

# Evaluation of Liver Size in Bangladeshi Adult Male & Female

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**Abstract:** Liver size was determined in a non-selected population sample to find out regular and reference values and to study possible factors which can influence liver size. A total of 250 patient's from the Dhaka city (150 male and 100 female; age range, 18-35 years) under potential ultrasound inspection to determine their liver size. The average measured liver diameter SD was 14.0 +/- 1.6 cm (median), 14.3 cm, and 9.5-20.3 cm. Average size for male 14.5 +/- 1.5 cm; and average in female subjects, 13.6 +/- 1.6 cm). The results of the experimental analysis presented that the factors body mass index, body height, sex, age, and frequent alcohol consumption influence over liver size (male) measured at the midclavicular line.

**Keywords:** Liver, Ultrasonography, midclavicular line, palpation of liver, scratch test.

## 1. Introduction

The liver is a crucial organ that has various functions in the human body, including producing proteins and blood clotting factors, manufacturing triglycerides and cholesterol, glycogen synthesis, and bile creation. It weighs around 1500g and has a higher concentration in the male. Its function is to filter and store blood, absorb carbohydrates, hormones, proteins, and strange chemicals. It acts as a storage for vitamins and iron. The liver has two functional parts, the right lobe and left lobe, which is divided by an imaginary line that comes from the gallbladder into the lower vena caval. During a clinical interview, a number of liver patients, those are related liver size disorder getting pain is the main protest. The liver is also stores vitamins and chemicals, including vitamin B12, folic acid, iron required to make red blood cells, vitamin A for vision, vitamin D for calcium absorption, and vitamin K to help the blood to clot properly. The liver is the largest internal organ of the body and is located in the right upper quadrant of the abdomen, beneath the diaphragm and is protected by the lower right ribs. It also extends across the midline toward the left upper quadrant of the abdomen.

Resulting from the clinical discussion, patients undergo a physical examination, when they checkup for beating, palpation and auscultation of the liver. Physical analysis of the liver addresses almost the entire chest wall. Any diseases can affect their size, ranging from infective processes to malignant disorders (1,2). Palpation and liver and spleen size vary widely according percussion are the standard bedside techniques to document liver and spleen size, but are far from accurate to detect a small increase in size. After checkup, percussion is performed with the aim of determining the liver, upper boarder and, when possible, the lower border, estimating liver size [1]. Ultrasonography is a non-invasive, established, safe, quick and accurate method for measurement of liver and spleen size. Generally, it can vary between 5.5 and 13 cm in all subjects when hitting is performed in the midclavicular line [2]. Thumping should start softly in the midclavicular just lower to the second rib, and from the pulmonary clear sound until tediousness live. This percussion occurs roughly in the fifth intercostal space and links to the diaphragm muscle on the liver dome. The

patient should be positioned supine and the examiner always on his right [3]. Women breast should be gently moved upwards so as not to concession the percussion. The last dullness points create on percussion in the imaginary body line from midclavicular to craniocaudally direction which determine the liver lower boarder [4, 5]. The liver size is measured by several techniques such as radiography, computed tomography, scintigraphy, ultrasonography, and magnetic resonance [6, 7]. Ultrasonography is the first imaging method to assess hepatic affections, which has a number of key advantages, such as low cost, risk-free, rapid implementation, no use of ionizing radiation or sedation that facilitates technical performance, especially for children [8]. This paper presented an evaluation of normal liver size among different age population. Moreover, it will investigate safety, reliability of ultrasonogram as the primary for investigation of normal liver size in our population. All statistical analyses were performed by the biostatistician using STATA 10 software.

## 2. Related Literature

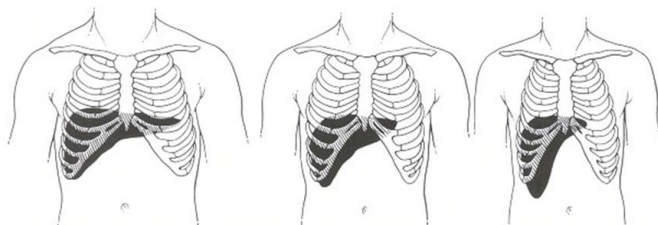
The biliary tree describes a system of tubes that collect bile, used to help digest food, and drains it into the gallbladder or the intestine. Intrahepatic ducts are located inside the liver (intra=inside + hepar=liver) while extrahepatic ducts are located outside the liver. Liver size increases with increasing age, averaging 5 cm span at 5 years and attaining an adult size by age 15. The size depends on age, sex, body size and shape. By percussion, the mean liver size is 7 cm for women and 10.5 cm for men (Table.1). S.Rahman et.al did a study included 59,227 patients (age ranged 15-95 years). The majority of the patients were males (67.9%). Although all patients appeared at the department of hepatology, 13.2% were diagnosed with liver diseases, but a vast majority of patients (77.35%) were suffering from no ulcer dyspepsia or irritable bowel syndrome. Patients with liver diseases were mostly suffering from chronic liver diseases (CLDs) (37 - 69%). [9]

**Table 1:** Typical Liver size by Percussion in Normal People

| Height | Liver dullness (cm) |        |                 |        |
|--------|---------------------|--------|-----------------|--------|
|        | Midclavicular line  |        | Midsternal line |        |
|        | Male                | Female | Male            | Female |
| 60     | 8.30                | 6.00   | 6.00            | 4.00   |
| 63     | 9.00                | 6.75   | 6.50            | 4.50   |
| 66     | 9.75                | 7.50   | 7.00            | 5.00   |
| 69     | 10.25               | 8.00   | 7.50            | 5.50   |
| 72     | 11.00               | 8.75   | 8.00            | 5.75   |
| 75     | 11.75               | 9.50   | 8.50            | 6.25   |

Source: Castell DO, Frank BB. Abdominal examination role of percussion and auscultation. Postgrad Med with permission 1977; 62(6):131-34

All of the normal liver is concealed by the right rib cage and is beyond the feel of the examiner's hand. According to the American Liver Foundation (ALF), the liver is the body's second-largest organ weighing about 3 lbs. (1.4 kilograms) and it holds 13 percent of the body's blood supply, according to Johns Hopkins Medicine. Liver failure is an urgent, life-threatening medical condition. It means that the liver has lost or is losing all of its functions. Symptoms of liver failure may include nausea, appetite changes, fatigue, diarrhea, jaundice, easy bleeding. Typical causes of liver failure include Tylenol overdose, viruses, hepatitis B & C, cirrhosis, alcoholism, and some medications. Donated livers can come from cadavers or living donors. In the case of living donors, the donor donates part of his or her liver to another person, according to the American College of Gastroenterology. There are several risks involved with liver transplants, including: Bile duct complications, including leaks or shrinking, Bleeding, Blood clots, Failure of donated liver, Memory and thinking problems.



**Figure 1:** Frontal views of the liver for different body types. (Source: Frank BB. Abdominal examination: role of percussion and auscultation. Postgrad Med 1977; 62 (6): 133. Reproduced with permission)

S.alam et.al showed that one third of the population of Bangladesh is affected by Nonalcoholic fatty liver disease (NAFLD). Individuals with higher body mass index (overweight and obese), diabetics, midlife adults, married individuals, and rural women were more at risk of having NAFLD than others.[10] A total of 2782 (1694 men and 1088 women) participants were included in the study, with a mean age of 34.21 ( $\pm 12.66$ ) years. The overall prevalence of NAFLD was 33.86%.

### Techniques

The purpose of liver palpation is to approximate liver size, feel for tenderness and masses. The basic Techniques are

- With patient supine, place right hand on patient's abdomen, just lateral to the rectus abdominis, well below lower border of liver dullness.

- Ask patient to take a deep breath and try to feel the liver edge as it descends.
- Be sure to allow liver to pass under the fingers of your right hand, note texture. Pressing too hard may interfere.

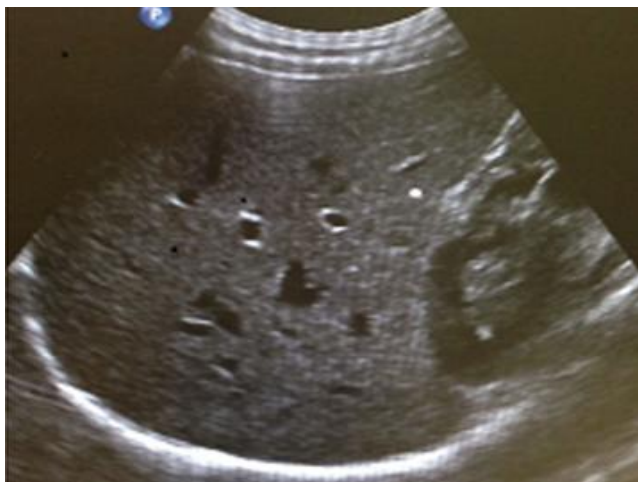
The investigation is performed with the patient in the lying down position with the right-handed doctor on the right side of the patient. Every effort should be made to have the patient relaxed to avoid tensing of the abdominal musculature. Flexing of the knees or placing a cushion beneath the knees may assist relaxation of abdominal portion. Approach the examination of the liver from the right side of the patient. For the best experiment need to make sure the patient is warm and feeling comfortable and the doctors hand hands should also warm.

Percussion is executed to determine liver size, for the margins of the liver can be estimated by this technique. The upper border is percussed using heavy percussion, eliminating the resonant quality produced by the overlying segment of the lung. Light beating, with the doctor's ear close to the abdomen, which is the best approaches to determine the lower border of the liver, because of the liver's opposition to the anterior abdominal wall. Percussion should first be made at the right midclavicular line, then at the midsternal and anterior axillary lines. The normal upper level of the liver is at the level of the right nipple, whereas the lower margin of the liver is at the right costal margin. The normal size is variable, mainly in relative to body size. Palpate for the liver with one or two hands palm down, moving upward 2-3 cm at a time towards the lower costal margin. Has the patient taken a deep breath. The liver will move downward due to the downward shaking of the diaphragm. Palpate the bottom margin of the liver for the texture of the liver. Palpation is made to determine liver shape and regularity check. The epigastric region even in this region the liver can only be felt through deep palpation start. The examination by asking the patient to exhale afterwards as the patient is inhaling slowly slide your fingers towards the right ribcage. Single-handed palpation is used for lean individuals, while the bimanual technique is best for obese or muscular. The best way to assess size is by percussion - a normal-sized liver can appear enlarged if displaced downwards by lung disorders. An enlarged liver expands down and across towards the left iliac fossa (LIF). The right hand moves upward using gentle, steady pressure until the liver edge is felt from fig 2.



**Figure 2:** Bimanual technique for palpation of liver

The normal liver may be slightly tender upon palpation, but the inflamed liver (hepatitis) is often superbly tender. The patient should be calmed that such discomfort will be only momentary.



**Figure 2:** which represents the right lobe of the liver

Figure 2 was taken with the transducer orientated longitudinally in a plane that was in line with the midpoint of the participant's clavicle (mid-clavicular line). This image embodied the right lobe of the liver and which was a linear measurement from the dome to the tip of the right lobe of the liver.

#### a) Scratch Test

For this test, scratch need to place the diaphragm over the area of the liver and then scratch parallel to the costal margin until the sound intensity drops off marking the edge of the liver. Other techniques involve different patterns of the scratching, for example as in spokes of a wheel and other places for placing the stethoscope such as over the abdomen.

#### b) Elementary Skills

Frequent studies have exposed that percussion of the liver is superior to the palpatory measurement of liver under the right costal for hepatic enlargement. Though palpation and percussion are commonly used as clinical methods for defining liver size. Technetium liver scans were popular in the past but often underestimated liver size. Ultrasound is fairly correct, but computed tomography is the most dependable method to defining vertical liver span. Calculated volume measurements by ultrasound or by computed tomography provide the best estimates. A recent report using sagittal sections of the liver found by ultrasound was found to be superior to transverse sections obtained with computed tomography.

#### c) Medical Implication

In the normal liver is palpable include emphysema, right-sided pleural effusion, thin body carriage, Riedel's lobe, or deep diaphragmatic excursion. In emphysema, the lungs are hyper expanded with diaphragmatic destruction, in that way lowering the upper and lower borders of the liver. A large right pleural effusion will have the same effect of lowering the liver boundaries. Accurate percussion of the upper liver border in a patient with a right pleural expression can be difficult because of the fluid density covering liver dullness.

The most common diseases are tabulated in the Table -2 which is associated to palpable and enlarged liver include cancer, congestive heart failure, lymphoma, hepatitis, and

other causes of fatty liver. Cirrhosis may be associated with a liver size.

**Table 2:** Examination Findings Associated with Specific Liver Diseases

| Liver disease            | Palpation              | Size   |
|--------------------------|------------------------|--|
| Acute Hepatitis          | Smooth, surface tender | Enlarged                                       |
| Chronic Hepatitis        | Firm liver edge        | Enlarged, especially left lobe                 |
| Fulminant Hepatitis      | surface tender         | Shrinking size                                 |
| Cirrhosis                | Non tender, Firm       | Variable, Late stages, liver decreases in size |
| Hepatocellular carcinoma | Nodules                | Moderate to massive enlargement                |
| Metastatic carcinoma     |                        | Enlarged                                       |
| Fatty liver              |                        | Enlarged                                       |
| Right heart failure      |                        | Moderate to massive enlargement                |

Primary liver cancer becomes penetrated with deposits of cancer cells, which can grow rapidly. Such type of growth can be illustrious from normal liver by palpation of nodular tissue consistency. Similar liver expansion can occur in lymphoma. In cirrhosis, enlargement of liver may occurs in end-stage cirrhosis or fulminant hepatic. Naturally it is micro nodular due to alcoholic or nutritional when cirrhosis is post hepatitis. Alcohol other causes of fatty liver which leads to liver enlargement or infiltration. Hepatic distention and smooth enlargement are typical of significant right-sided heart failure, which occurs because of hepatic venous congestion secondary to impaired myocardial function

### 3. Results and Discussion

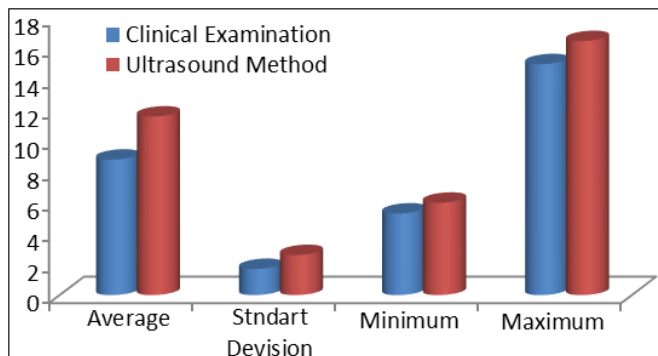
250 patients, were consecutively evaluated here. One hundred fifty (54.2%) were males and one hundred (45.8%) were females. Mean age was 24 years (SD  $\pm$  5.5), with age ranging between 18 and 35 years. Mean height was 165 cm (SD  $\pm$  8), with height ranging between 150 and 190 centimeters. Mean weight was 60,460 grams (SD  $\pm$  12,954), with weight ranging between 42,500 and 102,000 grams. Mean BMI was 22 kg/m<sup>2</sup>, ranging between 18 and 40 kg/m<sup>2</sup>. When using BMI of 24 kg/m<sup>2</sup> as a cutoff point, 20 subjects (24.5%) reached values higher than or equal to 24, while 60 subjects (75.5%) had values lower than 24. There was a statistically significant difference between the values of liver size obtained by clinical inspection or using ultrasound. Liver size by experimental assessment, included in Table 3.

**Table 3:** Results of liver measurement through clinical assessment and ultrasound

| Levels            | Clinical Inspection | Ultrasound |
|-------------------|---------------------|------------|
| Average           | 8.2                 | 11.5       |
| Standard Division | 1.6                 | 3.1        |
| Minimum           | 5.2                 | 5.5        |
| Maximum           | 16                  | 15.5       |

There was no statistically significant difference of liver measurement obtained by percussion, when stratified by gender (p = 0.791). Similarly, liver measurement obtained by ultrasonography when stratified by gender (p = 0.311). The results are shown in Table 4.





**Figure 3:** Results of liver measurement in by clinical inspection and ultrasound

There was no statistically significant difference of liver measurement obtained by percussion, when stratified by gender ( $p = 0.861$ ). Similarly, there was no statistically significant difference of liver measurement obtained by ultrasonography when stratified by gender ( $p = 0.389$ ). The results are shown in Table 4.

**Table 4:** Liver measurement in centimeters through checkup and ultrasound by gender

| Gender | N (%) | Ultrasonography Mean | Percussion Mean |
|--------|-------|----------------------|-----------------|
| Female | 45.8  | 11.9                 | 8.7             |
| Male   | 54.2  | 11.4                 | 8.8             |
| P      |       | 0.389                | 0.861           |

Pearson's correlation coefficients between BMI and liver measurement obtained by percussion and by ultrasonography were  $-0.092$  and  $0.01$ , respectively, which is not statistically significant. There was no statistically significant difference of liver measurement obtained by percussion, when stratified by BMI cutoff point ( $p = 0.576$ ) and correlation between clinical and ultrasound ( $r = 0.419$ ) measures of liver span (midclavicular line, midsternal line). Normal values of liver and spleen measures were classified by age and sex; data were tabulated and graphed. The liver span also correlated with body weight, height, and BMI and ultrasound spleen axis which is also described in the literature.

It is known that several factors can interfere with liver measurement, such as weight, height, age, gender, percussion technique, site of percussion, phase of respiration, anatomical abnormalities, obesity, large-volume ascites, cirrhosis, tumors, hepatomegaly, personal habits and patient's position during the examination.

In a review, the percentage of a palpable liver in healthy subjects is 28%. It is found a good correlation between the three examiners (82% to 84%) in determining palpable liver in 36 patients with increased liver by ultrasonography, and concluded that 20% of patients had palpable livers. Sullivan et.al concluded that clinical evaluation of liver can be difficult due to the hepatic shape, position and axis [10]. Even the percussion angle of the examiner's fingers may interfere with liver measurement, as well as the force applied during the percussion. Rosen field et.al [11] studied the correlation between scintigraphy and palpation in 100 adult patients and concluded that palpation can be changed with the patient in orthostatic or supine position also concluded

that the patient's position interferes with liver measurement. In a study showed among clinical limitations to accurately determine the midclavicular line. All these factors may lead to an inaccurate identification of the liver borders, thus interfering greatly with the results. In that study, mean liver size measured by clinical method was  $8.8 \pm 1.6$  cm on the midclavicular line.

In a study of 250 adults, it is found that gender is a determining factor for liver size. They discovered that men have larger liver size than women and they even proposed a formula for correcting liver measurement by clinical percussion for each gender and significant difference for ultrasound liver measurement between male and female individuals. Mean values for men was  $14.5 \pm 1.5$  cm and  $13.6 \pm 1.6$  cm for women. Mean ultrasound-measured liver size in long linear, normoliner and breviliner individuals was  $12.3 \pm 1.6$  cm,  $10.5 \pm 3.2$  cm and  $12.5 \pm 2.4$  cm, respectively, the difference being statistically significant ( $p = 0.005$ ). The difference in clinical liver measurement according to the biotype was not statistically significant ( $p = 0.470$ ). These results suggest that there is no relationship between liver volume and body size.

In the group of individuals with BMI less than 25, there was a statistically significant difference between the mean values obtained by both methods ( $p = 0.000$ ), but in this group the correlation between the two methods showed a Pearson's correlation coefficient of 0.473, with statistical significance ( $p < 0.01$ ). The results of this study shows that liver measurement obtained by clinical examination correlates well with ultrasound method, but underestimates the actual liver size in adults, which can be demonstrated by the statistically significant difference between the final mean value obtained by clinical observation and that obtained by ultrasound.

#### 4. Conclusions

There are significant differences in liver size obtained by medical inspection and ultrasound. Only the subject of  $BMI \leq 24 \text{ kg/m}^2$ , the correlation between clinical investigation and ultrasound is significant. The results of this investigation illustrated that liver measurement obtained by clinical examination correlates well with ultrasound process. But underestimates the actual liver size in adults, which can be demonstrated by the statistically significant difference between the final mean value found by clinical observation and that obtained by ultrasound method. It can be inferred that clinical method is less accurate for this group of patients. We believe that the results of this study can be used as a practical and comprehensive guide to indicate the normal liver and spleen length range for every adult Male and Female, according to their age and body habitus.

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