaging modality for liver assessment, it is the most reliable and most applicable examination when the liver evaluation is concerned because it can be applied easily and rapidly without preparation, highly accepted among patients, practical, accurate, not harmful and cheap. Measurement of liver span is one of the vital steps in the sonographic assessment of liver, and it is frequently requested by clinicians for accurate evaluation of liver size, since clinical measurement of liver size by percussion and palpation can be inaccurate because generally the normal

liver is concealed by the right thoracic cage, beyond the examiner's hand and some pathological condition may affect liver size estimation like pleural effusion, ascites and tympany, leading to overestimation or underestimation of actual liver size, magnetic resonance imaging is expensive and time consuming, computed tomography is also expensive and exposes the patient to undesirable amount of ionizing radiation, and radionuclide scan may underestimate the actual liver size.

Many studies have been done all over the word for establishing precise sonographic value of liver span and identify its relation to anthropometric variables. There is deficiency of information on the standard sonographic value span of liver span among Saudi adults by in this region. Therefore, this study was designed to set baseline data for sonographic value of liver span for Saudi adults in Najran and to identify its relationship with anthropometric variables.

II. LITERATURE REVIEW

[1] Ultrasound is the cornerstone imaging method in the evaluation of the liver simply because it is easy to use, inexpensive, quick, and provides real time images and doesn't require anesthesia or utilize ionizing radiation. All anthropometric variables contribute highly and significantly in female liver span. The same factors however, with the exception of body mass index, significantly contributed to the variation in male liver span, however to a much lesser extent than females. The best predictor of liver span was height in case of males, body surface area in case of females, and both height and body surface area when both genders are considered.

[2] Diagnostic imaging techniques are superior to clinical examination in determining the size liver. Palpation and percussion are the standard bedside techniques to document liver and spleen size, but are far from accurate to detect the small increase in size.

[3] Comparison of sonographic measurements of liver diameter in the right MCL with those compiled from autopsy studies showed good correlation between sonographic findings and data obtained from autopsy. In our collective, the average diameter of the liver measured in MCL stood at 13.8 + 1.7 cm. In 74.1% of subjects, the diameter of the liver was 15 cm or less.

[4] Liver and spleen size vary widely according to age. Many diseases can affect their size, ranging from infective processes to malignant disorders. Sonography is one of the most common imaging methods which are used in routine practice. The clinical assessment of hepatomegaly by palpation and percussion has also been shown to lack both accuracy and reliability.

[5] There was a statistically significant difference between the values of liver size obtained by clinical examination and ultrasound method, demonstrating a tendency towards underestimation of liver size by clinical evaluation. There was no statistically significant difference of liver measurement obtained by percussion, when stratified by gender. Similarly, there was no statistically significant difference of liver measurement obtained by ultrasonography when stratified by gender.

[6] There was a statistically significant difference between the values of liver size obtained by clinical examination and ultrasound method, demonstrating a tendency towards underestimation of liver size by clinical evaluation.

III. ANATOMY

Liver anatomy is mainly defined by ligaments and fissures as well as by the vascular architecture: branches of hepatic artery, portal vein, and bile ducts in their parallel course define the centers of liver segments anatomy. A simplified anatomy divides the liver into the larger right lobe (including segment V, VI, VII, VIII), the left lobe with its medial (VIa,b) and lateral segments (II, III), and the caudate lobe (I). Liver segment anatomy is explained by the widely accepted architecture described by Couinaud. The Couinaud modified by Bismuth segment IVa,b), is based on 8 segments, each of which has its own arterial and portal venous vessel architecture (Glisson's triad) indicating vascular inflow, outflow, and biliary drainage. "Fig.1". [3]

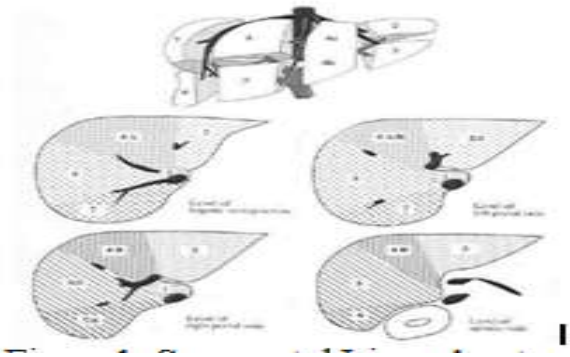

Figure1: Segmental Liver Anatomy (Reference from Radiology Review Manual-Wolfgang Dahnert 3rd Edition 1996)

IV. SUBJECTS AND METHODS

This cross-sectional prospective, hospital-based study was done in The Specialized Radiology Center at Najran University Hospital in the period between April 2013 and February 2014, it was approved by the committee of ethics at Najran University Hospital. The study population was a random sample of 584 subjects (270 adult males and 314 adult females) with age ranging between 18 and 70 years. Subjects who were included in this study were referred for different sonographic examinations not related to the liver.

The study was approved by the committee of medical ethics at Najran University Hospital. An informed consent, with complete explanation of the study and its purpose, was obtained from all subjects included in the study, those subjects fulfilled the following criteria: they should not be diabetic nor jaundiced have no history of hepatitis or frequent alcohol consumption, no history of chronic anemia, no history of abdominal trauma nor surgery, no history of biliary disease and pregnant women were not included in the study. Clinical examination of subjects was done by a physician, concentrating on the gastrointestinal system, respiratory system and pelvis, and to exclude fever, jaundice, lymphadenopathy and organomegaly. Laboratory examination was done to evaluate liver function. Sonographic examination was conducted by examiners to avoid inter-observer bias, applying the method described by Kratzer et al. Niederau et al. liver span measurement was done in the midclavicular line for the right lobe with the subject lying in supine position taking deep inspirations to fully visualise the superior borders of the liver. The probe was applied gently on the abdominal wall of the subject running from the right hepatic dome to the inferior hepatic tip, the right hand of the subject was raised behind the subject head to create better access to the liver. Another mid-sagittal plane was done for the left lobe, from the highest to the lowest point of the liver. Liver span represents the diagonal axis from the most lateral aspect on the left to the most inferior aspect on the right. Scans were done with Siemens SONOLINE G40 Ultrasound Machine with Sector Array Transducer of 2-4 MHz frequency. Sonography of included subjects showed their liver with homogenous echotexture and smooth surfaces without evidence of focal lesions. "Fig.2"

Figure2: ultrasound measurement in the mid clavicular line

For each subject weight was calculated in kilograms and height was calculated in meters, body mass index is calculated using the following formula:

BMI= (HT 2 /WT)

BMI represents body mass index, HT represents height and WT represents weight.

Body mass index is the measurement of weight proportional to height, it gives an idea about the individual's weight if it is within the healthy range or not, if the BMI below 18.5 it is considered underweight, between 18.5 and 24.9 is adequate weight, between 25 and 29.9 is overweight, between 30 and 39.9 is obesity and above 40 is extreme obesity. In our study BMI is divided into two categories, below 25 and above 25, where below 25 is considered rather adequate weight (unless it falls below 18) and above 25 is considered overweight.
All data were collected and analyzed by applying SPSS version 19.0. Anthropometric variables were correlated positively and significantly with the liver size.

V. RESULTS

Out of 789 Saudi participants included in this study, only 584 subjects fulfilled the criteria of this study, 270 (46.23%) were males and 314 (53.76%) were females "Fig.3". Average age of males was 32.5 years and the average age of females was 38.8 years. BMI calculation showed that 88% of whole males have BMI below 25 while 12% above 25 "Fig.4", and 70% of females have BMI below 25 while 30% are above 25 "Fig.5".

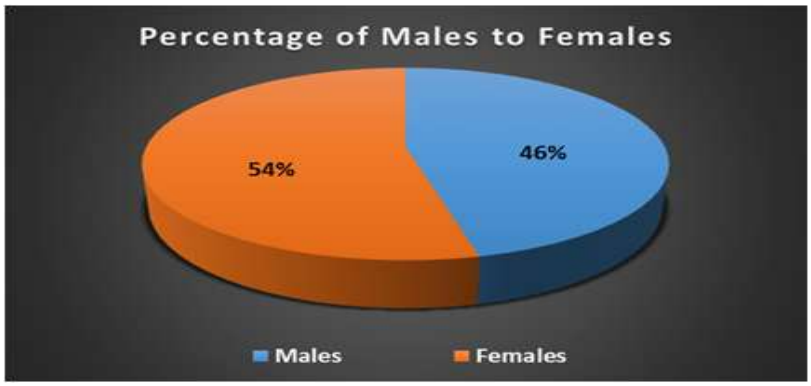

Figure3: A pie chart showing percentage of males to females among study population

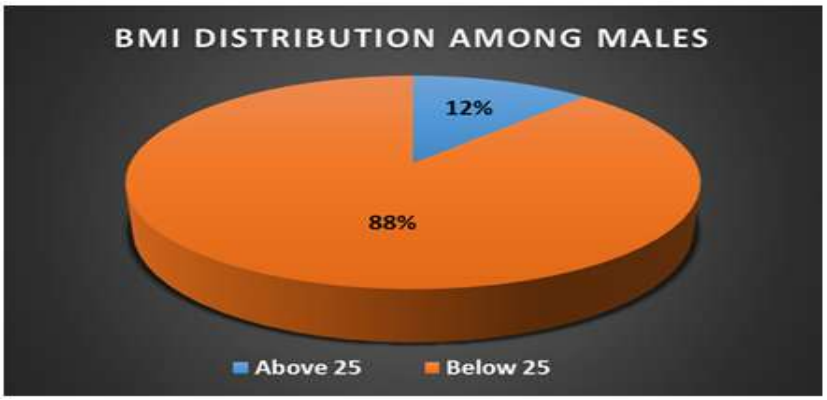

Figure4: A pie chart showing distribution of BMI among males in study population

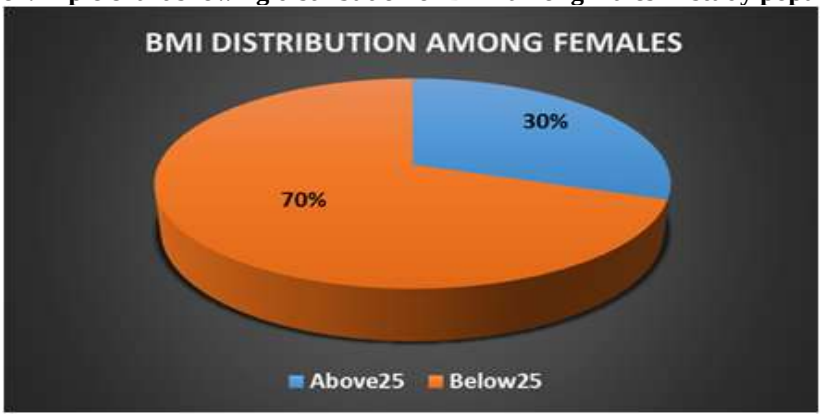

Figure5: A pie chart showing distribution of BMI among females in study population

Liver span measurement in the midclavicular line showed that the average span of liver among Saudi males is 12.5 cm while it is 11.9 among females showing significant difference of liver size between males and

females. Average age of males was 32.5 years and average age of females was 38.7 years. Anthropometric calculation showed that the average height of males in our study population is 174.2 cm while the average height of females is 164.5 cm. The average weight of males is 65.6 Kg while it is 65.6 Kg for females. BMI calculation among males and females in our study showed that average BMI of males is 21.6 while it is 23.8 for females "Table1".

Table 1: Average values of anthropometric variables and age among males and females

Variables	Males	Females	P- value
Age (Years)	32.5	38.7	0.015
Height (cm)	174.2	164.5	0.001
Weight (Kg)	65.6	64.4	0.001
Body Mass Index	21.6	23.8	0.012
Liver span (cm)	12.5	11.9	0.005

The relation between liver span and anthropometric variables was analysed statistically for each gender. First for males, there was significant statistical relation between liver span and height with a strong positive correlation coefficient in order of 0.95 "Fig.6". Weight of males showed statistical positive correlation with liver span but not strong in order of 0.18 "Fig.7". BMI showed negative correlation with male's liver span in order of - 0.59 and it was not significant statistically "Fig.8". Correlation is significant for all variables at 0.01 level.

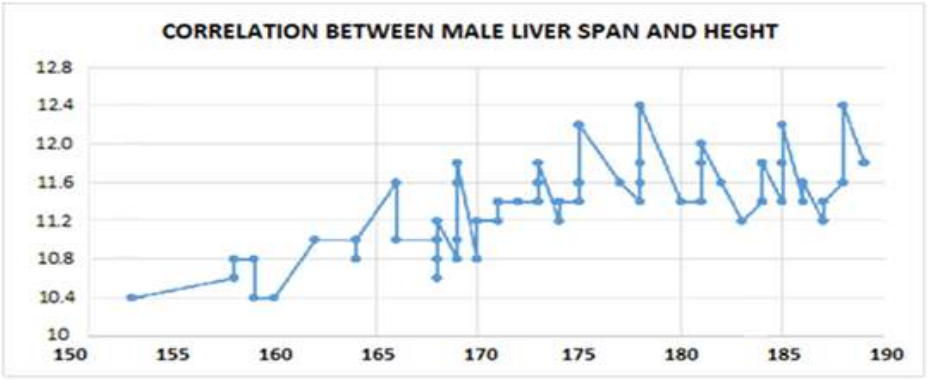

Figure6: A graph showing the relation between liver span and height among males

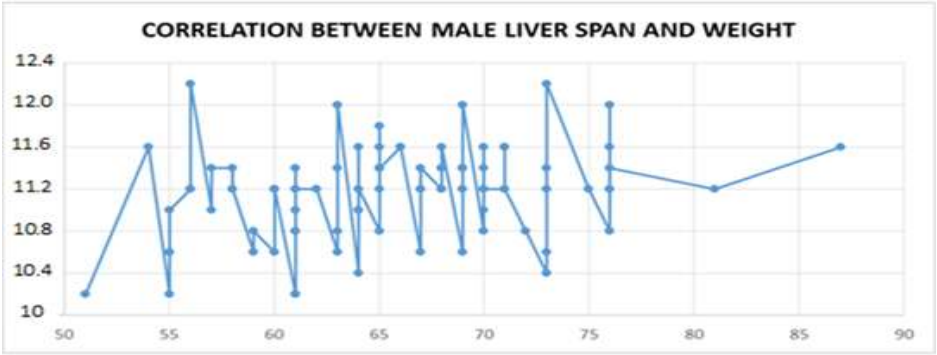

Figure7: A graph showing the relation between liver span and weight among males

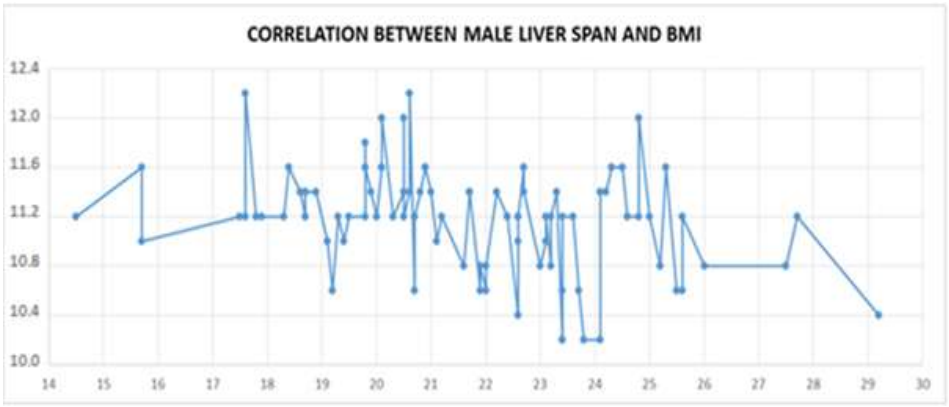

Figure8: A graph showing the relation between liver span and BMI among males

For females, there was significant statistical correlation between liver span and height with a strong positive correlation coefficient of 0.38 "Fig.9". Weight of females showed significant relation to liver span with a positive correlation in order of 0.06 "Fig.10". Females BMI showed positive correlation coefficient in order of 0.014 that was statistically significant "Fig.11". There was also significant statistical correlation between liver span and females' age showing a strong positive correlation coefficient in order of 0.4. "Fig.12".

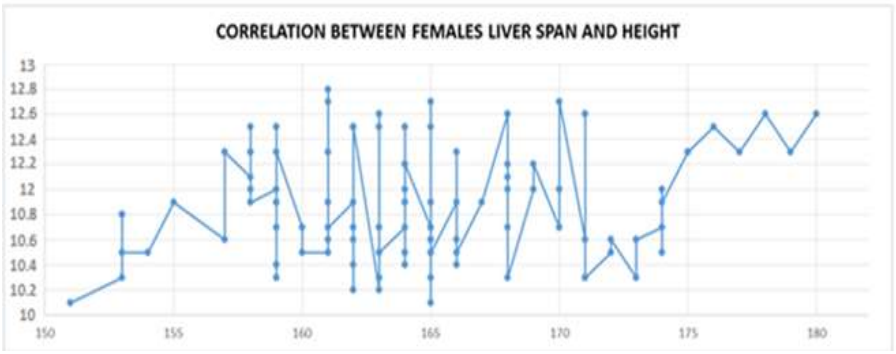

Figure9: A graph showing the relation between liver span and height among females

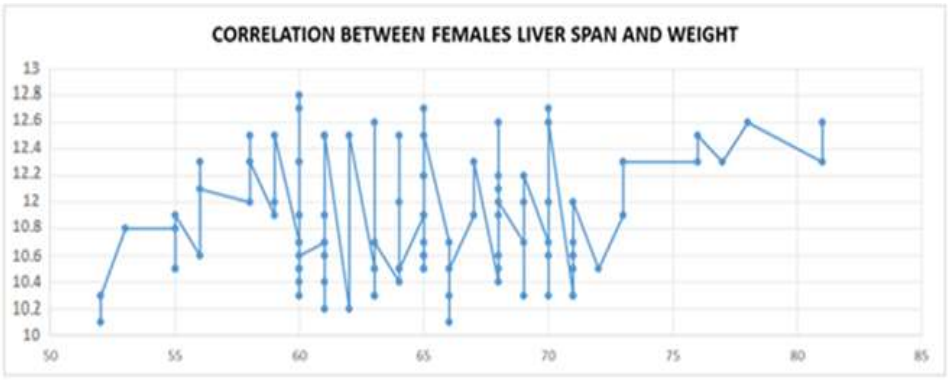

Figure10: A graph showing the relation between liver span and weight among females

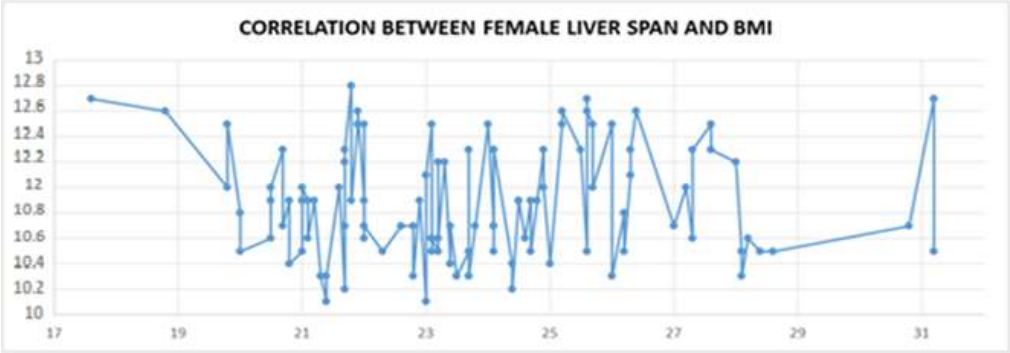

Figure11: A graph showing the relation between liver span and BMI among females

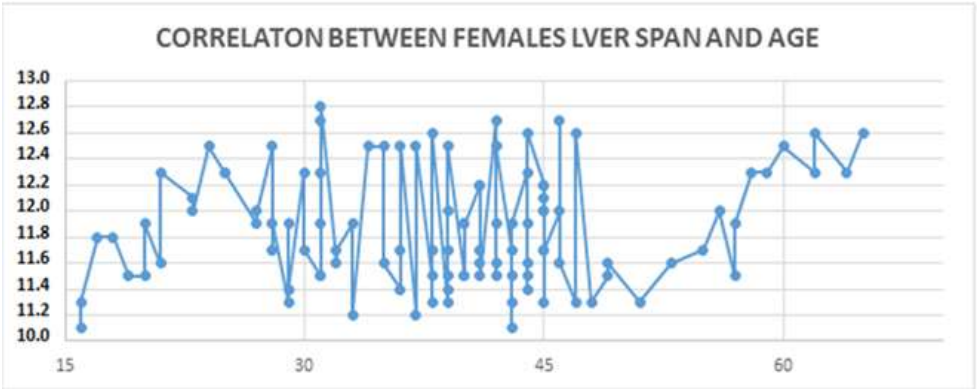

Figure12: A graph showing the relation between liver span and females' age

VI. DISCUSSION

Ultrasound became the most applicable and practical imaging method for liver evaluation, because it is easy to use, cheap, rapid, provides real time images and does utilize ionizing radiation. [1, 3] It is mandatory to identify the normal average value of liver dimensions measured sonographically as a reference value, because it can help in early diagnosis of pathological changes in liver. Longitudinal hepatic diameter at MCL is the most commonly applied and predominant clinical method of estimating liver size in routine diagnostic situations. [1, 3] As well, it proved to be the best-measured diameter in differentiating between healthy and diseased livers, had a better correlation with autopsy studies and BSA measurement, and was proved to be an easy practical method for routine use in this purpose. [6, 7] This study is a trial to set a baseline data of normal liver span in the midclavicular line measured by ultrasound among Saudi adults in the area of Najran, and correlate liver span to anthropometric variables.

Emad S. Tarawneh et al [1] did similar sonographic study among Jordanian adults; their study population was 242 males and 275 females. They found that the normal value of liver span in the mid clavicular line for males is 12.6 cm and for females 12.1 cm, with 5 mm difference in liver size between two genders. Liver size in our study population was 1 mm smaller among males than their study and 2 mm smaller among females, while liver span difference between males and females in our study is 6 mm. They have also concluded that height was the best determinant of liver span on both genders, which was in-line with our study results with a strong positive correlation coefficient in order of 0.95 for males and 0.38 for females. This proximity in results raised the possibility that liver size among Middle East population may be within a close range.
A study conducted in Saudi Arabia between 2004 and 2005, by Mohammad I. El Mouzan et al [8] they measured liver size among 18 112 healthy Saudi children and adolescents up to 18 years of age. The study found that there was no difference in the liver span between boys and girls of up to 60 months of age. Thereafter, a difference could be seen increasing with age, with girls having smaller liver spans than boys do and that was in line with our study.

Our findings are in agreement with many previous worldwide studies of liver size by clinical methods, and Ultrasound. Neiderau et al [7] made a survey among 840 males and 160 females in Germany; he found that there is a positive relation between liver span in the midclavicular line and height, which is similar to our conclusion.

Kratzer et al [9] conducted a sonographic survey on a population of 2080 subjects to establish normal value for liver diameter at midclavicular line and to determine the influence of sex, height, BMI and alcohol consumption on liver size. He found that the average measured liver diameter at midclavicular line was 14.0 cm compared to 12.5 cm in our study. This difference may be due to ethnic variation and the increased values of heights and weight in their sample compared to our study. In addition, they observed an increase in average liver diameter with higher frequency of alcohol consumption, while alcohol consumption was excluded in our study. Finally, he concluded that sonographic measurement of liver span in the midclavicular line is a practical and easy method for routine use; which supports the adoption of this method in our study.

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