1.1 Introduction:

Portal vein is a special conduit which transmits blood from the capillaries of intestinal wall and spleen to capillaries of hepatic sinusoids (1,2)The most common abnormality of this special conduit (portal venous system) is portal hypertension . Portal hypertension is a prevalent clinical syndrome defined as an increase in portal venous pressure, and this leads to in impendence of blood flow through the vein into the hepatic circulation. The most common causes of portal hypertension cited in different studies were cirrhosis (in developed countries) .schistosomiasis (in endemic areas) and hepatic vascular abnormalities . As a result of portal hypertension, dilatation of portal vein, splenomegaly and formation of portal systemic collaterals at different sites are consequently developed. (Anakwue 2009)

Hence, it leads to high mortality and morbidity because it is the most common complication and leading reason for deaths among clients with chronic liver disease . Regardless of the types of causes, the complications (consequences) of portal hypertension are similar . Since many centuries ago, there were trials for the development of portal hypertension measuring tools (Ultrasound) among which Gray-scale Ultrasound (US), Doppler US and Sonography were better sensitive and specific ones . Although Gray-scale and Doppler US allow anatomic and functional evaluations of the major tributaries of the portal venous system, ((Anakwue 2009))

Sonography is non-ionizing, easily accessible, non-invasive and portable in nature, reliable, low in cost and also it is rapid. These features make Sonography a good diagnostic tool for portal hypertension. The normal portal vein diameter (PVD) can vary normally between 7 to 15 mm while

normal portal venous pressure lies between 5 and 10 mmHg (14 cm of H2O) .If portal venous pressure is more than 15 mmHg (30 cm of H2O), then it might indicate portal hypertension .A portal vein diameter greater than 13 mm is assumed to be the cutoff point for portal hypertension in the appropriate clinical setting .On the contrary, a portal vein diameter greater than 10 mm was also considered as portal hypertension in previous literatures .However, mean normal portal vein diameter greater than 10 mm was also indicated from previous studies:13 mm ,greater than 11mm in Nigeria . 11.54 mm in Kolkata ,which contradicts with the mentioned cutoff point. ((Anakwue 2009))

These imply the existence of limited evidence on normal portal vein diameter for all populations in all countries of the world prior to setting the cutoff points. On top of this, the need for having scientific evidence on mean portal vein diameter among normal and with portal hypertensive clients in all countries was cited by literatures. (Anakwue 2009)

1.2 Problem of the study:

Lack of reference value for normal main portal vain diameter in adult related to various factors including hepatic disease this study tries to assess the range of normal measurements in relation with age, sex and anthropometry.

1.3 General objective:

The aim of this study to estimate normal main portal vain Diameter in adult using ultrasound

1.4 Specific objectives:

1\to measure the normal main portal vain diameter.

2\ to correlate the normal diameter with age and gender and body mass index

1.5 Overview of the study:

The study consist of Chapter one include the introduction ,chapter two include the previous study and literature review ,chapter three include the material and method chapter four result ,chapter five discussion conclusion.

2.1 Anatomy of Portal vein

The portal vein or hepatic portal vein is a blood vessel that carries blood from the gastrointestinal tract, gallbladder, pancreas and spleen to the liver. This blood is rich in nutrients that have been extracted from food, and the liver processes these nutrients; it also filters toxins that may have been ingested with the food. 75% of total liver blood flow is through the portal vein, with the remainder coming from the hepatic artery proper. The blood leaves the liver to the heart in the hepatic veins.The portal vein is not a true vein, because it conducts blood to capillary beds in the liver and not directly to the heart. It is a major component of the hepatic portal system, one of only two portal venous systems in the body – with the hypophyseal portal system being the other. *.(* Henry Gray 2004)

The portal vein is usually formed by the confluence of the superior mesenteric and splenic veins and also receives blood from the inferior mesenteric, gastric, and cystic veins. Conditions involving the portal vein cause considerable illness and death. An important example of such a condition is elevated blood pressure in the portal vein. This condition, called portal hypertension, is a major complication of cirrhosis.(Henry Gray 2004)

Generally, the portal vein enters the porta hepatis and divides into the right and left main branches. The right main branch divides into anterior and posterior branches that supply the anterior and posterior segments of the right lobe. The left main branch courses horizontally to the left before turning vertically to form the medial and lateral segmental branches. Several variations of the portal venous anatomy have been described by using ultrasonography, CT, and cadaveric dissection. (Ravi SG el al 2011)

2.1.1 structure

Measuring approximately 8 cm (3 inches) in adults, the portal vein is located in the right upper quadrant of the abdomen, originating behind the neck of the pancreas. In most individuals, the portal vein is formed by the union of the superior mesenteric vein and the splenic vein. For this reason, the portal vein is occasionally called the splenic-mesenteric confluence. Occasionally, the portal vein also directly communicates with the inferior mesenteric vein, although this is highly variable. Other tributaries of the portal vein include the cystic and gastric veins. Immediately before reaching the liver, the portal vein divides into right and left. It ramifies further, forming smaller venous branches and ultimately portal venules. Each portal venule courses alongside a hepatic arteriole and the two vessels form the vascular components of the portal triad. These vessels ultimately empty into the hepatic sinusoids to supply blood to the liver. (Wikipedia 2015)

2.1.2Portacaval anastomoses :

The portal venous system has several anastomoses with the systemic venous system. In cases of portal hypertension these anastamoses may become engorged, dilated, or varicosed and subsequently rupture.

2.1.3 Accessory hepatic portal veins

Accessory hepatic portal veins are those veins that drain directly into the liver without joining the hepatic portal vein. These include the paraumbilical veins as well as veins of the lesser omentum, falciform ligament, and those draining the gallbladder wall. (*Plinio Rossi; L. Broglia (2000)*)

2.1.3.1Function

The portal vein and hepatic arteries form the liver's dual blood supply. Approximately 75% of hepatic blood flow is derived from the portal vein, while the remainder is from the hepatic arteries. Unlike most veins, the portal vein does not drain into the heart. Rather, it is part of a portal venous system that delivers venous blood into another capillary system, the hepatic sinusoids of the liver. In carrying venous blood from the gastrointestinal tract to the liver, the portal vein accomplishes two tasks: it supplies the liver with metabolic substrates and it ensures that substances ingested are first processed by the liver before reaching the systemic circulation. This accomplishes two things. First, possible toxins that may be ingested can be detoxified by the hepatocytes before they are released into the systemic circulation. Second, the liver is the first organ to absorb nutrients just taken in by the intestines. After draining into the liver sinusoids, blood from the liver is drained by the hepatic vein. (*Plinio Rossi; L. Broglia (2000)*)

2.1.4 Variant anatomy

The overall incidence of portal vein variation is reported to be ~25% (range 20-30%), which should be recognized prior to procedures such as liver transplantation, complex hepatectomy and portal vein embolisation portal vein trifurcation (most common), portal vein divides into three branches: left portal vein, right anterior portal vein, and right posterior portal vein, right posterior portal vein splits off as the first branch of the portal vein; the right anterior and the left portal veins then originate from a common trunk .and portal vein duplication (rare). And portal vein absence (rare).There is an increased risk of bile duct hilar anatomical variation in the presence of portal vein variants.(Br J Radiol 2015)

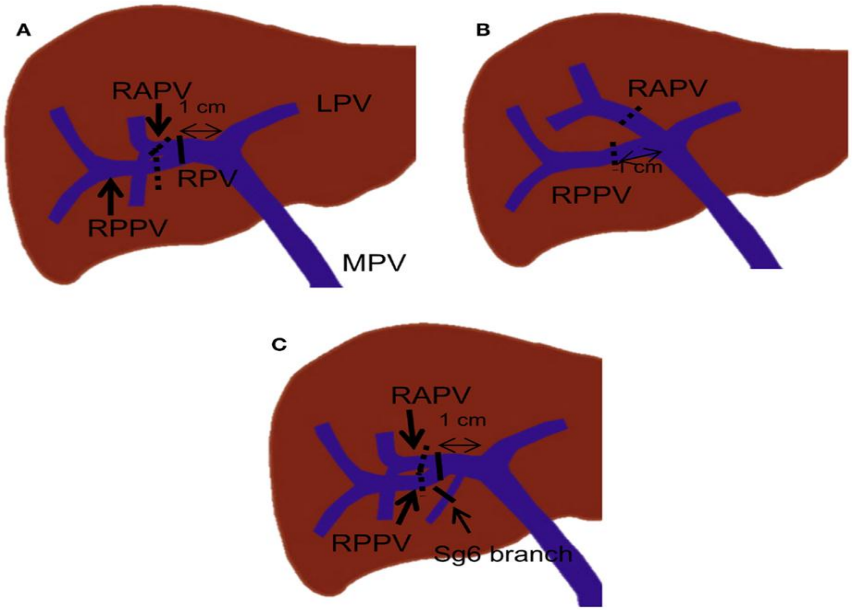


Figure 2-1 showed Variant anatomy of portal vain (journal.frontiersin.org(2016))

2.2 Physiology:

The hepatic portal system is the system of veins comprising the hepatic portal vein and its tributaries. It is responsible for directing blood from the region of the gastrointestinal tract between the esophagus and rectum and also includes venous drainage from the supplementary organs such as the spleen and pancreas. It functions to supply the liver with metabolites and ensures that ingested substances are processed in the liver before reaching the systemic circulation, limiting the damage ingested toxins may cause.The hepatic portal vein supplies about 75% of the blood the liver requires, with the other 25% supplied by the hepatic artery. Blood from the hepatic artery is oxygenated but nutrient-poor compared to that supplied by the hepatic portal vein. *(* Hepatol Res. *2016)*

Blood from either source passes into cavities between the hepatocytes of the liver called sinusoids, which feature a fenestrated, discontinuous endothelium allowing for the efficient transfer and processing of nutrients in the liver. Since blood received from the hepatic portal vein may be contaminated with pathogens such as bacteria, the liver is rich in specialized immune cells called Kupffer cells that detect and destroy foreign organisms. Following processing, blood collects in a central vein that drains into the hepatic vein and finally the inferior vena cava. The liver consumes about 20% of the total body oxygen when at rest. That is why the total liver blood flow is quite high at about 1 liter a minute and up to two liters a minute. That is about a quarter of the average cardiac output at rest. (Hepatol Res 2016)

2.3 Investigation Done :

2.3.1 Radiographic features

Acutely only the thrombus may be evident, with associated findings related to the ischemic bowel (especially if significant superior mesenteric venous (SMV) involvement is also present).In chronic cases, cavernous transformation of the portal vein may be seen, with numerous periportal veins replacing the normal single channel of the portal vein

2.3.2 CT of portal vain:

Non-contrast scans are usually incapable of demonstrating the thrombus, except is some acute cases where the thrombus is hyper attenuating . In longstanding cases, low-density change in the liver may be evident, related to increased arterial supply, and representing fatty change. The diagnosis can only reliably be made on portal venous phase contrast enhanced studies.

2.3.3MRI portal vain:

Although MRI is not as widely available, and can be difficult in unwell patients, it is the most sensitive modality for demonstrating portal venous thrombosis. 3D contrast enhanced MRA is the most sensitive sequence. However, the differentiation between bland and tumour thrombus usually requires integrating multiple sequences and taking into account chronicity of the thrombosis. Appearances include:T1. acute thrombus will have high signal (see ageing blood on MRI), beware slow or turbulent flow artifacts .

T2: acute thrombus may have high signal, chronic thrombus may be low and appear as flow voids, beware slow flow-related artifacts, tumor thrombus is typically hyperintense. T1 + C (Gad): tumor thrombus enhancement may be detectable on postcontrast dynamic sequences. transient hepatic intensity differences (THID) may be seen in the arterial/early portal phase if the thrombus occludes only a branch of the portal vein, as the hepatic artery takes on the affected lobe/segment's perfusion. And MR angiography, 3D contrast enhanced MRA (98% sensitive and 99% specific).

2.3.4 Ultrasound (U/S):

Ultrasound relies upon the transmission of targeted sound waves of varying selected frequencies through tissues, with subsequent computerized conversion of the signals from the reflected waves into anatomical images on a screen. The degree of reflection of sound waves depends upon the interface between tissues with different acoustic properties. The degree of echogenicity depends upon the ability of the tissue being evaluated to reflect or absorb the ultrasound waves. Thus, a fatty liver will attenuate the ultrasound beam somewhat, limiting full evaluation of the liver parenchyma. Similarly, waves are not transmitted through air.

Normal measurements on ultrasound : Measurements of components of the hepatobiliary tree depend upon the skill of the ultrasonographer obtaining the measurements, and there is variability in terms of what is considered "normal." However, some general estimates are available regarding the expected sizes of structures in the hepatobiliary tree(ultrasoundpeadia,2007).

2.3.4.1 Imaging approach:

Trans abdominal ultrasound is an ideal initial investigation for suspected portal vain and hepatic pathology ,supplemented by various imaging modalities include MR/MRA/and CTA. US plays a key role in the multimodality evaluation of complex portal vain pathology.

2.3.4.2. Imaging protocol:

patient should be fasted at least 4 hours prior to US examination .

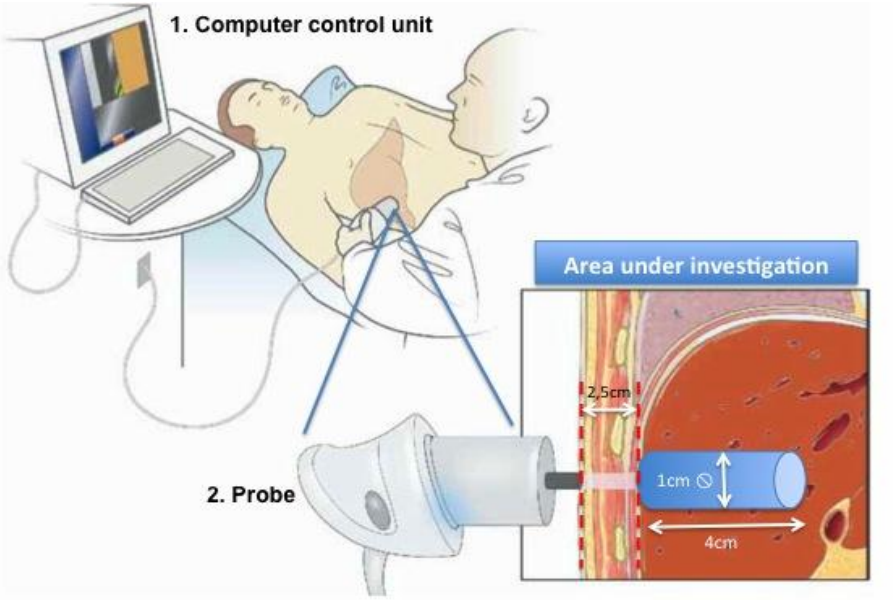


Figure 2-2 Diagram showing the scanning areas used to obtain the portal vain(ultrasoundpeadia,2007).

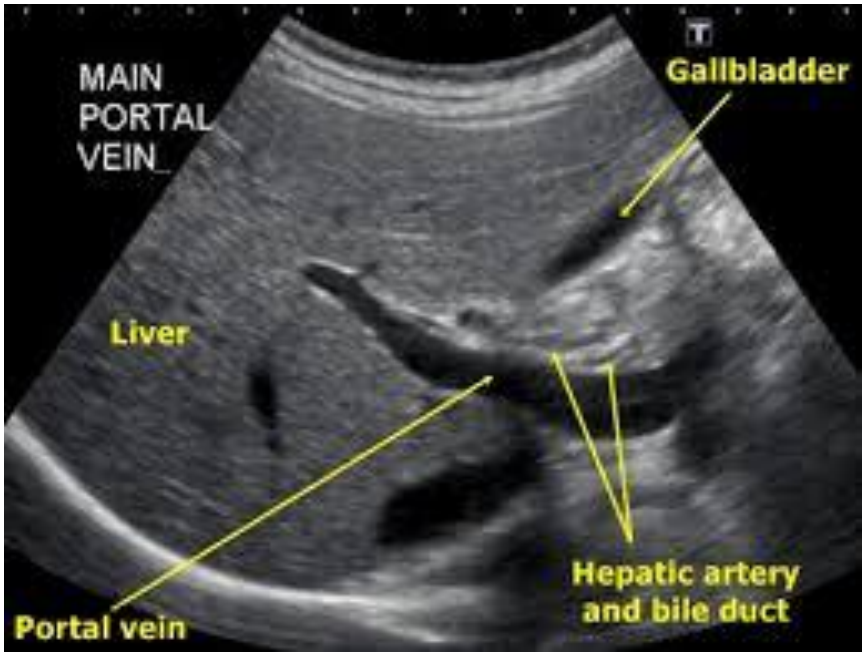


Figure 2-3 Image show the normal appearance of the portal vain (Lee WK 2002*)*

2.4 Previous studies :

Study done by Nahid S Y in October 2009- February 2010 in sudanes population study done in kartome and Gazera states to obtain data on sonographically measured diameters of portal vain in normal Sudanese population and to measure its correlation with age ,sex and anthropometry. the study include 102 participants 54 female and 48 male .portal vain measured in longitudinal scan at the coronal plain in med clavicles line .Anthropometric measurements including height ,weight .chest circumference ,circumference at umbilicus were obtained using standard procedure ,the results revealed that Mean age of study subjects was 45.5 years (Range 20-70 years). Mean diameters of the portal vain were: proximal, 10. mm (mean +_SD 10.26+1.30 mm). We observed there was no significant diferant between P.V diameter in male and female in the sample of study. The diameter did not show any statistically significant correlation with any of the anthropometric measurements.

Another study done by Jeffrey weinreb et al .in 1982 united states of amareca . real time ultrasound of normal portal vain measurements is presented the main diameter of portal vain in 107 patients between the ages of 21 to 40 was 11+\-2mm . And in 21 patient aged 0-10 years, the mean diameter of the portal vain (+\-SD) was 8.5+\-2.7 mm (range 5-12mm). in 20 patients aged 11-20 years, the mean diameter was 10 +\- 2 mm (range 8-12 mm). in 49 patients aged 21-30 years, the mean diameter was 11 +\- 2 mm (range 6-15 mm). in 58 patients aged 31-40 years, the mean diameter was 11 +\- 2 mm (range 6-15 mm). the overall mean diameter in 107 patients aged 21 to 40 was 11+\-2mm . there was no difference between the portal vain measurements of male and female patients .

3.1 Materials:

This retrospective crossectional study aimed to measure the normal diameter of the portal vain . The data used in this study was collected from military hospital and health insurance in gadaref state from January 2017 to April 2017.

3.1.1 Subjects:

Study cases were 100(56female and 44male)all was normal subject came to the ultrasound department for routine scan ,all subjects had liver ,biliary ,pancreatic disease and pregnant ladies were excluded from the study, portal vain was measured at its association with the CBD in the long axis of the gallbladder. Anthropometric measurements including height, weight, chest circumference, and abdominal circumference at umbilicus were obtained using standard procedures.

3.1.2 Area of the study:

Qadaref state

3.1.3 Duration of the study:

From January 2017 to April 2017.

3.1.4 Method of data analysis and presentation:

The data will be analyzed using the SPSS and EXCEL programmers.

3.1.5 Machine used:

All patients where scanned by esaote ultrasound machine using curve linear low frequency transducer (3.5-5 MHz).

3.2 Method:-

Ultrasounds scanning of 100 normal subjects were done by sinologist. Portal vain internal diameter was measured in millimeters.

The area for evaluation was fixed and skin adequately lubricated to facilitate ultrasound transmission. The transducer was gently applied and longitudinal scan was taken. the appearance of the intrahepatic portal venous system is very similar from patient to patient when viewed from Para sagetal planes of section. By positioning an ultrasound transducer appropriately

3.2.1 Image interpretation:

The scan include sonographic information at the mid clavicle line, at this location the portal vain appear in long axis.

3.2.2 Data collection and analyses :

The data collecting by collection data sheet .

The data was analyzed using Standard Package of Social Science and EXCEL programmers

4. Result:

Table 4.1 show frequency distribution of population according to gender

Gender

		Frequency	Percent
Valid	Female	56	56.0
	Male	44	44.0
	Total	100	100.0

Figure 4.1 show frequency distribution of population according to gender

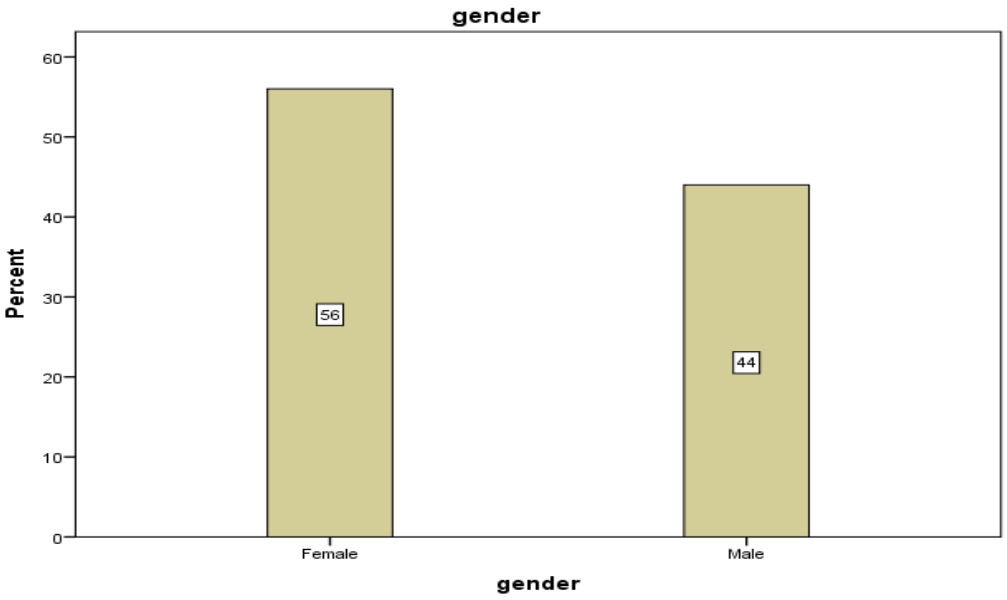


Table 4.2 show frequency distribution of population according to age

Age Group	Frequency	Percent
17-25	25	25.0
26-35	19	19.0
36-45	19	19.0
46-55	14	14.0
56-65	16	16.0
66-77	7	7.0
Total	100	100.0

Figure 4.2 show frequency distribution of population according to age

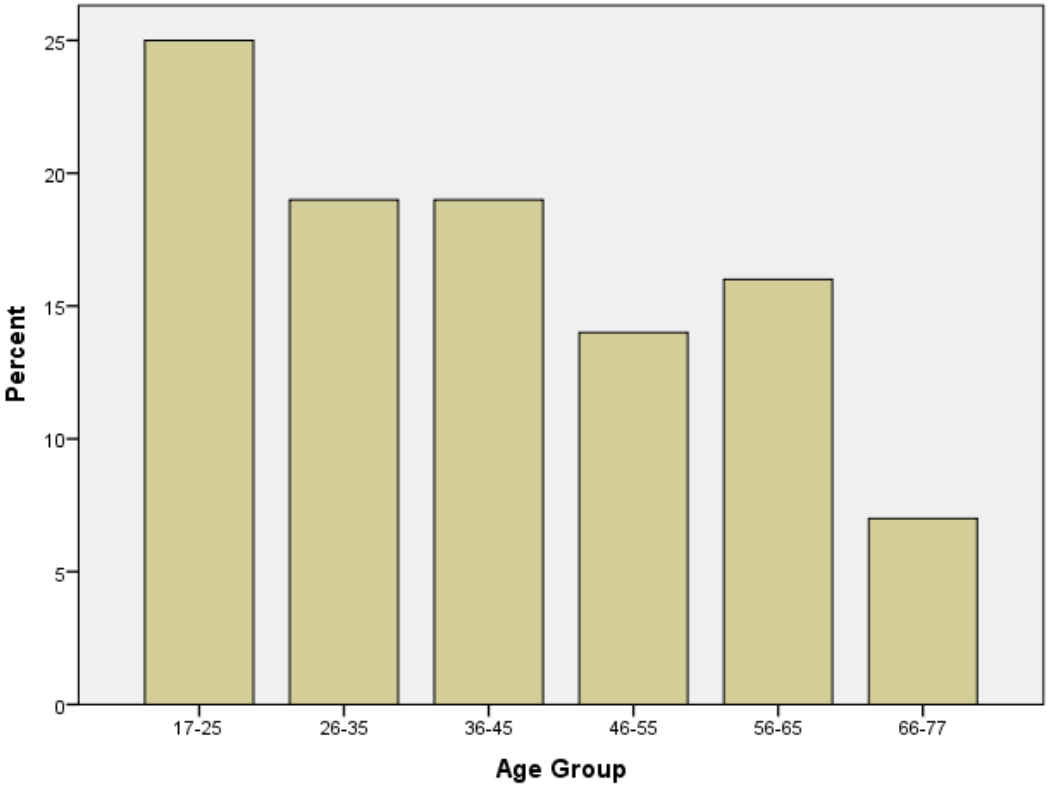


Table 4.3 show frequency distribution of population according to portal vain diameter

Portal Vein	Frequency	Percent
7-9	44	44.0
9-11	40	40.0
11-13	16	16.0
Total	100	100.0

Figure 4.3 show frequency distribution of population according to portal vain diameter

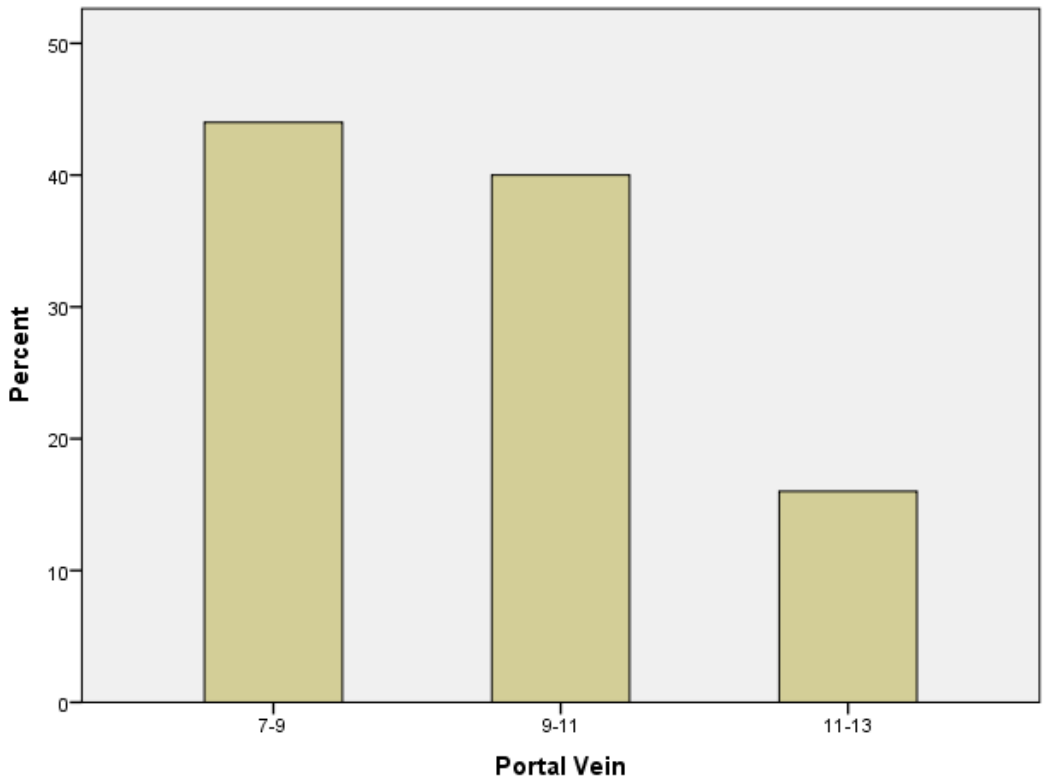


Table 4.4 show statistical parameters for all population

	Mean	Median	STD	Min	Max
Age	40.68	40	16.24	18	76
BMI	25.51	25.86	4.08	15.57	38.94
chest cir	86.28	87	11.16	50	112
Ad cir	86.52	85	14.48	50	118
P.V	9.56	9.30	1.20	7.5	12.20

Table 4.5 show statistical parameters for female population

	Mean	Median	STD	Min	Max
Age	43.07	42.50	15.66	18	72
BMI	26.72	26.46	4.01	18.36	38.94
chest cir	87.07	87.50	10.77	50	112
Ad cir	89.89	88.50	14.28	61	118
P.V	9.54	9.30	1.11	8	12.2

Table 4.6 show statistical parameters for male population

	Mean	Median	STD	Min	Max
Age	37.64	34.50	16.64	18	76
BMI	23.96	23.38	3.66	15.57	34.23
chest cir	85.27	85.50	11.68	58	108
Ad cir	82.23	81	13.72	50	108
P.V	9.57	9.15	1.32	7.5	12

Figure 4.4 show correlation between Body Mass Index and Chest Circumference (C1)

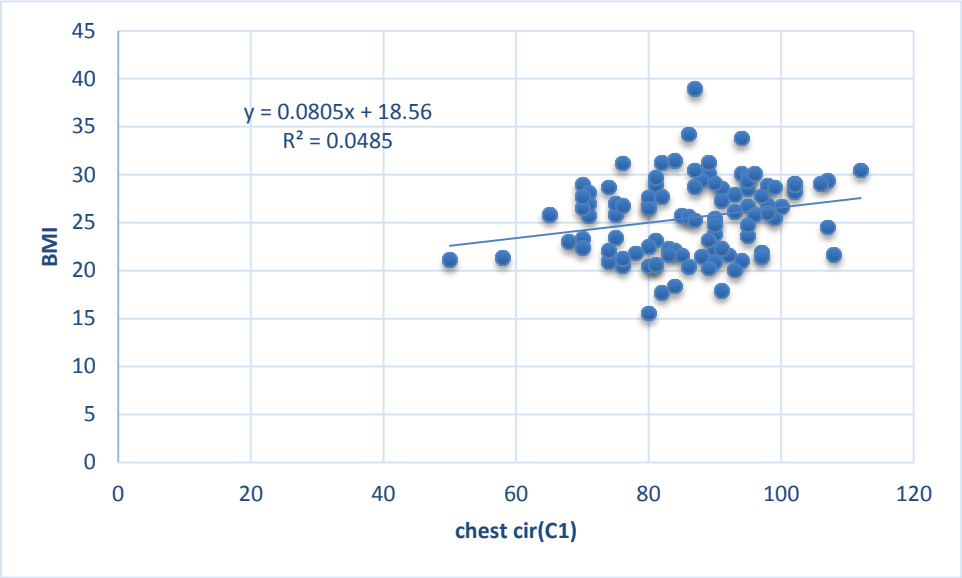


Figure 4.5 show correlation between Body Mass Index and portal vain

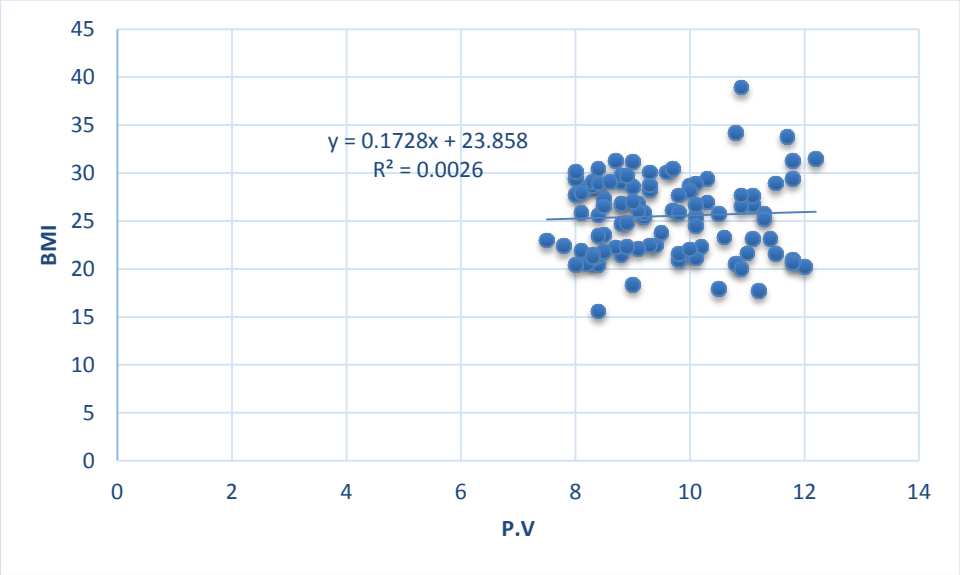


Figure 4.6 show correlation between Body Mass Index and Abdominal Circumference (C1)

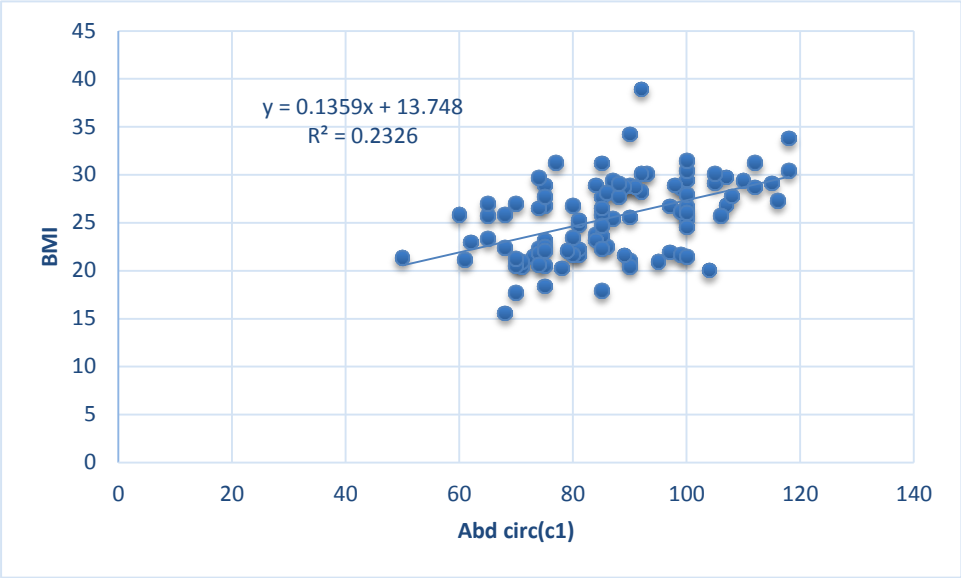


Figure 4.7 show correlation between Age and portal vain

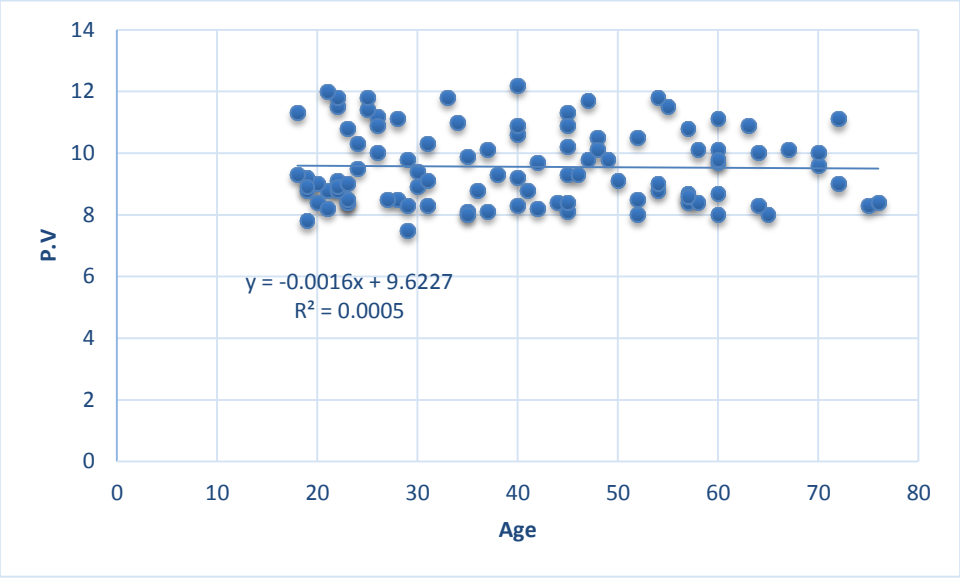


Figure 4.8 show correlation between Age and Abdominal circumference (C1

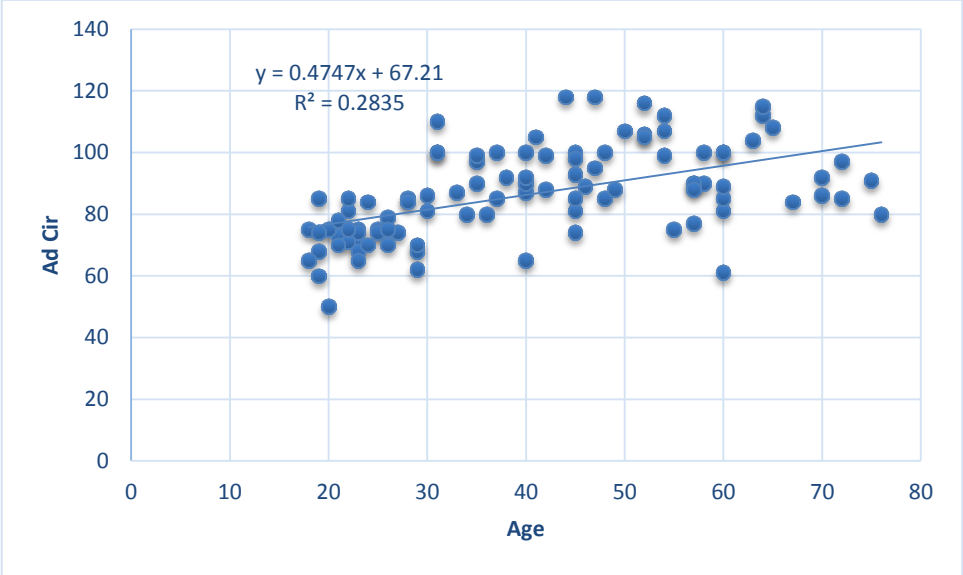


Figure 4.9 show correlation between Age and Chest circumference (C1)

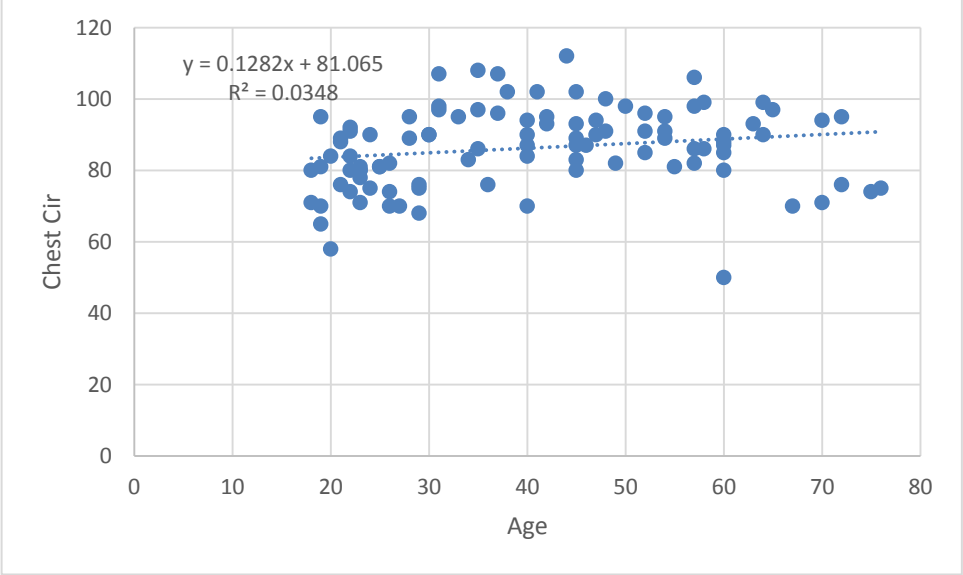


Figure 4.10 show correlation between portal vain and Chest circumference (C1)

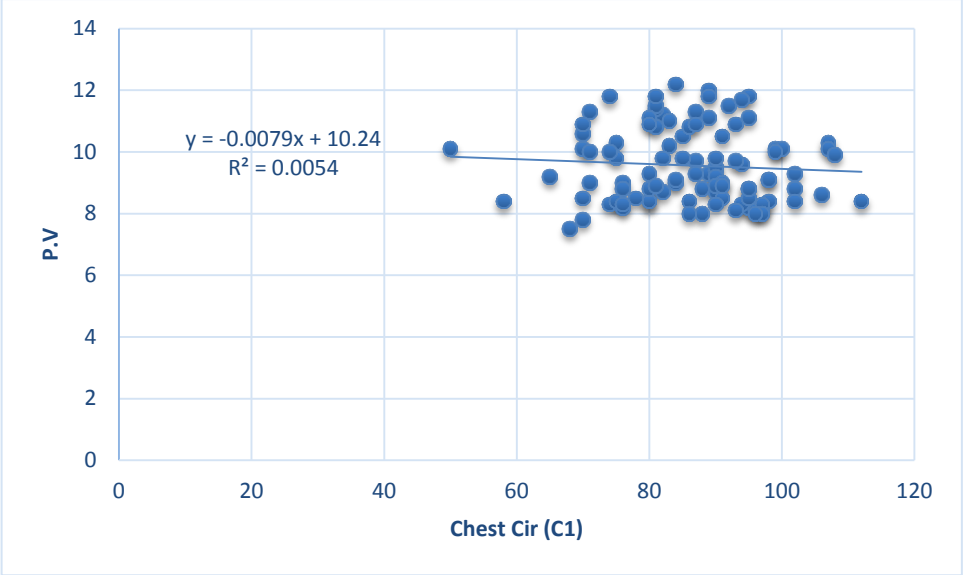
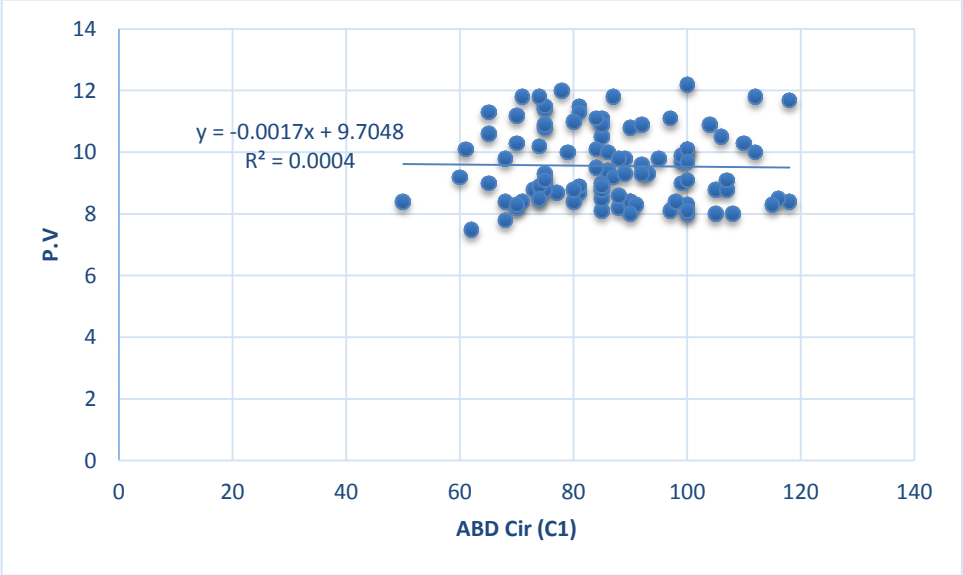


Figure 4.11 show correlation between portal vain and abdominal circumference (C1)



5.1 Discussion:

Table4-1 show frequency distribution of population according to gender, wear the female represented 56 with percentage 56% of all population. And male represented 44 with percentage 44%of all population, as shown in figure 4-1. Table 4-4show statistical parameters for all population as mean (+\-SD) for age 40.68+\-16.24, and mean of body mass index (+\-)25.51+\-4.08, mean of chest circumference (+\-SD)86.28+\- 11.16, mean of abdominal circumference (+\-SD) 86.52+\-14.48, mean of portal vain (+\-SD) 9.56 +\- 1.2 . Table 4-5 show statistical parameters for female population as mean (+\-SD) for age 43.07+\-15.66, and mean of body mass index (+\-)26.72+\-4.01, mean of chest circumference (+\-SD)87.07+\- 10.77, mean of abdominal circumference (+\-SD) 89.89+\-14.28, mean of portal vain (+\-SD) 9.54 +\- 1.11. Table 4-6 show statistical parameters for male population as mean (+\-SD) for age 37.64+\-16.64, and mean of body mass index (+\-)23.96+\-3.66, mean of chest circumference (+\-SD)85.27+\- 11.68, mean of abdominal circumference (+\-SD) 82.23+\-13.72, mean of portal vain (+\-SD) 9.57 +\- 1.32.

Figure 4-4 show correlation between body mass index and chest circumference wear the relation (R^2 =0.048) , which represent very week relation . Figure 4-5 show correlation between body mass index and portal vain wear the relation (R^2 =0.002) , which represent very week relation . Figure 4-6 show correlation between body mass index and abdominal circumference wear the relation (R^2 =0.232) , which represent week relation . Figure 4-7 show correlation between age and portal vain wear the relation (R^2 =0.000) , which represent no relation . Figure 4-8 show correlation between age and abdominal circumference wear the relation (R^2 =0.283) , which represent week relation . Figure4-9 show

correlation between age and chest circumference wear the relation (R^2 =0.034), which represent very week relation. Figure 4-10 show correlation between portal vain and chest circumference wear the relation (R^2 =0.005), which represent very week relation. Figure 4-11 show correlation between portal vain and abdominal circumference wear the relation (R^2 =0.000) , which represent no relation .

5.2 Conclusion:

The study conclude that normal measurement of normal main portal vain diameter for adult in al Gadaref state for one hundred normal population from January 2017 to April 2017, and the result of study show that normal measurement of portal vain less than 13 mm , and there is no significant correlation between portal vain diameter and age and sex and other anthropometry measurement .that result agree with another previous study done by Nahid S Y in 2009 in khartome and Gazera state.

5.3 Recommendation:

1. Ultrasound is a simple, time saving tool for evaluation parts diameter It should be the first investigation to be done to evaluate the normal index for populations.
2. Further studies in measurement of portal vain in different locations with larger sample of population for more accurate results.
3. Measurement with different patient body posture for more accuracy and to have limits of normal diameter according to the position of the patient.
4. Further studies should be done with more body characteristic.
5. Educating and training technologist sonographers and radiologists to perform optimum examination and correct measurements.
6. The most profound limitation of the study was the small sample size. So we recommend that study with larger sample be considered.

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Appendices A Ultrasound images:

ultrasound image of 19years female shows the portal vein in longitudinal plane, caliber measuring of P.V diameter (8 mm).

ultrasound image of 54 years male shows the caliber measuring of P.V diameter (11 mm).

ultrasound image of 60 years male shows the caliber measuring of P.V diameter (12 mm).

ultrasound image of 20 years female shows the caliber measuring of P.V diameter (7.5 mm).

ultrasound image of 70 years male shows the caliber measuring of P.V diameter (7.5 mm).

ultrasound image of 60 years female shows the caliber measuring of P.V diameter (8 mm).

ultrasound image of 59 years male shows the caliber measuring of P.V diameter (7 mm).

ultrasound image of 65 years female shows the caliber measuring of P.V diameter (7.5 mm).

Appendices B:

Sudan University of Science and Technology

College of Graduate Studies

Collecting Data Sheet

No	Gender	Age	Height	Weight	BMI	P.V (mm)	Chest cir.(cm)	Abd.cir.(cm)