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Estimation of Pulmonary Artery Pressure in Sudanese Population Using Echocardiogram

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Abstract:
Background*: In spontaneously breathing cardiac patients, pulmonaryartery pressure (PAP) can be accurately estimated fromthe transthoracic Doppler study of pulmonary artery and tricuspidregurgitation blood flows.This study aimed to figure out the standard value of the pulmonary artery pressure in Sudanese population using an echocardiogram.*
Materials and Methods*: In a total of Three hundred participants males 157 (52.3%) and 143 females (47.7%) their ages ranged from 20 to 69years old subjects enrolled, SPAP was estimated by transthoracic Doppler echocardiography in Military hospital, Omdurman, Sudan. ,were deeply investigated by Easote MY LAB 50 echocardiography ultrasound machine applying the ideal positions for adult echocardiogram using required and suitable equipment.*
Results*: Of 300 subjects, had echocardiography appropriate for estimation of pulmonary artery systolic pressure. In these 250, a wide range of PASP was observed mean ±and std(33.08±2.95), but none fell outside of the normal range.The most frequency age group(30-50 years old (369%) ,there is good correlation of age with Systolic pulmonary artery pressure (SPAP) p-value 0.00. Regarding the right ventricle (RV) dimension, 133 participants (44.3%) revealed that their (RV) dimension of 2.3 cm.*
Conclusion: *the study revealed that the standard value of the pulmonary artery pressure in Sudanese population is markedly greater than the universal slandered reported in the public literature, more studies with a large population is recommended*
Key Word*:PulmonaryArtery Pressure; Echocardiogram; Sudanese; the right ventricle; pulmonary artery systolic pressure.*

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I. Introduction

Pulmonary circulation moves blood between the heart and the lungs. It transports deoxygenated blood to the lungs to absorb oxygen and release carbon dioxide. The oxygenated blood then flows back to the heart. [(1)] Pulmonary hypertension (PH) is defined by a mean pulmonary arterial pressure (mPAP) ⩾25 mmHg at rest (in fact, the original cut-off was >25 mmHg. [(2)] The evaluation of pulmonary pressure in the detection of patients with pulmonary hypertension (PH) is essential. Besides the role of echocardiography in the diagnosis of pulmonary artery hypertension (PAH), as well as in therapeutic and prognostic evaluation in pulmonary thromboembolism patients, echocardiography is currently being widely used for monitoring therapeutic response in patients with primary PH, in the assessment of chronic obstructive pulmonary disease and in the follow up of lung transplant patients. [(3)] Current guidelines recommend that a detailed echocardiographic assessment is performed in all patients with suspected PH. Detailed echocardiographic assessment of patients with PH allows useful diagnostic valuable information to be collected. It can also be used to assess and diagnose the severity of right ventricular dysfunction, providing prognostic information and a non-invasive means of following up. [(4)]

A precise evaluation and assessment of pulmonary pressure are of fundamental importance in the diagnosis and management of patients with pulmonary hypertension (PH). Doppler echocardiography is a low-

cost, non-invasive technical method that is widely used for anatomical and functional assessment of the right cardiac chambers and estimation of pulmonary pressure, and the hemodynamic information obtained correlates well with that obtained through cardiac catheterization. Although the most appropriate and common technique for determining pulmonary pressure is a measurement of the gradient between the right ventricle and right atrium through tricuspid regurgitation, it can also be determined by analysis of pulmonary regurgitation or systolic pulmonary artery flow. When transthoracic echocardiography does not provide adequate viewing, transesophageal echocardiography is an excellent choice, allowing for high-quality imaging of cardiac structures and detection of some PAH-related disorders. In the literature, the role of echocardiography in the diagnosis of PAH, as well as in therapeutic tools and prognostic evaluation has been well established. [4]

II. Material And Methods

This prospective descriptive study was carried out from June 2015 to June 2021in an ultrasound department in Omdurman military hospital in Khartoum state-Sudan., there were a total of 300 subjects enrolled in this study. The subjects consisted of 157 males and 143 females. Their ages ranged from 20 to 69 years old. No subject had atrial fibrillation or congenital diseases of the pulmonaryartery such as pulmonary valve stenosis. All subjects had detectable tricuspid valve regurgitation (TR)by transthoracic Doppler echocardiography (Italy ultrasound machine Easote MY LAB 50. (SN 03486 manufacture 2005 modules; Doppler.CFM). An investigation was done on participants by using phased array linear high frequency and convex probe echocardiography with 5 MHZ frequency. Coupling agent ultrasound gel was used as a coupling medium between the probe and the patient's skin.), so the SPAPwas able to be estimated. Briefly speaking, the continuous-wave Doppler detected the flow of TR.

Procedure methodology:

The flow chart depicted in Fig. 1 is used to assess the probability of PH.If the tricuspid regurgitation velocity (TRV) is >3.4 m/s then the echocardiographic probability of PH is high. If the TRV is ≤3.4 m/s, then other echocardiographic parameters suggesting PH must be used to assign the probability of PH. These parameters are split into three categories (A: the ventricles; B: the pulmonary artery; C: the inferior vena cava (IVC) and right atrium (RT)). Parameters from at least two different categories are needed to determine the probability of PH.

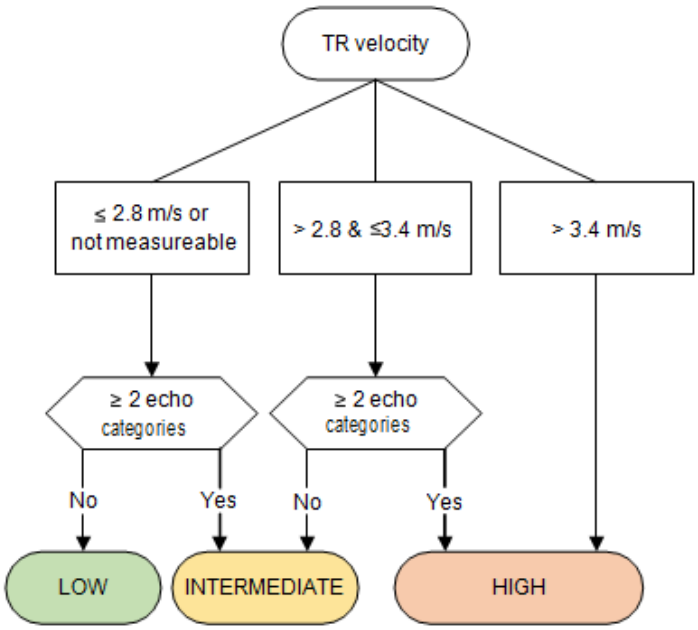

Figure 1: Flow chart to assess the probability of pulmonary hypertension usingparameters identified from within ≥2 categories (the ventricles,pulmonary artery, or the inferior vena cava and right atrium) inconjunctionwithtricuspidregurgitationvelocity.AdaptedfromESC/ERSGuidelines for the diagnosis and treatment of pulmonary hypertension2015.[5]

As part of a full echocardiographic assessment, Doppler examination should be performed in the following sequence: 1) color Doppler in all apical projections; 2) color Doppler in parasternal projections (long axis/short axis); 3) pulsed-wave Doppler for transmitral velocities; 4) pulsed-wave Doppler for left ventricles (LV) outflow tract; 5) pulsed-wave Doppler for the tricuspid inflow; 6) pulsed-wave Doppler for the RVOT; 7) continuous-wave Doppler across the LV outflow aortic valve; 8) continuous-wave (CW) Doppler across the tricuspid valve (for tricuspid regurgitation); 9) continuous-wave Doppler (WC)across the pulmonary valve (for pulmonary regurgitation); and 10) tissue Doppler imaging (TDI) of the RV free wall.

A pulmonary regurgitation (PR) signal is obtained in the parasternal short-axis view using color Doppler. CW Doppler at a sweep speed of 100 mm/s is used to measure the peak PR velocity. Peak pressure difference (measured by the Bernoulli equation) is then added to the RAP. This method has been validated against gold standard catheter measurements. Mean PAP can be approximated from the peak PR Doppler signal using the following formula: mPAP = 4(PRpeak velocity)^2 + RAP.[6,7]

Mean pulmonary pressure is calculated by the formula: **$mPAP = 90 - (0.62*AT_{RVOT})$**. For example, if the AT_{RVOT} is 80 ms, the mPAP = 90 −(0.62*80), that is 40.4 mmHg (normal < 25 mmHg). On the other hand, if the AT_{RVOT} is 137 ms, then the calculated mPAP is 90 − (0.62*137) = 5.06 mmHg. Images below represent normal sonographic appearance for pulmonary artery by Echocardiogram.

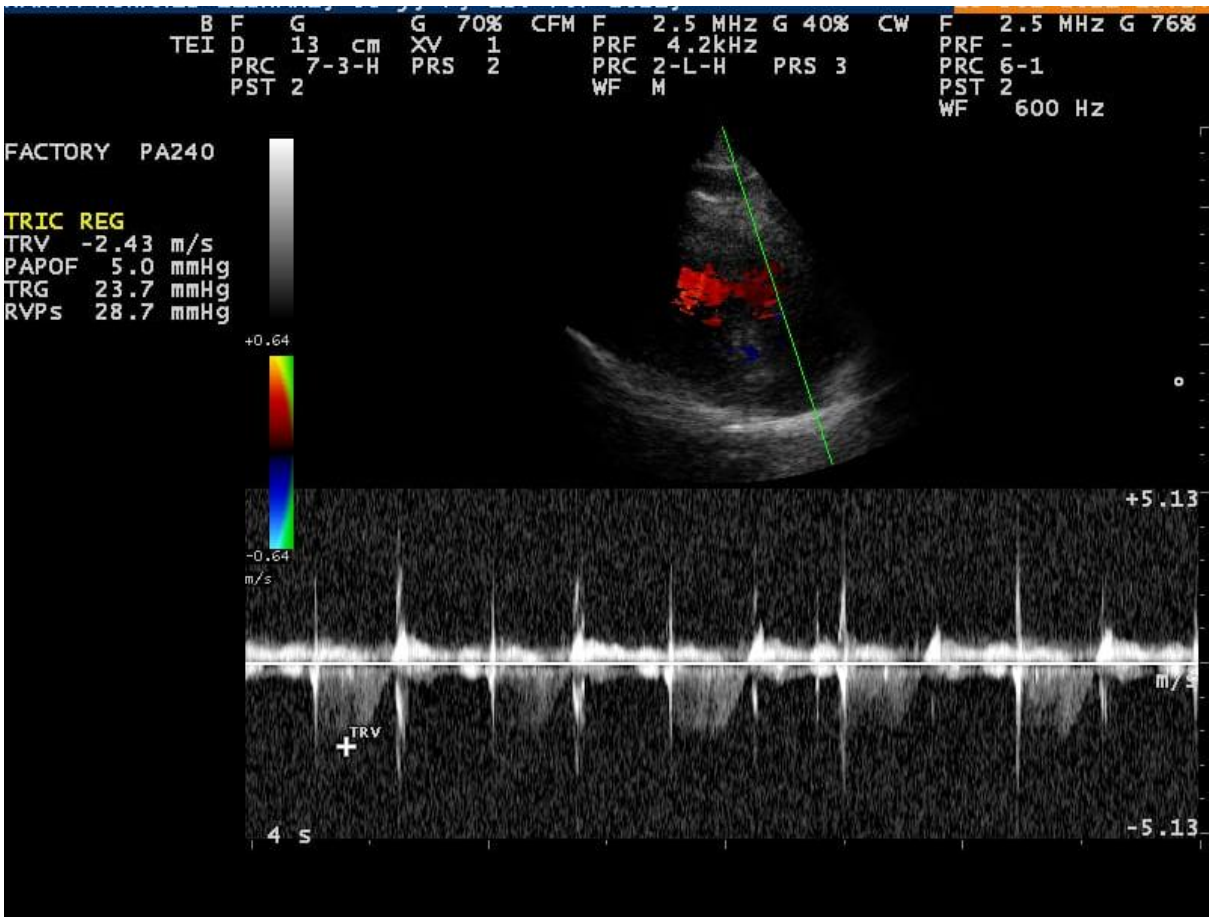

Image 1:51 yrs. M with mild Tricuspid regurgitant jet TV max (2. 43 m/s) PAP elevated by 5 mmHg with PASP 28.7 mmHg (Bernoulli equation) 4 (TV max)^2 + PAP.

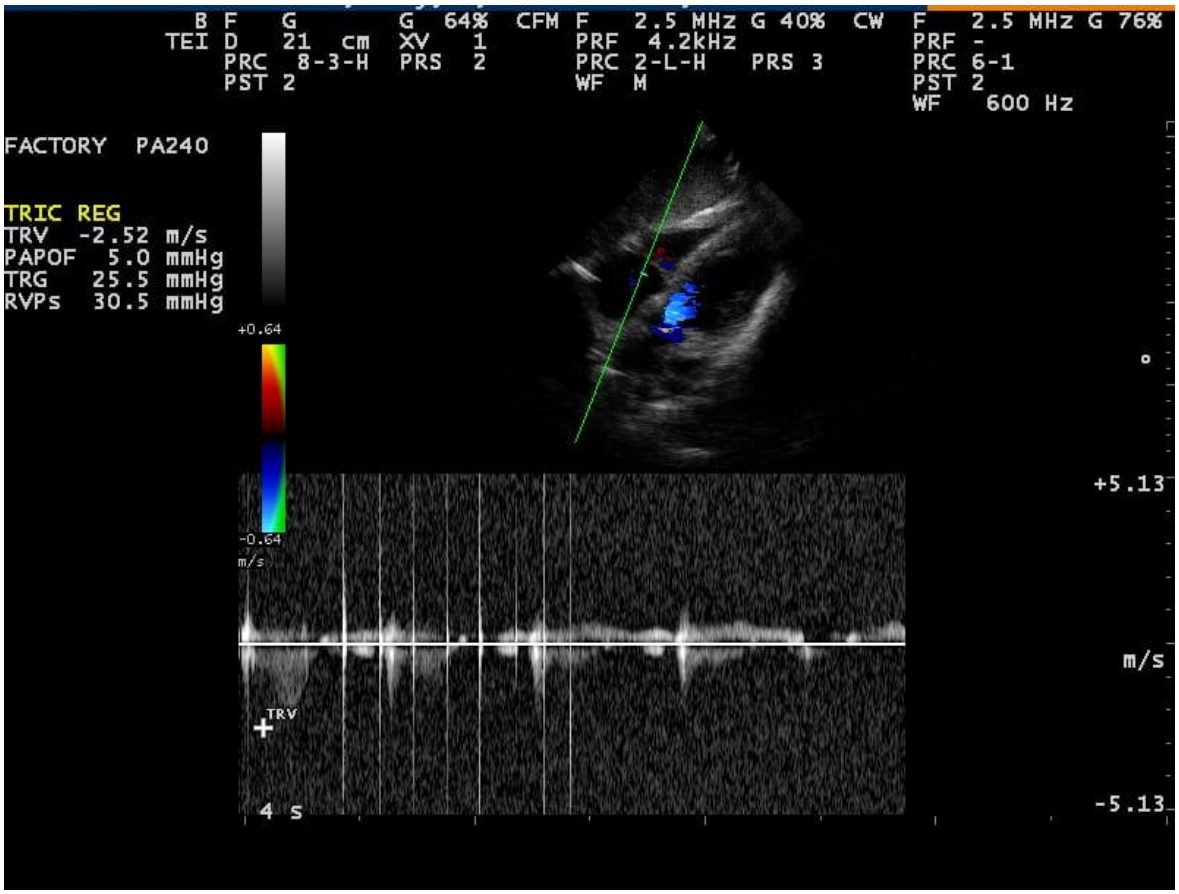

Image 2 : 70 yrs. M with mild tricuspid regurgitant jet TV max (2.52 m/s) PAP 5 mmHg the PASP 30.5 mmHg (Bernoulli equation) 4 $(TV\ max)^2$ + PAP,

Statistical analysis

By using the SPSS program version16 all data and variables are analyzed. Descriptive statistics, including frequency and percentages, were calculated. An ANOVA test was applied to test the significance. Data are presented as percentages and frequencies The complex tables were used in the analysis and was carried out the relationship between different variables and the important statistical indicators was drawn from the study. The covariates for the multivariable regression analysis were chosen as potential confounding factors based on their significance in univariate analysis. The *p*-value of less than 0.005 was considered to be statistically significant.

III. Result

All collected data analyzed and tabulated in tables and graphs as follows:

Table (1) show gender distribution among a sample of the study

Gender	Frequency	Percent
Male	157	52.3
Female	143	47.7
Total	300	100.0

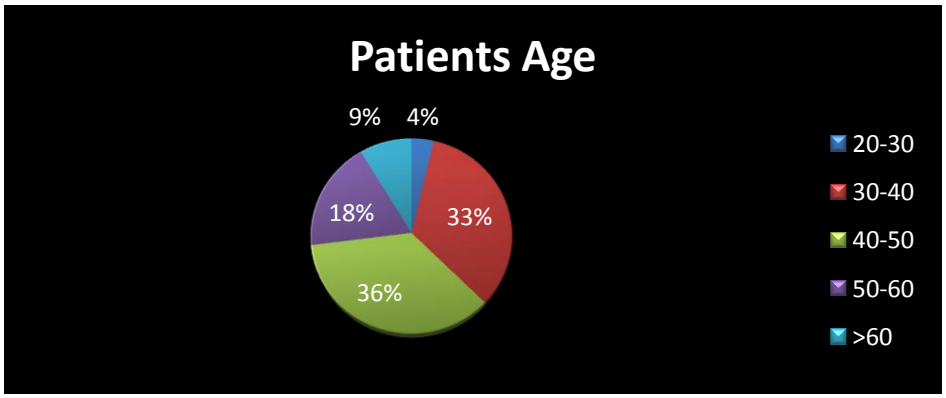

Figure 2: show patients age distribution

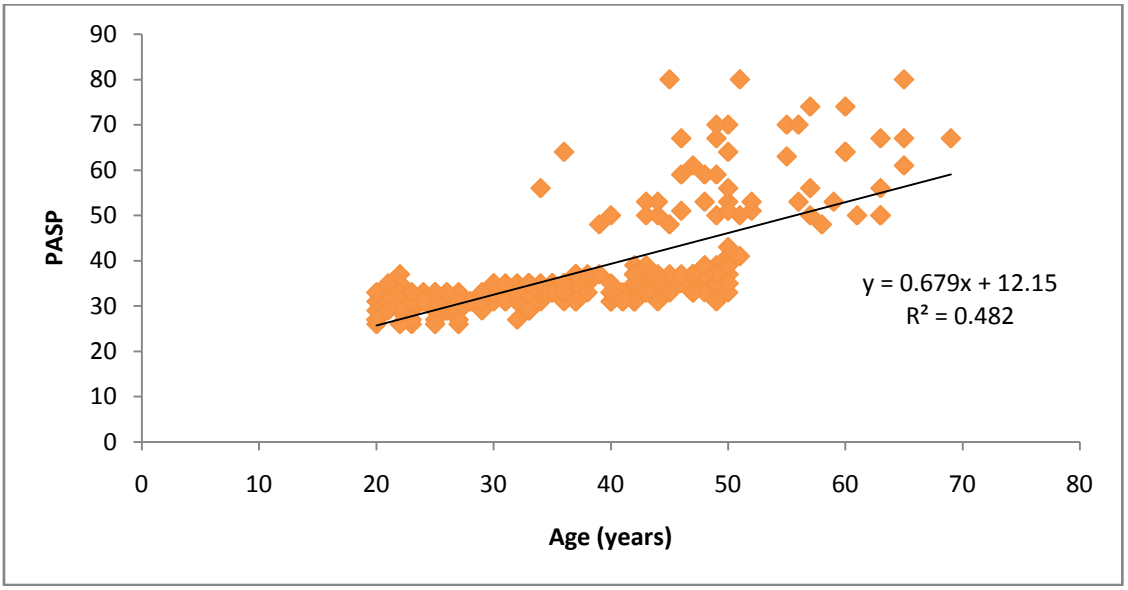

Figure (3): Linear regression analysis showed the correlation between Age (years) and PASP

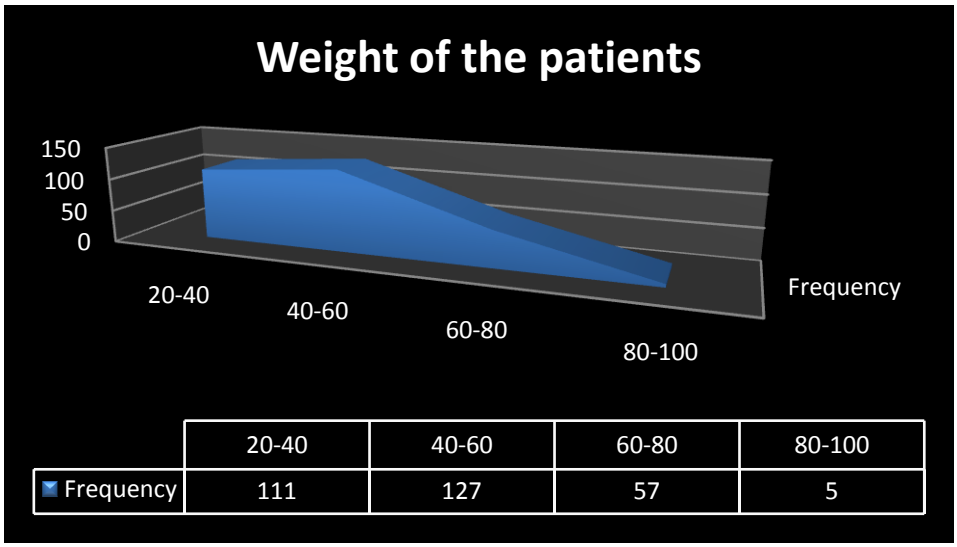

Figure 4: show weight of patient's distribution

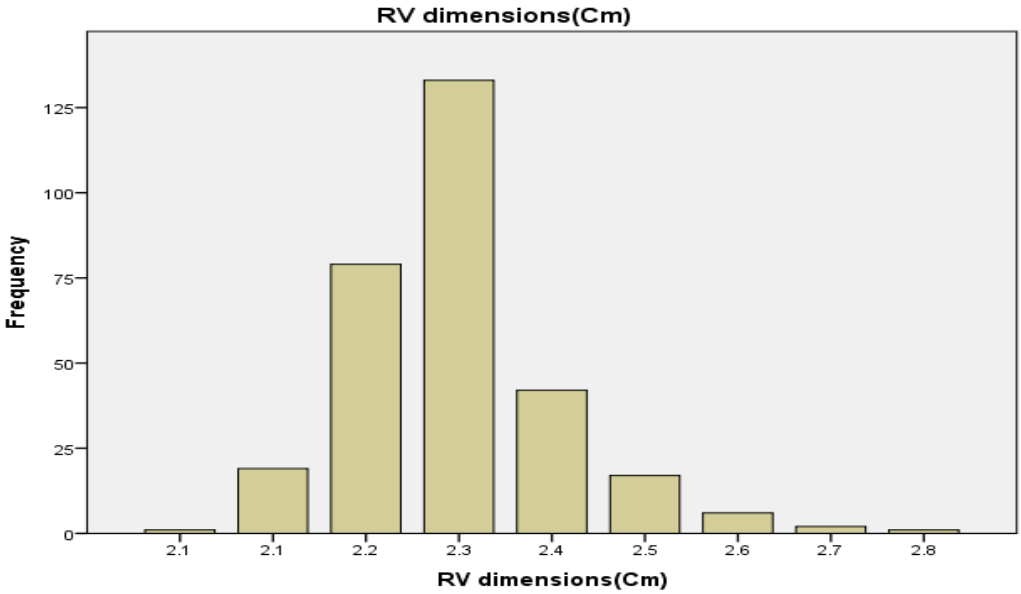

Figure 5: show the right ventricle dimensions (RV)

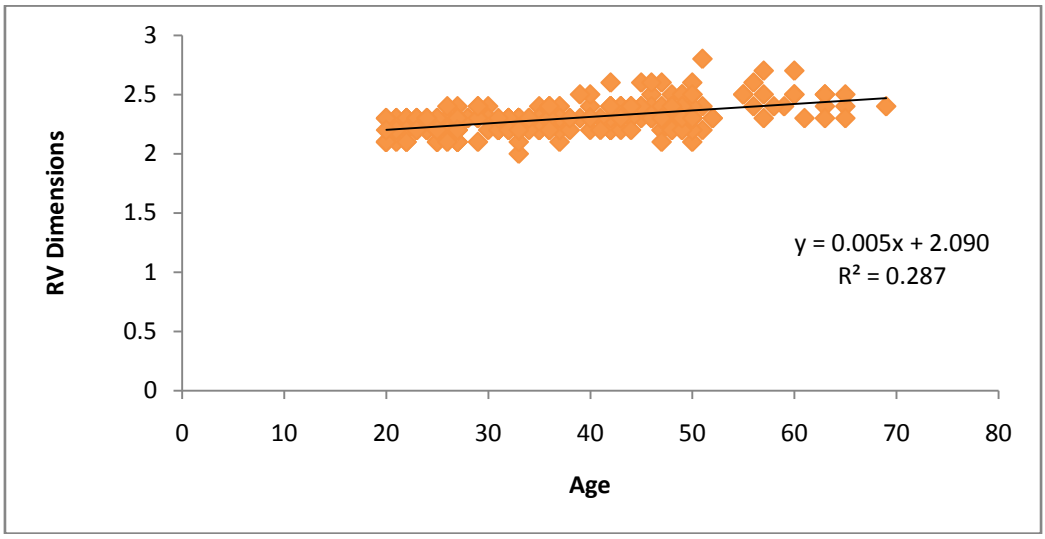

Figure 6: show relation between ages and RV dimension

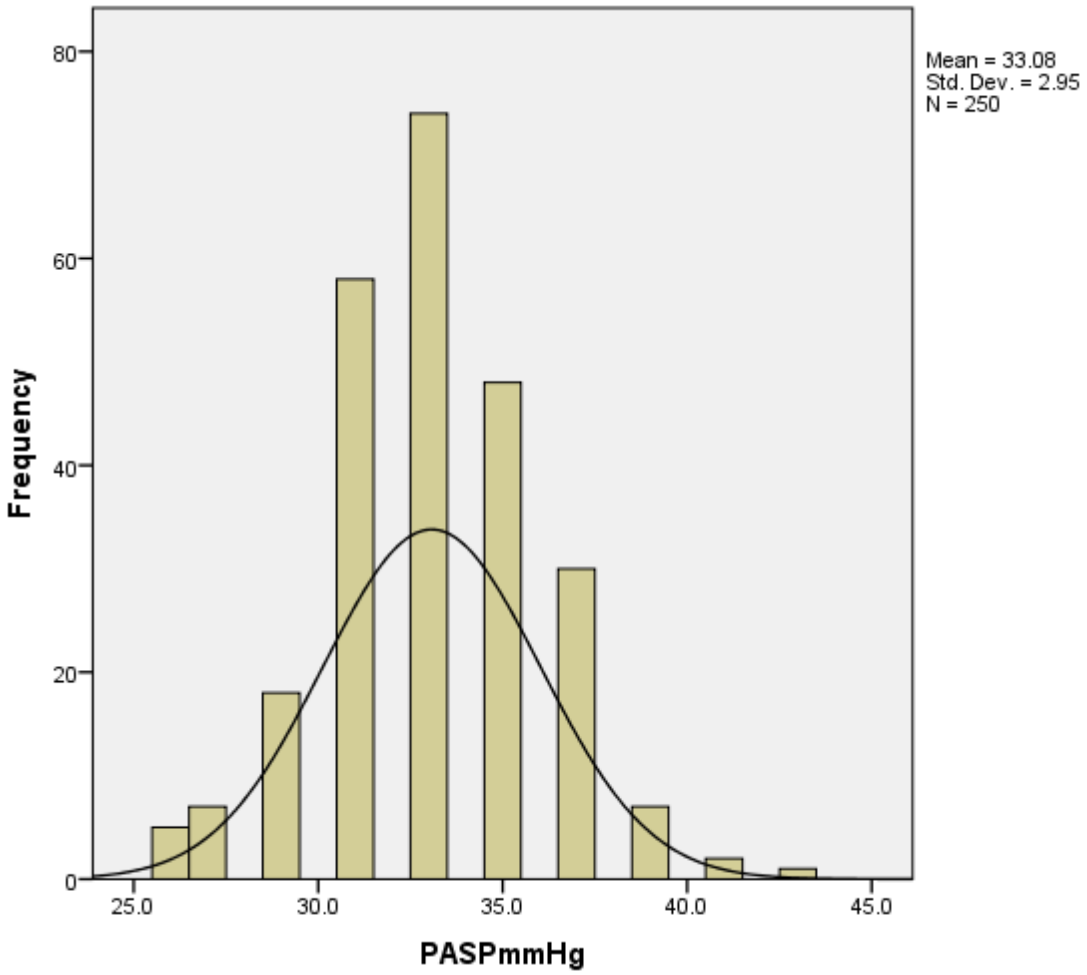

Figure 7: show the pulmonary artery systolic pressure (PASP)

Table no (2) show correlation between TVmax and RV dimension

RV dimension * TV max		TV max																							
		2.30m/s	2.35m/s	2.45m/s	2.55m/s	2.65m/s	2.75m/s	2.84m/s	2.95m/s	3.0m/s	3.9m/s	3.17m/s	3.21m/s	3.28m/s	3.30m/s	3.40m/s	3.50m/s	3.58m/s	3.65m/s	3.68m/s	3.78m/s	3.87m/s	3.88m/s	4.00m/s	4.19m/s
RV dimension	2.0cm	3	3	6	26	37	19	16	3	1	1	3	1	1	1	0	2	0	1	1	1	1	2	0	1
	2.1cm	0	1	8	22	32	10	14	1	0	0	3	0	3	1	1	0	1	0	1	2	0	0	1	0

	2.2cm	**1**	**3**	**2**	**7**	**4**	**10**	**0**	**2**	**1**	**1**	**2**	**0**	**0**	**1**	**2**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**1**
	2.3cm	**0**	**0**	**1**	**3**	**0**	**7**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
	2.4cm	**0**	**0**	**1**	**0**	**0**	**2**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
	2.5cm	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
	2.6cm	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
P value		**0.00**																							

IV. Discussion

A precise evaluation of pulmonary pressure is of fundamental importance in the diagnosis and management of patients with pulmonary hypertension (PH). Doppler echocardiography is a low-cost, non-invasive method that is widely used for anatomical and functional assessment of the right cardiac chambers and estimation of pulmonary pressure, and the hemodynamic data obtained correlates well with that obtained through cardiac catheterization. Although the most appropriate and common technique for determining pulmonary pressure is the measurement of the gradient between the right ventricle and right atrium through tricuspid regurgitation, it can also be determined by analysis of pulmonary regurgitation or systolic pulmonary flow. [(8)]

This is descriptive analyses of a prospectively collected data. A total of 300 consecutive hypertensive patients arriving at the echocardiography department of the Military hospital in Omdurman- Khartoum-Sudan The sample consisted of 157males and 143 femalesTable (1). Their ages ranged from 20 to 69 (mean: 37.2, SD: 11.0646) years.

Baseline clinical and demographic characteristics were obtained from the subjects. These included: Date of birth, age, gender and indication for echocardiography, weight, height.

Two- dimensional guided M- mode echocardiography with the use of commercially available echo- machine Easote my lab 50 ultrasound machine ,Italy, Manufacture 2005 Modules; Doppler. CFM.Phasedarray.linear and HF. Convex Convex probe echocardiography ,Frequency 5 MHZ was performed on each subject in the partial decubitus position. Echocardiographic examination was performed in the parasternal long axis, short axis, two chambers, apical four chambers, five chambers and occasionally in the subcostal and suprasternal views.

The most frequency of ages distribute as (40-50 years old (36%), 30-40 years (33%), 50-60 years (18%), more than 60 years (9%)and few percentages in aged group 20-30 years Fig (2)), there is good correlation of age with Systolic pulmonary artery pressure (SPAP) p-value 0.00(Fig (3), this agree with finding of Lam et al ,2009.The age-related increase in SPAP is more common in patients with diabetes and is likely due to pulmonary arterynoncompliance or abnormal leftventricular (LV) diastolic fillingpressures occurring with agingand systemic hypertension.[(9)]Recently, Argiento et al.studied,50 in a series of 113 healthy volunteers

(mean age, 37 613 years; range, 19–63 years; 57 women [50%]) reported exercise flow-corrected upper limits of normal for MPAP of 34 mm Hg at a cardiac output (CO) of <10 L/min, 45 mm Hg at a CO of <20 L/min, and 52 mm Hg at a CO of <30 L/min.[10]

Participant's weight were as (40-60 Kg, in127 participants, 20-40Kg in 111 participants, 60-80 Kgs in 57 participants, and the less one their weight range between 80-100 Kg. Fig (4).

In current study, Right ventricles (RV) dimensions as(2.3 cm in 133 (44.3%), 2.2cm RV in 79 (26.3%), and 2.1 cm in 19(6.3%) and 2.8 Cm in one participant 0.3%, Fig (5), there is good relationship between RV and age fig (6).

In figure (7) the result of this study showed that, PASP mean and std. deviation and frequency of all subjects, Mild TR, (33.08±2.95. These results are significant and deal with Sheikhzadeh et al[11]

In table 2 below we show the correlation between RV dimension and TV max, 2cm, 2.1 cm, and 2.2cm RV dimension to 2.55 cm, 2.65 and 2.75 TV max represent the most frequents normal participants, therefore are 26, 37, 19 in 2 cm RV respectively, while 22,32, and 10 of participants in 2.1 cm measurements respectively and few of participants measure 2.2cm RV are 7,4, 10 related to TV max So there was a significant correlation between TV max and RV dimension at a significant correlation with P-value 0.000.

V. Conclusion

Echocardiography is a non-invasive procedure that plays an important to accurately quantify PAPs, showing their impact on the right heart chambers and systemic veins. It is also useful as an analytical tool in the evaluation of therapeutic responses and prognoses.

The study revealed that the standard value of the pulmonary artery pressure among Sudanese population is markedly greater than the universal slandered reported in the public literature, more studies with a large population are recommended.

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