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NORMAL VALUES FOR DIMENSIONS OF THE HEART BY ECHOCARDIOGRAPHY IN NORMAL EGYPTIAN ADULTS

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All the authors contributed significantly to the research that resulted in the submitted manuscript.

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ABSTRACT

Objective: To define the normal values of cardiac dimensions and its relation to BMI, BSA among healthy Egyptian adults living in Sohag Governorate.

Methodology: The study included 663 normal adults, ranging from 18 years to 35 years old who underwent full echocardiographic study (M- mode, two-Dimensional echocardiography, Doppler echocardiography to exclude any cardiac abnormalities).

Results: The IVS was 0.82 and 0.90, PWT was 0.80 and 0.90 ,LVIDD was 4.58 and 4.90, LVIDS was 2.90 and 3.12, LAD was 2.56 and 2.72, AO root was 2.38 and 2.52, RV was 2.46 and 2.56 in patients with BMI less and more than 25 respectively. The EF was 69.80 and 68.52 in BMI less than and more than 25 respectively ($p=0.13$). There was significant difference between BSA$<$1.8 and BSA$>$ 1.8 as regards IVS, PWT, LVIDD, LVIDS, LAD, AO root, RV and EF. The IVS was 0.80 and 0.94, PWT was 0.80 and 0.91, LVIDD was 4.58 and 4.93, LVIDS was 2.88 and 3.17, LAD was 2.57 and 2.72, AO root was 2.39 and 2.50, RV was 2.46 and 2.58 in patients with BSA less than 1.8 and more than 1.8 respectively.

Conclusion: We reported statistically significant difference in adult Egyptian population for echocardiographic cardiac dimensions with respect to body mass index and body surface area. It also varies from standards of normalcy of populations of other countries. More studies are needed in various governments of Egypt to get normal Egyptian cardiac dimensions in adults.

Keywords: Normal dimensions, echocardiographic, Egyptian adults, Sohag.

INTRODUCTION

Echocardiography was one of first imaging modalities used clinically for determination of cardiac dimensions, despite dramatic advances in new cardiac imaging technologies; echocardiography remains the most important diagnostic imaging tool in diagnosis of cardiac dimensions. Echocardiography is a safe, powerful, non-invasive and painless technique. The reference values of echocardiographic measurements for adults which are currently used in Egypt are based on standards of values of other countries. Estimations can be made with different modalities. M-mode echocardiography is widely used in clinical and scientific practice, despite its lacking accuracy and reproducibility.[1-3]

Age, height, weight, and sex emerged as the principal determinants of aortic root dimensions and other echocardiographic cardiac dimensions. The additional influences of blood pressure measurements were small; direct associations of aortic root dimensions with mean arterial and diastolic blood pressures and inverse associations with pulse and systolic blood pressures were observed. Additional prospective studies are needed to confirm these observations and to assess the impact of aortic root dimensions on the incidence of hypertension.4 Echocardiographic cardiac dimensions also varies between various populations of the world. The aim of the study was to define the normal values of cardiac dimensions and its relation to body mass index (BMI), body surface area (BSA) among healthy Egyptian adults living in Sohag Governorate.

METHODOLOGY

The study included 663 adults ranging in age from 18 to 35years. The people with Long-term physical training program, any systemic disease (endocrine, collagen, metabolic, nutritional or infectious) and any congenital or acquired cardiac abnormalities. All patients in the study underwent full history and General examination Blood pressure was measured after subjects have rested, in a supine position in a quiet room using a mercury sphygmomanometer with the appropriate compression cuff. The fourth Korotkoff phase was used as the diastolic blood pressure. Height and weight of all participants were obtained. BSA is calculated by the Haycock formula.5

BSA =0.024265 Xheight0.3964X Weight0.5378

Body mass index = Weight/(height)6

12 leads ECG was performed for all subjects at rest to exclude the presence of any ECG abnoramilies. Echocardiographic studies were performed using (Vivid 3,GE)ultrasound machines. Transducer frequancy ranged from 2.5MHz to 3.5MHz, according to patient's size. All studies were performed with the patient breathing spontaneously in a quiet state. At the time of transthoracic echocardiographic examination, the patient was positioned comfortably for each view in either a left lateral decubitus or supine position. Parasterenal Long- axis views performed With the patient in a left lateral decubitus position and the transducer in the left third or fourth intercostal space adjacent to the sternum, a long axis view of the heart was obtained which included both aortic and mitral valves, the aortic root, sinuses of valsalva, sinotubular junction, and proximal 3 to 4cm of the ascending aorta .The left ventricular septum and posterior wall were seen at the base and midventricular level in the long axis view, allowing assessment of wall thickness, chamber dimensions, endocardial motion, and wall thickening of these myocardial segments. The right ventricle do not have an easily defined long or short axis. As the right ventricle is (wrapped around) the left ventricle, with an inflow region, an apical region, and an outflow region forming a somewhat anteroposteriorly flattened U-shaped structure. Short axis views were obtained from the parasternal window by rotating the transducer clockwise 90 degree and then angulating the transducer superiorly or inferiorly to obtain specific image planes. The short axis view at the papillary muscle level allowed measurements of wall thickness and internal dimensions of the left ventricle in systole (LVIDS) and in diastole (LVIDD) from either the 2 D image or 2D guided M mode recording. Rotating the transducer between the long and short axis views at this level ensures true short- axis measurements (perpendicular to the long axis). Short axis view at level of aortic valve allowed measurements of aortic root diameter (AO) and left atrial diameter (LA) . The apical window was identified initially by palpation of the left ventriclular apex with patient in a steep left lateral decubitus position. Five chamber vew was obtained byAngulation of the transducer anteriorly, the aortic valve and root were seen in an oblique long view. From the four-chamber view,the transducer was rotated counterclockwise about 60 degree to obtain the two chamber view of the left ventricle, mitral valve and left atrium. The apical two chamber view was used for evaluation of the anterior left ventricular wall (seen to the right of the screen) and the posterior wall (seen on the left). A linear dimension of left atrium approximating the anteroposterior plane was measured at endsystole, just before mitral valve opening (when the left atrial volume was maximal). Theplane should pass through the aortic valve.M-mode recording through the aortic root at the leaflet tip level showed the parallel walls of the aorta moving anteriorly in systole and posteriorly in diastole. The left atrium is posterior to the aortic root. M-mode recording perpendicular to the long axis of and through the centre of the left ventricle at the papillary muscle level provided standard measurements of systolic and diastolic wall thickness and chamber dimensions. The LV end diastolic and end systolic dimensions, IVS wall thickness (IVS) and LV posterior wall thickness (PWT) measurements were taken from the 2-dimensions targeted M-mode

echocardiography tracings in the parasternal short axis views, according to the criteria of the American Society of Echocardiography. 7 Measurements were made from the leading edge of the septal endocardium to the leading edge of posterior wall endocardium. Right Ventricle (RV) Measurements were made in diastole in short axis parasternal view (using the ASE recommendations) from the leading edge of anterior wall endocardium to the leading edge of the septal endocardium. 8 Visualization of the right ventriclar anterior wall was optimized by placing the transducer in a high left parasternal position as close as possible to the sternal border. Data were collected, revised, verified then edited. Data were then analyzed statistically using SPSSstatistical package version 15. Mean ±SD were used for numerical variables while frequencies were calculated for categorical variable Student T test was used for independent samples. ANOVA (F) 95% confidence interval for mean (CI).

RESULTS

The study group consisted of 663 adults, 301 females and 362 males. Their age ranged from 18 to 35 years, they were all normal adults. Echo dimensions were measured and related to BMI, BSA in both males and females as shown in the tables 1,2,3,4 to obtain normal references. There was significant difference between males and females with BMI<25 and BMI>25 as regards various Echocardiographic parameters. The IVS was 0.82 and 0.90, PWT was 0.80 and 0.90 ,LVIDD was 4.58 and 4.90, LVIDS was 2.90 and 3.12, LAD was 2.56 and 2.72, AO root was 2.38 and 2.52, RV was 2.46 and 2.56 in patients with BMI less than 25 and more than 25 respectively. All these parameters were statistically significant between low and high BMI respectively. The EF was 69.80 and 68.52 in BMI less than and more than 25 respectively (p=0.13). There was significant difference between BSA<1.8 and BSA> 1.8 as regards IVS, PWT, LVIDD, LVIDS, LAD, AO root, RV and EF. The IVS was 0.80 and 0.94, PWT was 0.80 and 0.91, LVIDD was 4.58 and 4.93, LVIDS was 2.88 and 3.17, LAD was 2.57 and 2.72, AO root was 2.39 and 2.50, RV was 2.46 and 2.58 in patients with BSA less than 1.8 and more than 1.8 respectively. All these parameters were statistically significant between low and high BSA respectively. The EF was 70.10 and 67.68 in BSA less than and more than 1.8 respectively (p=0.005). We performed correlation between BMI, BSA and cardiac dimensions as shown in the figures[1-14.]

DISCUSSION

Normal dimensions and functions of the heart must be correlated to the body surface area, weight, height and age.[9]

Table 1: Relation between BMI and different echo dimensions in females

Finding	BMI		p value
	<25	≥25	
IVS	0.82(0.11)	0.90(0.15)	<0.0001
PWT	0.80(0.10)	0.90(0.15)	<0.0001
LVIDD	4.58(0.36)	4.90(0.40)	<0.0001
LVIDS	2.90(0.34)	3.12(0.38)	<0.0001
LAD	2.56(0.28)	2.72(0.34)	<0.0001
AOROOT	2.38(0.30)	2.52(0.26)	0.0001
RV	2.46(0.29)	2.56(0.29)	0.00035
EF	69.80(6.62)	68.52(7.42)	0.13

Table 2: Relation between BMI and different echo dimensions in males

Finding	BMI		p value
	<25	≥25	
IVS	0.86(0.11)	0.94(0.12)	<0.0001
PWT	0.83(0.10)	0.95(0.12)	<0.0001
LVIDD	3.06(0.37)	3.22(0.39)	0.0009
LVIDS	2.66(0.31)	2.76(0.35)	0.0001
LAD	2.66(0.31)	2.76(0.35)	0.0053
AOROOT	2.48(0.26)	2.53(0.31)	0.12
RV	2.51(0.27)	2.59(0.28)	0.00034
EF	68.39(6.68)	67.91(6.94)	0.51

Normal values for dimensions and functions of the heart are very important to avoid misclassification of normal persons into the high- risk category and the reverse.[10] Also, appropriate reference ranges are essential for identifying abnormalities of the heart quantitatively. The difference in values of cardiac dimensions betweenstudies may be due to racial, environmental, social and economic factors.

The reference values of echocardiographic measurements for adults which are currently used in Egypt are based on standards of values of other countries. Using values of echocardiographic measurements from other countries as a reference in the adults may lead to interpretation errors when assessing Egyptian adults, since environmental, social, economic and racial factors can influence the anthropometric standards of a population. The objective of this study was to establish values for echocardiographic measurements in a sample of normal and healthy adults in Sohag.

It is known that the results may be influenced by the number of individuals and by the characteristics of the population studied. Therefore, it is necessary to establish values of reference based on a large number of adults including all age groups, and to take racial factors into account, as these factors can influence the values of cardiac measurements.

Type of machine used is another important difference between studies in echocardiography. The higher temporal and spatial resolution of echocardiographic scanners provide more accurate measurements of cardiac structures, in addition cardiac anatomy is displayed more clearly, and in particular heart structure can be identified more easily. For instance the trabeculae of the right ventricle wall are generally well visible and can be avoided while measuring interventricular thickness.

Most studies reported that there is a significant correlation between the left ventricular dimensions, functions and body size, heart rate and race.[11] Felner et al in 1980 did not find changes in LVID with spontaneous (not paced) variations in heart rate.[12] Overestimation occurs if the LV is angulated or the short axis view is not perpendicular to the long axis of the LV. However, underestimation is possible if the M-mode cursor is not in the largest (central) anteroposterior dimension. In the study performed by Roge in 197813, it was probably more useful to relate normal echocardiographic dimensions to body weight since a large change in body weightresults in only minimal changes in body surface area and echocardiographic dimensions from [93] normal persons without heart disease. Pearimanet al., 1988 studied the relationship between left ventricular internaldimensions and body surface area in 268 black and white subjects (aged 6 days to 76 years).[14] The mean value of the length of major axis of the left ventricle (at the end diastole) -in subjects had BSA 0.3m2- was 3.5mm and it was 2.8mm (at end systole). In 1990 Gutgesellet al. stated that in children it was more practical to relate the echocardiographic measurements to body surface area

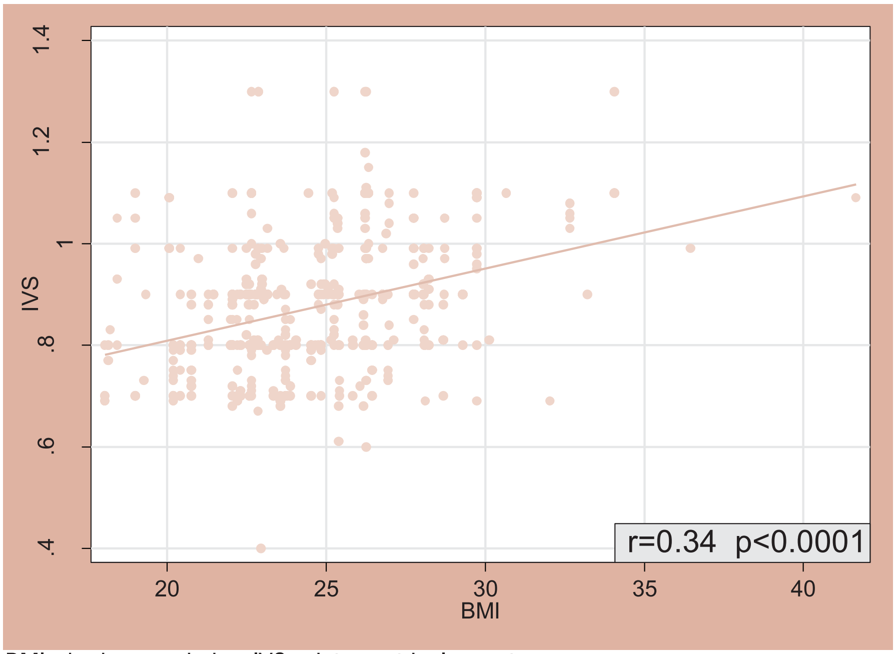
Table 3: Relation between BSA and different echo dimensions in females

Finding	BSA		p value
	<18	≥18	
IVS	0.80(0.11)	0.94(0.13)	<0.0001
PWT	0.80(0.10)	0.91(0.14)	<0.0001
LVIDD	4.58(0.35)	4.93(0.42)	<0.0001
LVIDS	2.88(0.32)	3.17(0.39)	<0.0001
LAD	2.57(0.28)	2.72(0.36)	0.0002
AOROOT	2.39(0.28)	2.50(0.29)	0.005
RV	2.46(0.30)	2.58(0.28)	0.002
EF	70.10(6.65)	67.68(7.20)	0.005

Table 4: Relation between BSA and different echo dimensions in males

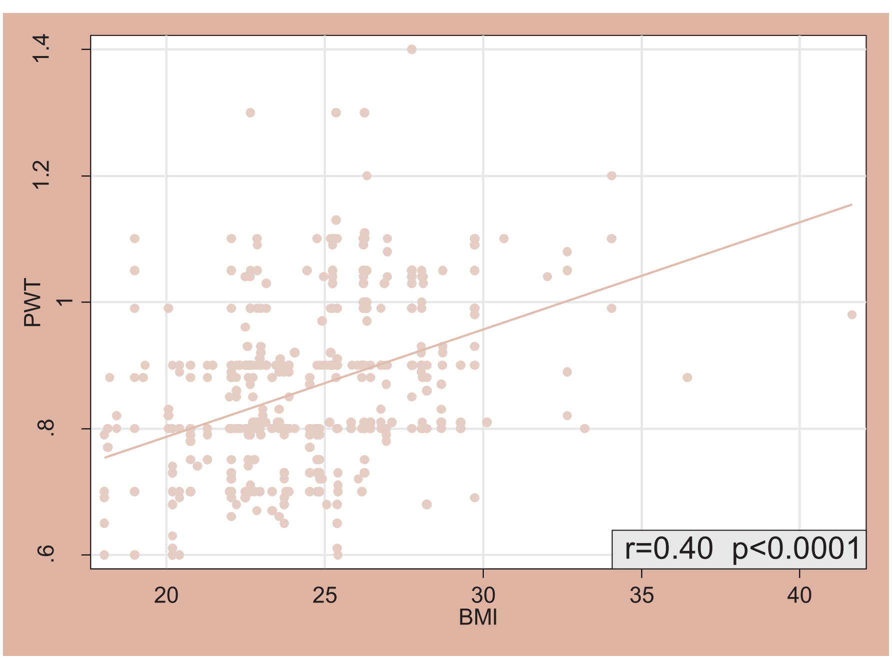
Finding	BSA		p value
	<18	≥18	
IVS	0.86(0.10)	0.92(0.13)	<0.0001
PWT	0.84(0.10)	0.93(0.13)	<0.0001
LVIDD	4.75(0.45)	5.03(0.40)	<0.0001
LVIDS	3.00(0.36)	3.25(0.37	<0.0001
LAD	2.63(0.31)	2.77(0.33)	0.0001
AOROOT	2.46(0.29)	2.54(0.28)	0.01
RV	2.48(0.26)	2.61(0.27)	<0.0001
EF	69.10(6.56)	67.35(7.02)	0.02

Figure 1: Correlation between BMI and IVS showed a significant value and a moderate positive linear relationship



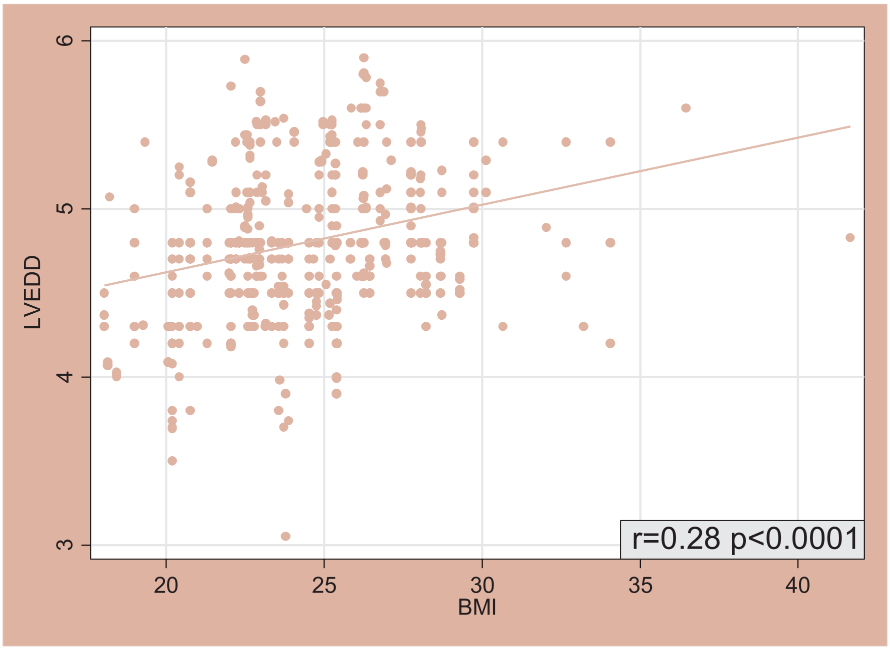
BMI=body mass index, IVS= interventricular septum

Figure 2: Correlation between BMI and PWT showed a significant value and a moderate positive linear relationship



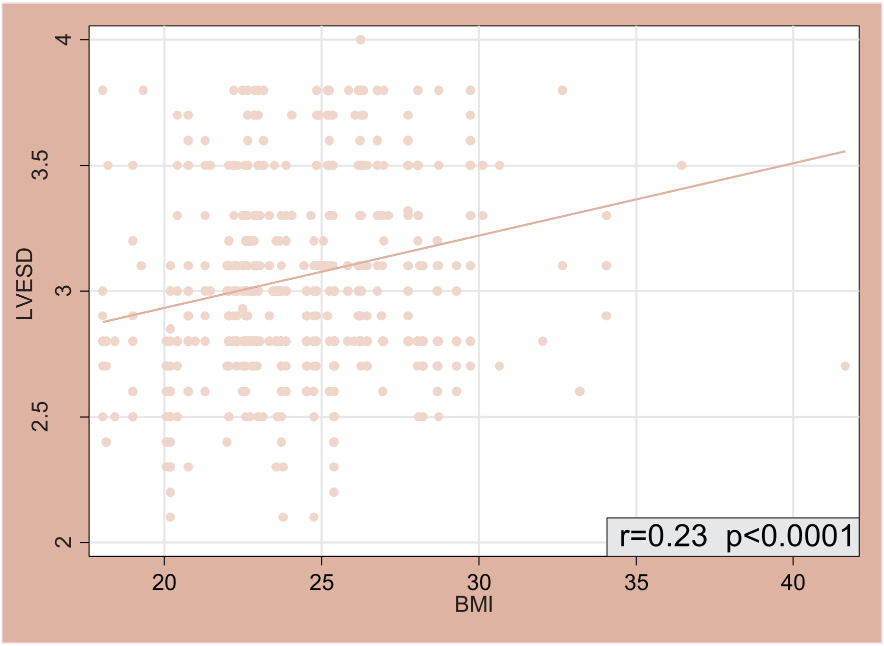
BMI=body mass index, PWT= posterior wall thickness

Figure 3: Correlation between BMI and LVIDD showed a significant value and a weak positive linear relationship



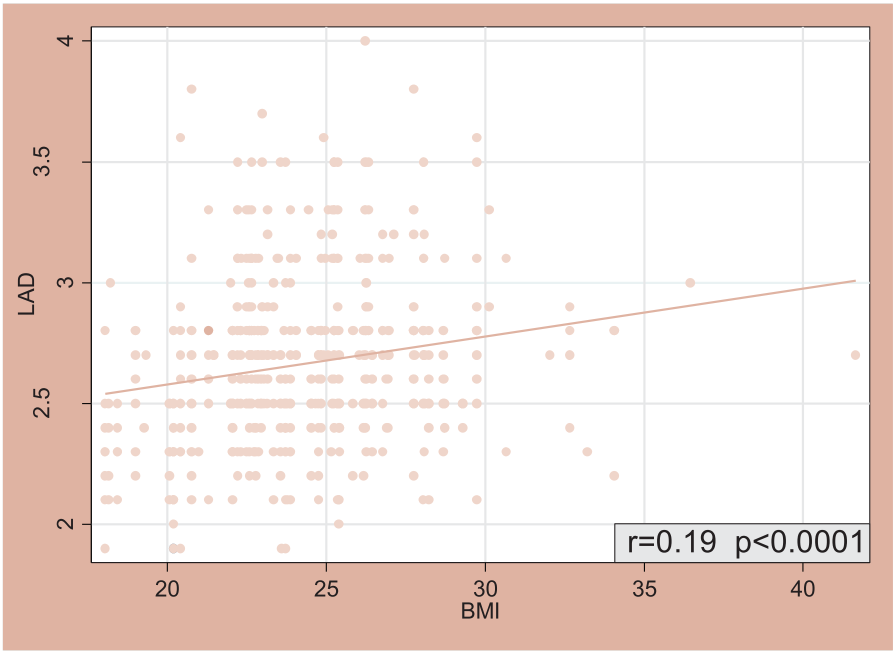
BMI=body mass index, LVIDD= left ventricular internal diameter diastole

Figure 4: Correlation between BMI and LVIDS showed a significant value and a weak positive linear relationship



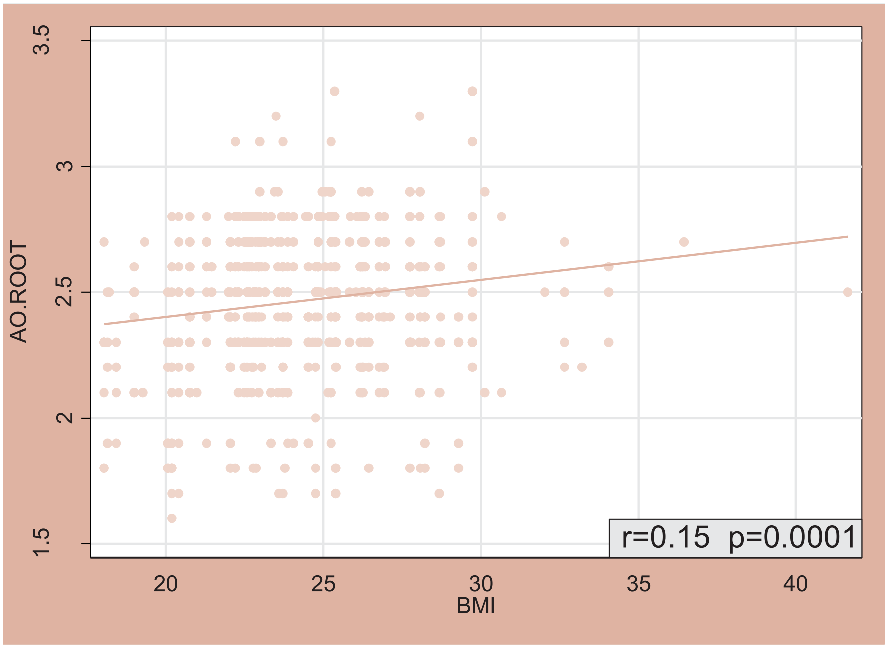
BMI=body mass index, LVIDS= left ventricular internal diameter systole

Figure 5: Correlation between BMI and LAD showed a significant value and a weak positive linear relationship



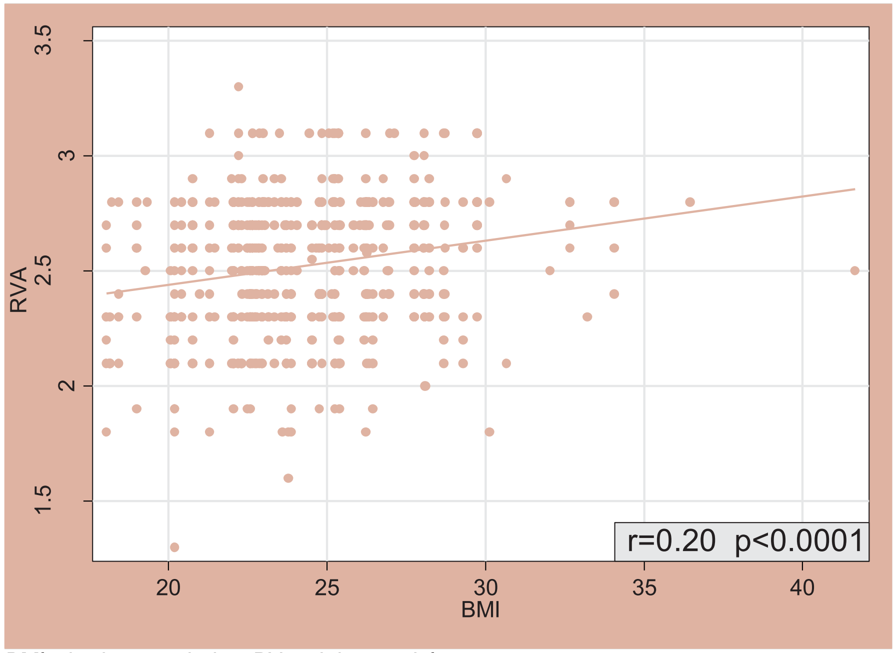
BMI=body mass index, LAD= left atrial diameter

Figure 6: Correlation between BMI and Aoroot showed a significant value and a weak positive linear relationship



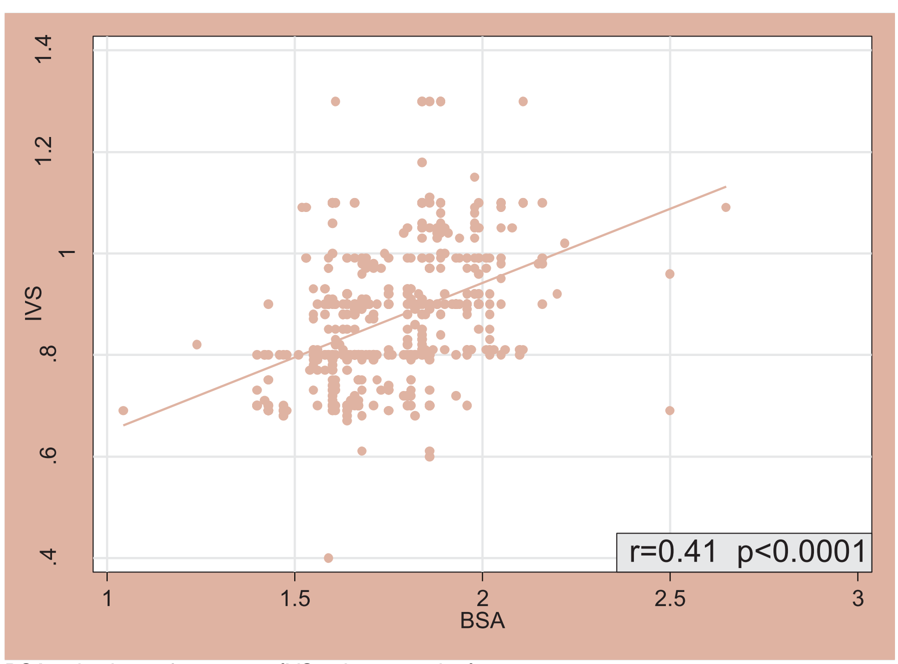
BMI=body mass index, Ao root= aortic root

Figure 7: Correlation between BMI and RV showed a significant value and a weak positive linear relationship



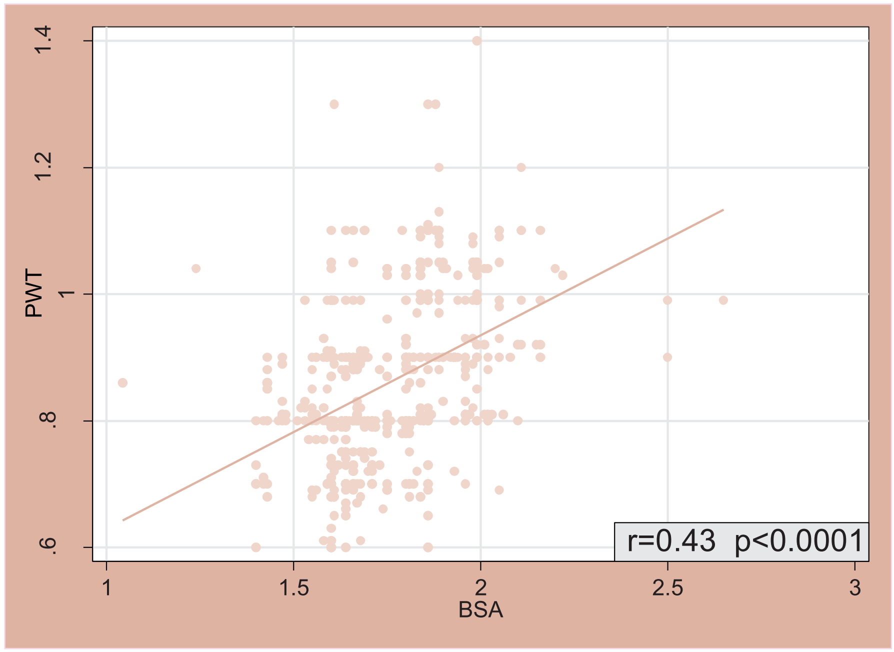
BMI=body mass index, RV= right ventricle

Figure 8: Correlation between BSA and IVS showed a significant value and a moderate positive linear relationship



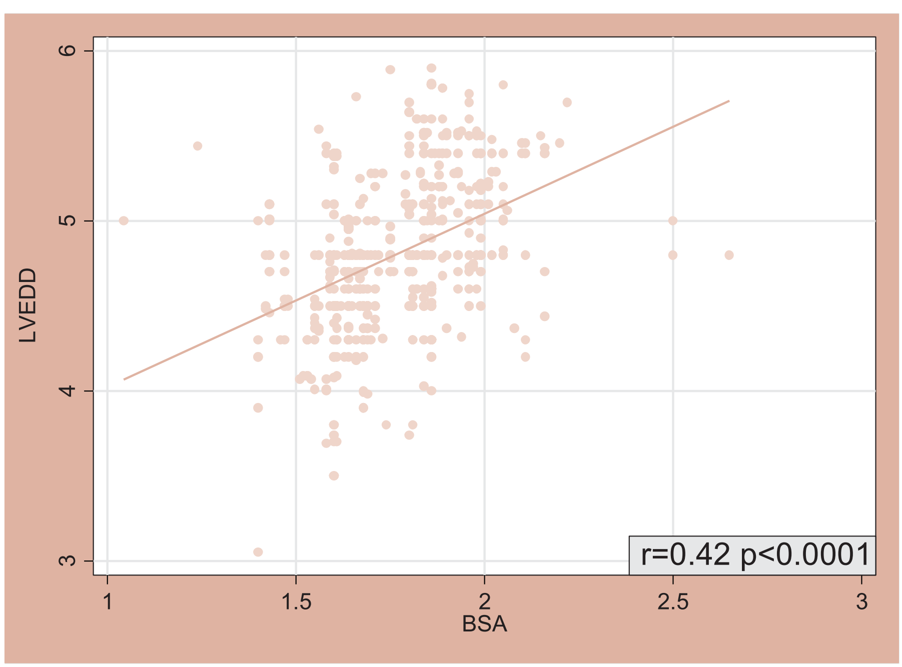
BSA= body surface area, IVS= interventricular septum

Figure 9: Correlation between BSA and PWT showed a significant value and a moderate positive linear relationship



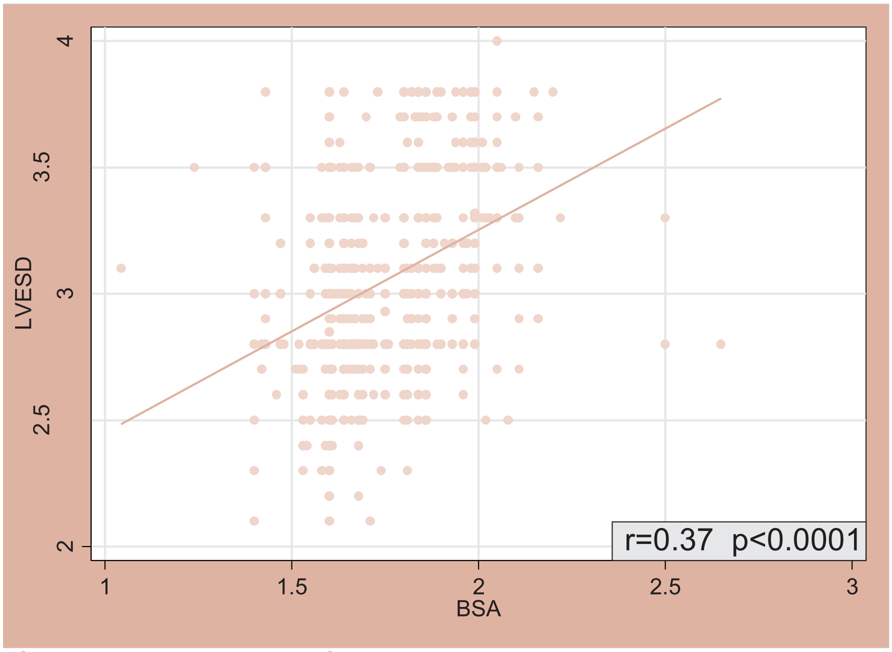
BSA= body surface area, PWT= posterior wall thickness

Figure 10: Correlation between BSA and LVIDD showed a significant value and a moderate positive linear relationship



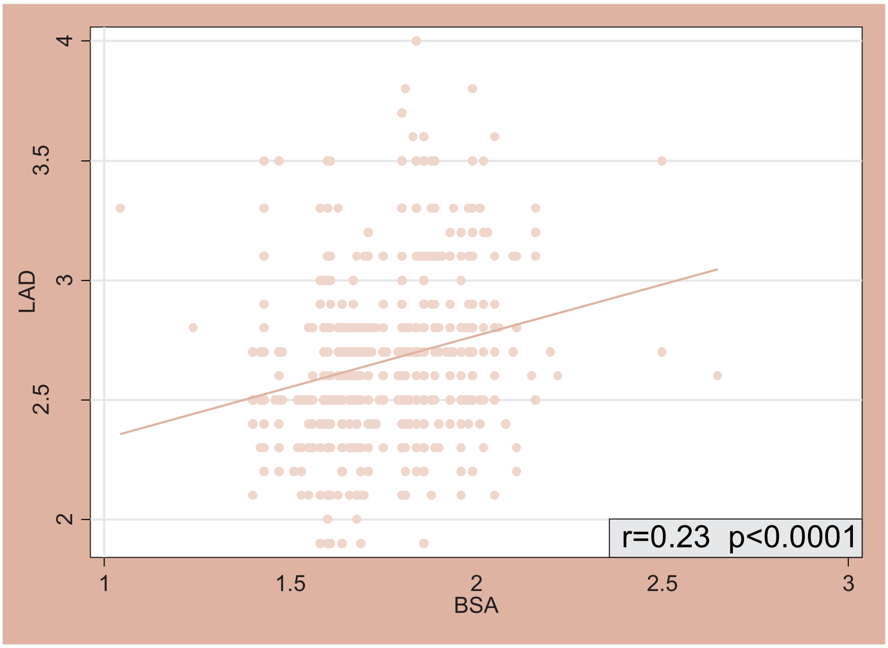
BSA= body surface area, LVIDD= left ventricular internal diameter diastole

Figure 11: Correlation between BSA and LVIDS showed a significant value and a moderate positive linear relationship



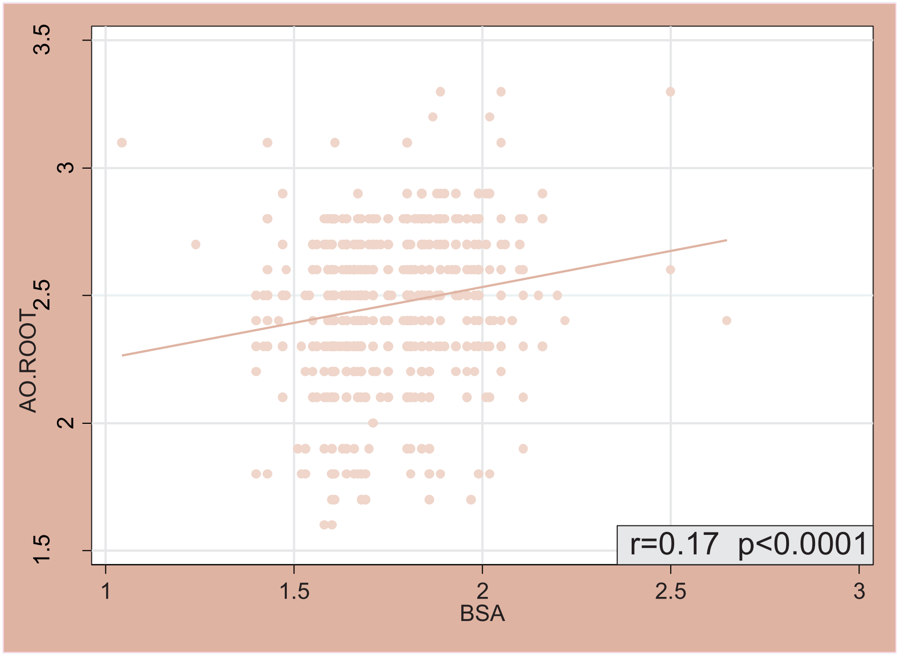
BSA= body surface area, LVIDS= left ventricular internal diameter systole

Figure 12: Correlation between BSA and LAD showed a significant value and a weak positive linear relationship



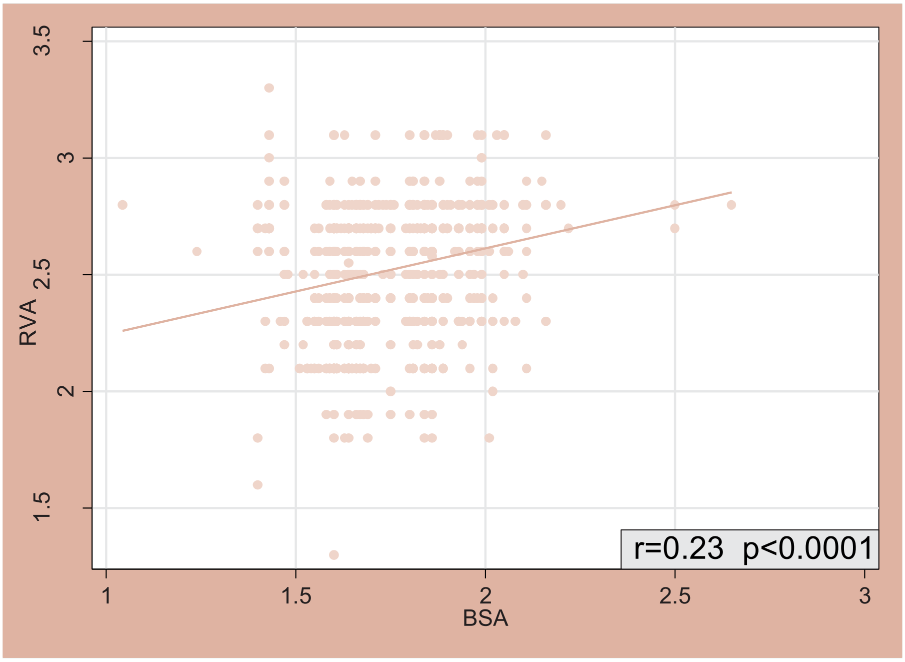
BSA= body surface area, LAD= left atrial diameter

Figure 13: Correlation between BSA and AO root showed a significant value and a weak positive linear relationship



BSA= body surface area, Ao root= aortic root

Figure 14: Correlation between BSA and RV showed a significant value and a weak positive linear relationship



BSA= body surface area, RV= right ventricle because haemodynamic data are usually expressed in relation to surface area.[15] The results of this study classified according to BMI and BSA as shown in results. The correlation between BMI and IVS, AO root,PWT, LAD,LVIDD, LVIDS and RV had a significant value. This correlation showed a moderate positive linear relationship between BMI and IVS, PWT but a weak positive linear relationship for LVIDD, LVIDS, AOroot, LAD and RV. The correlation between BSA and IVS, AO root,PWT,LAD, LVIDD, LVIDS and RV had a significant value. This correlation showed a moderate positive linear relationship between BMI and IVS, PWT, LVIDD, LVIDS but a weak positive linear relationship for AO root, LAD and RV.

The American Society of Echocardiography (ASE) has published recommendations for chamber quantification with M-mode and 2D echocardiography. It is critical that a method for chamber quantification be standardized because cardiac function is determined from the size of the chambers, which also frequently guides the strategy for patient management. The same range of normal values for chamber dimensions and volumes is used for both TEE and TTE.7 LVIDD ranged in our study from"3.05-5.9"cm with mean was 4.68 in women but it was" 3.9-5.3"cm according to ASE guidelines 2005. In men, the LVIDD was"4.2-5.9"cm in ASE 2005 but in our study was" 3.74-5.89"cm with mean was 4.90cm. Mean PWT in our study was 0.83cm and 0.89cm for females and males respectively while according to ASE guidelines 2005, PWT was 0.75cm and 0.8cm for females and males respectively. Mean IVS in our study was 0.84cm and 0.90cm for females and males respectively while in according to ASE guidelines 2005 IVS was 0.75cm and 0.8cm for females and males respectively. Mean mid RV axis (end diastole) in this study was 2.50cm for females and 2.55cm for males while in according to ASE 2010,the mean RV mid cavity axis was 2.8cm[8]. The difference may be due to environmental, social, economic and racial factors because these factors can influence the anthropometric standards of a population.

CONCLUSION

We reported statistically significant difference in adult Egyptian population for echocardiographic cardiac dimensions with respect to body mass index and body surface area. It also varies from standards of normalcy of populations of other countries. More studies are needed in various governments of Egypt to get normal Egyptian cardiac dimensions in adults.

RECOMMENDATIONS

More studies are needed in other governments of Egypt to get normal Egyptian cardiac dimensions in adults. Wide range of age should be included in next studies. Different categories should be included in next studies such as special habits of medical importance as those on regular physical exercise and variation of cardiac dimensions with exercise. Supplying all echocardiography laboratories with equipments that allow measurements of weight and height and body surface area of examined adults.

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