Original Research Article

ULTRASOUND ASSESSMENT OF PORTAL VEIN DIAMETER IN HEALTHY ADULT WOMEN IN SOUTH-SOUTH NIGERIA

ABSTRACT

Background: About 75% of the liver blood flow is from the portal vein, while the remaining 25% comes from the hepatic artery. One of the main abnormalities of the portal system is portal hypertension, and the portal vein diameter is key in make this diagnosis.

Objectives: To assess the mean normal portal vein diameter in healthy women in South-South Nigeria.

Subjects and Methods: This descriptive, cross-sectional study was conducted at all the clinical departments of the two tertiary health facilities, one secondary facility and one radio-diagnostic facility in Bayelsa State, South-South Nigeria, between April, 2022 and December, 2022. Data analysis was done using Statistical Product and Service Solutions for Windows® version 25, SPSS Inc.; Chicago, USA. Descriptive statistics (mean, standard deviation, frequency, and percentages) and Pearson product moment correlation were used for the analysis. The level of significance was considered at $p<0.05$.

Results: Portal vein diameter ranged from 6.8 mm to 16.6 mm, with a mean of 10.46 ± 2.00 mm. Body mass index ($r = 0.41$), age ($r = 0.43$), parity ($r = 0.44$), weight ($r = 0.49$) and height ($r = 0.27$) had a significant relationship ($p – 0.001$) with portal vein diameter. The relationship between portal vein diameter and age/parity of participants was of positive increasing trend.

Conclusion: This research has established baseline values for normal range of PV diameter in healthy women in our region of Nigeria, and also revealed significant correlation of PV diameter with age, parity, weight, height and body mass index.

Keywords: Portal vein diameter, Liver, Women, Age, Parity, Portal hypertension.

INTRODUCTION

The main sources of blood supply of the liver are the portal vein (PV) and hepatic artery. About 75% of the liver blood flow is from the portal vein, while the remaining 25% comes from the hepatic artery.[1] The superior mesenteric vein and splenic vein meet at the level of the second lumbar vertebra, behind the pancreatic neck, to form the portal vein.[1] The ultrasound measurement of the diameter of the portal vein is a crucial tool for making diagnosis of portal hypertension. Homeostasis is supported by the complex interaction between the liver and the portal vein.[1]

One of the main abnormalities of the portal system is portal hypertension. It mainly occurs as a result of a rise in portal venous pressure, which in turn causes resistance to blood flow into the hepatic circulation through the portal vein..[2–5] Splenomegaly, portal vein enlargement, and the development of portal

systemic collaterals at different sites, all result from portal hypertension. Portal hypertension causes significant mortality and morbidity, because it is the most frequent complication and the leading cause of death in people with chronic liver disease.[2,6,7] The normal PV diameter may vary from 7 mm to 15 mm, and the normal portal venous pressure varies between 5 mmHg and 10 mmHg.[8] A portal venous pressure of more than 15 mmHg (30 cmH_2O) may suggest portal hypertension.[8] The upper limit of the portal vein diameter has been documented as 13 mm by some authors, and a value greater than that suggests portal hypertension.[4,5,9,10]

Portal hypertension may result from pre-hepatic, hepatic, or post-hepatic causes. The most common causes of portal hypertension are liver cirrhosis, usually in the developed countries,[6,10,11] schistosomiasis, which occurs more in endemic regions[11,12] and hepatic vascular abnormalities[5] In addition to these conditions, other predisposing factors which include alcohol abuse and hepatitis, lead to scarring of the liver, which in turn cause liver cirrhosis.[11]

Some diagnostic imaging techniques like portal venography, splenoportography and arteriography have been used in the past to evaluate patients suspected to have portal hypertension; but these procedures are invasive and risky for the patient, costly and time-consuming. Magnetic resonance imaging and computed tomographic scan on the other hand, have the merit of providing better cross-sectional images. However, they are both costly, and the latter exposes the patient to ionizing radiation.[13,14] Ultrasonography uses non-ionizing radiation, and plays a major role in the diagnosis and follow-up of patients with portal hypertension due to its low cost, availability, accessibility, non-invasive nature, mobility, and less time-consuming. Therefore, the objective of this study was to assess the mean normal portal vein diameter in healthy women in South-South Nigeria.

SUBJECTS AND METHODS

Study design and setting: This descriptive, cross-sectional study recruited and enrolled healthy women from all the clinical departments at the Niger Delta University Teaching Hospital, Okolobiri, Federal Medical Centre, Yenagoa, Silhouette Radiodiagnostic Consultants, Yenagoa and Diete Koki Memorial Hospital, Yenagoa, all in Bayelsa State, Nigeria. The study was conducted between April, 2022 and December, 2022. These facilities offer obstetric and gynaecological care services to the people of Bayelsa State and nearby Rivers and Delta States, all of which are located in the South-South geopolitical region of Nigeria.

Sample size calculation: This was calculated using the formula: $n = Z\alpha^2 \times \sigma^2 / \delta^2$ [15,16]

Where: $Z\alpha$ = 95% CI, which is 1.96, σ = mean of 10.65 mm from a previous study.[11] δ = level of precision for our study ($\sigma/\sqrt{63}$).

Calculation:

$n = (1.96)^2 \times 10.65^2 / \sigma/\sqrt{63}$

n = 3.8416 x 113.42 / 1.34

n = 432.81 / 1.34

n = 322.993

n = 323

Considering attrition of 5% (16.15), n was adjusted to 339. For this study, 339 consecutive healthy women were enrolled.

Ethics: The protocol for this study was approved by the Research and Ethics Committee of the Federal Medical Centre Yenagoa, Bayelsa State, Nigeria (FMCY/REC/ECC/2022/683).

Inclusion criteria: Healthy adult women without any medical condition.
Exclusion criteria: Women with liver disease and other medical conditions.

Following counseling, written informed consent was obtained from all the women enrolled in the study. Sociodemographic information was obtained, including any presenting complaints that the patients may have. With the patient standing on the Frankfort plane, the height of the patient was measured using a wall-mounted stadiometer. A weighing scale was used to determine weight. Patients were asked to take off their bulky outerwear and shoes and stand in the middle of the scale to evenly distribute their weight across both feet. Body mass index (BMI) was determined as the product of height (m) squared and weight (kg). Urinalysis, liver function tests and serum electrolytes, urea and creatinine, were done for the women, and if these were normal, they were then referred to the Radiology Units of the study centres for ultrasound scan.

Procedure: Transabdominal ultrasound examination was performed for all the patients by consultant radiologists, using a 2012 Philips HD11 device with a 3.5 MHz curvilinear probe. Before data collection commenced, the consultant radiologists discussed, assessed for interobserver variability and reliability, and reached an agreement on the standard operative procedure of ultrasonography to ensure data quality. After an overnight fast, the individuals were placed in the supine and right anterior oblique positions for the ultrasound examination. When the main portal vein could be seen best, the patients were exposed from the xiphisternum to the suprapubic region, ultrasound gel was applied to the right upper quadrants of the abdomen, and the transducer was placed in the epigastrium in both the transverse and longitudinal planes. Measurements were taken at the location where the portal vein crosses anterior to the inferior vena cava, with the calipers placed between the inner margins of the echogenic walls of the vessel at the location where the portal vein crosses prior to the inferior vena cava (Figure 1).

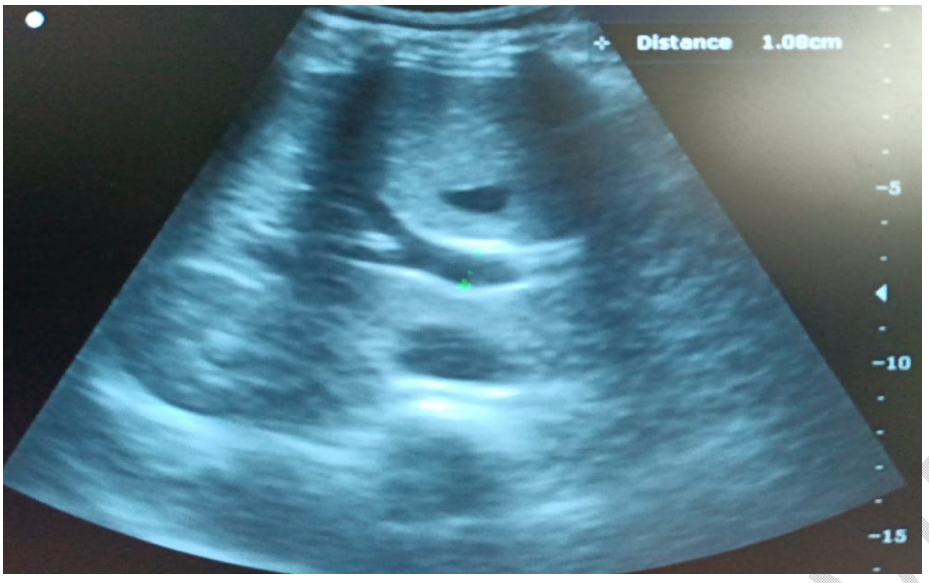

Figure 1: Longitudinal view of the abdomen showing the levels of measurement of the portal vein (green dotted lines).

Data analysis: A pre-designed proforma was used to record all the measurements obtained. Data analysis was done using Statistical Product and Service Solutions for Windows® version 25, SPSS Inc.; Chicago, USA. Descriptive statistics (mean, standard deviation, frequency, and percentages) and Pearson product moment correlation were used for the analysis. Interobserver and intraobserver variations were calculated with the use of the intraclass correlation coefficient (ICC) and documented. Statistical significance was set at $P<0.05$.

RESULTS

Baseline characteristics

A total of 339 healthy women with a mean age of 32.5 ± 11.2 years, were assessed for portal vein diameter. The modal (35.7%) age-group was 20 – 29 years. Women aged ≥ 40 years were 28.6%, while those 15 – 19 years were 13.0%. The mean body mass index was 23.9 ± 4.6 kg/m^2. More than half (57.8%) of participants had normal weight. Others were underweight (6.5%), overweight (22.7%) and obese (13.0%). Majority (38.9%) of the women were nulliparous. The median parity was 1; with a range 0 to 5 (Table 1).

Relationship between baseline characteristics and portal vein diameter

Portal vein diameter ranged from 6.8 mm to 16.6 mm, with a mean of 10.46 ± 2.00 mm (Figure 2). Body mass index (ɾ = 0.41), age (ɾ = 0.43), parity (ɾ = 0.44), and weight (ɾ = 0.49), had a fairly strong, significant relationship (p – 0.001) with portal vein diameter. Height also had a statistically significant (although weak) relationship with portal vein diameter (ɾ = 0.27; p – 0.001) (Table 2). The relationship between portal vein diameter and age/parity of participants was of positive increasing trend. There was a gradual increase in the portal vein diameter of participants 15 years to greater than 40 years. The difference in the

mean portal vein diameter between the age groups was significant (*f-stat* = 22.11; p -0.001). A similar trend was seen with parity (Table 3). Results for the intraobserver and interobserver correlation coefficients are shown in Table 4.

Table 1: Baseline characteristics of the participants

Characteristics	Frequency, n = 339	Percent (%)
Age group (years)		
15 – 19	44	13.0
20 – 29	121	35.7
30 – 39	77	22.7
≥ 40	97	28.6
Age in years – mean ± SD	32.5 ± 11.2	
Anthropometric measurements		
Weight in kg – mean ± SD	63.8 ± 13.8	
Height in metres – mean ± SD	1.63 ± 0.07	
Body mass index in kg/m^2 – mean ± SD	23.9 ± 4.6	
Body mass index		
Underweight	22	6.5
Normal weight	196	57.8
Overweight	77	22.7
Obese	44	13.0
Parity		
Nulliparity	132	38.9
Primiparous	55	16.2
Multiparous	109	32.2
Grand multiparous	43	12.7
Parity – Median (range)	1 (0 – 5)	

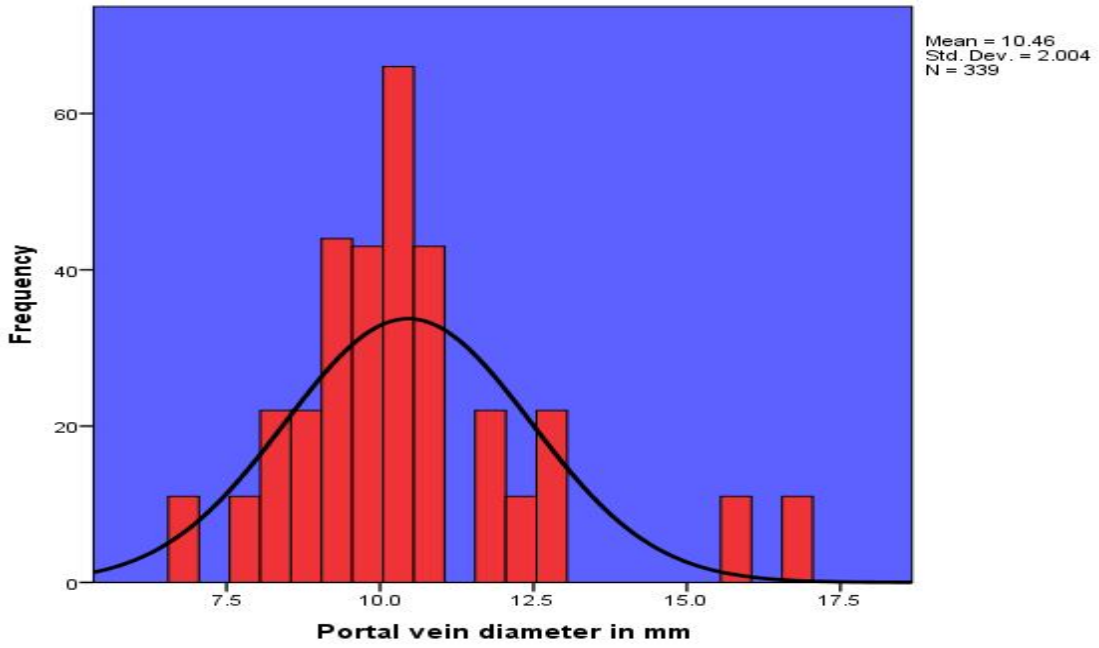

Figure 2: Histogram showing the measurements of portal vein diameter

Table 2: Correlation between portal vein diameter and age, parity and the anthropometric measures of participants

Characteristics	Correlation coefficient - ɾ (p-value)
Age	0.43 (0.001*)
Parity	0.44 (0.001*)
Weight	0.49 (0.001*)
Height	0.27 (0.001*)
Body mass index	0.41 (0.001*)

*Statistically significant

Table 3: Mean portal vein diameter at the different age groups and parity

Characteristics	Frequency	Portal vein diameter Mean ± SD	F-stat (p-value)
Total population	339	10.46 ± 2.00	
Age group (years)			
15 – 19	44	9.40 ± 1.32	22.11 (0.001*)
20 – 29	121	9.74 ± 0.73	
30 – 39	77	10.97 ± 2.25	
≥ 40	97	11.43 ± 2.51	
Parity			
Nulliparity (0)	132	8.50 ± 0.76	35.57 (0.001*)
Primiparous (1)	55	9.66 ± 0.99	
Multiparous (2)	54	9.90 ± 0.73	
Multiparous (3)	44	10.30 ± 2.17	
Multiparous (4)	11	11.53 ± 2.36	
Grand-multiparous (≥5)	43	12.94 ± 2.32	

*Statistically significant

Table 4: Interobserver and intraobserver intraclass correlation coefficient results

Ultrasound parameter	Intraclass correlation coefficient	
	Interobserver	Intraobserver
Portal vein diameter	0.99 (95% CI 0.51–0.99)	0.98 (95% CI 0.56–0.99)

DISCUSSION

This study revealed a mean PV diameter of 10.46 ± 2.00 mm (with a range of 6.8 mm to 16.6 mm). This finding is in consonance with the mean PV diameter of 10.43 ± 1.58 mm reported by Oriji *et al.,* in South-South Nigeria,[17] 11.5 ± 0.15 mm reported by Anakwue *et al.,* in South-East Nigeria,[2] 10.9 ± 0.81 mm reported by Usman *et al.,* in Maiduguri, North-East Nigeria,[11] 10.6 ± 1.8 mm reported by Geleto *et al.,* in South-West Ethiopia,[8] 11.7 ± 0.3 mm reported by Cosar *et al.,* in Turkey,[18] and 11.0 ± 2.6 mm reported by Tasu *et al.,* in France.[19] It is possible that the reason for these similarities is that ethnic and racial variations do not significantly influence PV diameter. Conversely, our mean PV diameter was slightly higher than the 7.9 ± 2.0 mm reported by Hawaz *et al.,* in Addis Ababa, Ethiopia,[6] 9.83 ± 0.95

mm reported by Akanni *et al*., in Parakou, Benin,[20] and 9.6 ± 1.9 mm reported by Rokni-Yazdi and Sotouden in Iran.[21] This may be a result of the different sample sizes, methodologies and measuring techniques of these different studies.

Age correlated significantly (r = 0.43; p – 0.001) with portal vein diameter in this study. PV diameter increased with increase in the age of the women. This finding is in agreement with the reports of Oriji *et al.,*[17] Anakwue *et al.,*[2] Usman *et al.,*[11] Hawaz *et al.,*[6] Shikha *et al.,*[22] and Geleto *et al.*[8] However, Adeyekun and Tsebi,[14] Cosar *et al.,*[18] and Weinreb *et al.,*[4] did not find any correlation between PV diameter and age. This may have also resulted from the difference in sample size, methodology and measuring technique of the studies.

Our study observed a significant correlation between PV diameter and parity. This finding is in tandem with that of Oriji *et al.*[17] The reason for this is not readily understood. This study also observed a significant correlation between PV diameter and weight, height, and body mass index. This observation agrees with the findings of Ayele *et al.,*[23] Akanni *et al.,*[20] in Parakou, Benin, Gareeballah *et al.*,[24] in Sudan, and Saha *et al.,*[25] and Lal *et al.,*[26] both in India, who reported that weight and height were associated with PV diameter. This was, however, in disagreement with the reports of Oriji *et al.,*[17] Usman *et al.,*[11] and Moriyasu *et al.,*[27] who did not observe any relationship between PV diameter and weight, height, and body mass index. The relatively small sample size of these studies and the measuring techniques for PV diameter may have contributed this variable correlation with PV diameter.

The ICC was employed in our study to reduce interobserver and intraobserver variability for measurements of portal vein diameter. It assesses the consistency of measurements for the same parameter[28] and takes into account both interobserver variability and the variance of all measurements.[28,29] A value above 0.8 indicates nearly perfect agreement, with the standard range being 0 to 1.[30,31] In our study, the results for the inter- and intraobserver variance were 0.99 and 0.98, respectively, showing nearly perfect agreement.

This study's strength comes from the fact that it was a multicenter study that only included healthy female participants. As a result, confounding factors that might have altered the measurements of the portal vein diameter, such as liver diseases or other medical disorders, were eliminated. The limitation of this study is that it is hospital-based, and may therefore, not reflect what is obtainable in the general population of women.

CONCLUSION

This research has established baseline values for normal range of PV diameter in healthy women in our region of Nigeria, and also revealed significant correlation of PV diameter with age, parity, weight, height and body mass index. A nomogram showing the value of portal vein diameter at different age-groups and

parity was produced. More researches on the relationship between PV diameter and age and parity are therefore recommended.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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