

# Impact of anthropometrical parameters on portal vein diameter and liver size in a subset of Karachi based population

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## ABSTRACT

**Objective:** The purpose was to study the impact of anthropometrical parameters on portal vein diameter and liver size by ultrasound in a subset of Karachi population.

**Methods:** Four hundred and fifty nine apparently healthy subjects were included in this cross sectional study. After recording weight and height of each subject, Portal vein diameter and both liver lobes were measured by gray scale ultrasonography. Students T test and ANOVA were applied for statistical analyses.

**Results:** With increasing age, portal vein diameter and right lobe of liver increased significantly (p value < 0.001). Increase in portal vein diameter was also observed with rise in body mass index (0.8 cm in underweight - 1.1 cm in obese subjects). Sizes of right and left liver lobes also increased with a rise in body mass index (p value < 0.001 and 0.001). Gender, however, did not have any effect on portal vein diameter and liver size.

**Conclusion:** Age and body mass index are reliable parameters to consider for avoiding false positive diagnosis of hepatomegaly and portal hypertension. Knowing the right and left liver size with respect to anthropometrical measurements also assist a clinician in selecting a subject for liver transplantation.

**KEY WORDS:** Anthropometrical measurements, Liver, Portal vein diameter.

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## INTRODUCTION

Liver is the largest organ of the body.<sup>1</sup> It encompasses functions pertaining to complex biochemical and metabolic pathways.<sup>1</sup> Previous studies have reported that clinical evaluation of liver size is an important prerequisite to avoid liver failure and small-for-size graft syndrome in liver transplantation.<sup>2</sup> Several studies have demonstrated that liver size depends upon several factors: age, gender, nutrition and body surface area.<sup>1,3-5</sup> Furthermore, establishing the hepatic span by assessing these physical parameters would improve the accuracy of clinical assessment in a particular population according to its own geographic genome.<sup>1,4-6</sup> Anatomically, portal vein (PV) is intricately related to the liver architecture because it carries deoxygenated but nutrient rich blood from the gastrointestinal tract towards liver in a hepatopetal flow.<sup>3,6,7</sup> Any pathology in the hepatic

vasculature and parenchyma would eventually affect the diameter and flow of the PV leading to cirrhosis and portal hypertension.<sup>4,8</sup>

In past decade, extensive work has been conducted in different parts of the world on portal vein diameter (PVD).<sup>3-5,9</sup> However, no specific data has been reported in our part of the world on the effect of different physical parameters on PVD and hepatic span.<sup>10,11</sup> In an Asian hepatitis survey, Pakistan has been reported to be at a high risk of hepatitis C infection which can eventually lead to liver failure.<sup>12</sup> Karachi, the largest cosmopolitan city of Pakistan, has an alarming rise in hepatitis B and C infection and its complications.<sup>13</sup> Reasons are attributed to a monumental influx of immigrants, lack of awareness and inadequacy of blood screening.<sup>13,14</sup>

This study was designed keeping in mind the vast spectrum of hepatobiliary diseases which can affect any age group. Also, in invasive procedures like liver transplantation, trans-hepatic portal vein embolization and pancreatectomy the portal vein is anastomosed with other vessels. Therefore, knowing the normal caliber of the vein and the hepatic span, with respect to age, gender and body mass index (BMI) is crucial for diagnosis of portal hypertension and hepatomegaly.

## METHODS

In this cross sectional study, four hundred and fifty nine healthy adults who met the inclusion criteria were recruited at Radiology clinic of Ziauddin University Hospital (Clifton campus) over a period of eight months. It was a convenience sampling in which the paramedical staff of Ziauddin Hospital had participated after its announcement. Subjects with hypertension, diabetes, hepatobiliary diseases, myeloproliferative disorders, cardiac diseases and pregnant females were excluded. This study was approved by ethical review committee of Ziauddin University. Medical history and personal data (blood pressure, weight, height and age) was recorded before sending the subject for ultrasound. Subjects gave written consent and were allotted serial numbers to safe guard their identity.

The gray scale sonographical examination was performed with a high-resolution real-time scanner (Toshiba version, Nemio XG) with a 3.75

MHz convex curved array transducer. Subjects were requested to report in the morning after an overnight fast as certain type of foods may affect the diameter of portal vein as suggested by Kok et al.<sup>15</sup> The measurements of dimensions of the liver size were made in left lateral decubitus position during deep inspiration. Longitudinal scans of right lobe (R-lobe) were obtained from the subcostal approach in the midclavicular position and left lobe (L-lobe) from the anterior subxiphoid approach. The diameter of the extra hepatic part of the portal vein was measured at the level of the porta hepatis where visualization was optimal. Both liver and portal vein were measured three times before the mean value was recorded by a single sonographer to avoid inter-observer variations.

Classification of PVD and liver lobes was done on the basis of age, BMI and gender. Subjects were divided into three groups according to age i.e.; 20-30 years (group 1), 31-40 years (group 2) and 41 years and above (group 3). BMI classification was done as suggested by World Health Organization (WHO) in the Asian population. Subjects with BMI less than 18.50 were classified as underweight. Those with BMI between 18.50- 24.99 were taken as normal weight. An individual with BMI ranging from 25.00-29.99 was classified as overweight and if BMI was 30.00 or more, it was in the obese bracket. On the basis of gender two groups of male and females were organized.

Data was entered and analyzed using statistical software SPSS version 20. Mean±SD was computed for the diameter of portal vein and sizes of right & left lobe of liver. Student's T-test was applied to compare continuous variables across gender. ANOVA was applied for comparison across continuous variables (PVD and liver span) for age and BMI among genders. Results with p-value less than 0.05 were considered as statistically significant.

## RESULTS

In our study liver span and PVD were compared in different age groups. The diameter of PV in a subset of Karachi based population varies with increasing age as shown in Table-I. As the age was increasing PVD and the right liver lobe increased with significant P value of < 0.001.

Table-I: Relationship of portal vein diameter and liver span with increasing age.

	Group 1 20-30 years (N=159)	Group 2 31-40 years (N=199)	Group 3 > 41 years (N=101)	p-value
PVD (cm)	0.84±0.14	0.90±0.17	0.99±0.21	<0.001
R- LOBE SPAN (cm)	11.38±1.67	11.64±1.80	12.77±1.51	<0.001
L-LOBE SPAN (cm)	7.18±2.12	7.23±2.06	7.51±2.53	0.45

Table-II: Relationship of portal vein and liver span with increasing BMI.

	Under Weight (N=41)	Normal Weight (N=314)	Over Weight (N=86)	Obese (N=18)	P-Value
PVD (cm)	0.8+0.2	0.9+0.2	0.9+0.2	1.1 +0.4	0.005
R-LOBE SPAN (cm)	9.4+1.2	11.5+1.5	13.4+0.9	13.9+0.7	<0.001
L-LOBE SPAN (cm)	6.4+2.2	7.2+2.2	7.7+1.9	7.8+2.5	0.01

With respect to BMI, there was significant difference also. The PVD increased from 0.8cm in underweight to 1.1cm in obese subjects. Furthermore, p-value was highly significant for both the lobes of liver as shown in Table-II with increasing BMI.

Table-III depicts effects of gender. The mean age of males was 35.7±11.3 years and in females it was 34±11.3 years. There was no significant statistical difference between any parameter.

### DISCUSSION

There is abundant data in different parts of the world on the normal and diseased hepatobiliary system which includes autopsies also.<sup>16-23</sup> Kratzer et al. conducted a massive sonographical survey concluding that age had a strong influence on hepatic span similar to our study as shown in Fig.1.<sup>24</sup> Similarly, Udoh et al also suggested that liver size of 14.20±1.62 cm does not point towards hepatomegaly in Nigerians and as the age advances the liver size also increases.<sup>25</sup> Increase in the liver size is attributed to build up in the work load and physiological adaptation for rise in metabolic demands with advancing age.<sup>26</sup> In our study, we measured the right and left lobes separately because it was noted by Ho CM et al that liver diseases usually occur in the right lobe because of the composition of blood that supplies it.<sup>27</sup> The liver size obtained by Mittal et al in Rajasthan (India) was comparatively higher than that observed in our study.<sup>28</sup> This is probably due to racial differences. In contrast to the above studies, colleagues of Tetsuya and Chouker et al who have studied liver sizes

with respect to age have suggested that the liver size decreases with age.<sup>2,29</sup>

Our study investigated effects of BMI on the liver span to provide a guideline for endocrinologists to prevent nonalcoholic fatty liver disease (NAFLD). It has been reported that weight gain and obesity are one of the major causes for developing NAFLD.<sup>30</sup> A limitation of our study was that in the obese bracket only 18 subjects could be enrolled because many had to be excluded because of asymptomatic fatty liver.

A novel study conducted in Jordan suggested that body surface area in females and height in males were suitable physical parameters to assess liver span.<sup>31</sup> Our results support Kratzer et al in concluding that BMI is an important parameter while measuring the extent of liver size.<sup>24</sup>

Literature search has revealed contrasting measurements of portal vein diameter in different countries which maybe because of diverse genome and technical differences.<sup>4,5,9,32,33</sup> Covey et al suggested that the understanding of PV anatomy is important for interventional radiologists and surgeons.<sup>34</sup> Our results showed significant positive correlation between PVD and age which are in agreement with Shankar et al who also concluded that with increasing age PVD also increases.<sup>3</sup> However, the author had neglected to mention whether the measurements were pre or post prandial.

Table-III: Relationship of portal vein and liver span with gender.

	Male (N= 231)	Female (N=228)	p-value
PVD (cm)	0.9+0.2	0.9+0.2	0.38
R-LOBE SPAN (cm)	11.9+1.7	11.7+1.9	0.412
L-LOBE SPAN (cm)	7.1+2.2	7.4+2.2	0.146

PVD: portal vein diameter,  
R-LOBE SPAN: right lobe of liver,  
L-LOBE SPAN: left lobe of liver.  
BMI: body mass index.

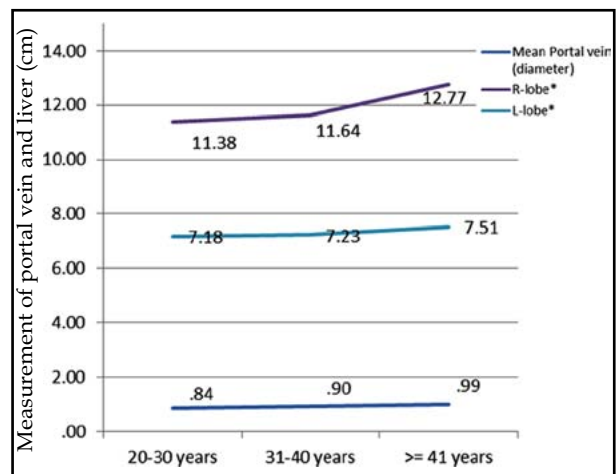


Fig.1: Impact of increasing age on portal vein and liver lobes.

Enlargement of PVD with increasing age may be explained by fragmentation of smooth muscles and loss of elasticity in the reticular network.<sup>35</sup> Jeffery et al hypothesized that a caliber greater than 1.3 cm would point towards portal hypertension.<sup>36</sup> However, the validity of this statement needs to be tested in a larger sample size and in comparison to patients with portal hypertension.

Our results of table 3 are compatible with Kratzer et al in concluding that gender did not affect the PVD and liver size.<sup>24</sup> A Doppler ultrasound study done in Iran on a small population concluded that gender was an important physical aspect for the determination of PVD.<sup>5</sup> Udoh et al have also suggested that gender is an important factor to influence the liver span.<sup>25</sup> Nonetheless, BMI was not taken into consideration which could have further validated these results.

Our study has concluded that age and BMI are important physical parameters that affect PVD and liver span. Results of this study can be considered in diagnosing NAFLD and portal hypertension. This reference range of our population can also be applied in routine radiological clinics. Future work should include large scale nationwide studies which can guide a clinician in selecting subjects for liver transplantation and for further strengthening our results.

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**Authors contribution:**

The concept, data collection and its analysis was done by Dr. Tanya Raza Siddiqui. Dr. Nuzhat Hassan critically analyzed and gave the final approval. Dr. Pashmina Gul provided the clinical input.