Effect of sex, age and anthropometric measurements on left ventricular mass index in a sample of Iraqi adults.

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Summary

Background: Echocardiography is a very important diagnostic modality in the clinical practice of cardiology. Although it has been extensively used as a diagnostic tool. Echocardiography has recently emerged as a sensitive, non invasive technique for evaluating left ventricular mass(LVM) and detecting left ventricular hypertrophy. **Objective**: to determine the effect of sex, age, and anthropometric measurements on echocardiographic values for cardiac chambers, left ventricular mass index in adults Iraqi sample.

Methods: This was observational study based on a randomly selected sample from Baghdad city, 75 normal obese Iraqi subjects with no history of cardiovascular disease underwent transthoracic echocardiography.

The following M-mode echocardiographic parameters were measured such as ventricular diameters, interventricular septal thickness (IVSTD), posterior wall thickness in diastole (PWTD), left ventricular mass, left ventricular mass indexes values were expressed as mean and standard error.

Results: Echocardiographic values were slightly influenced by gender and age. The overall, cardiac measurements were higher in male gender. LV posterior wall thickness, mass indexes corrected for height$^{2.7}$ and body surface area (BSA) were influenced by age. In multiple regression analysis age and BSA were a powerful predictors for non indexed LVM or for LVM to BSA , where as body mass index was the strongest predictor of LVM to height $^{2.7}$ (LVM/h $^{2.7}$).

Conclusions: Left ventricular mass (LVM) in normal obese Iraqi adults is age and body surface area (BSA) dependent. Age and body mass index (BMI) were the best predictors of LVM/h $^{2.7}$ in normal obese Iraqi adults. Left ventricular mass is larger in men, corrected or not for anthropometric variables.

Key words: left ventricular mass, normal subjects, obesity, anthropometric measurements.

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Introduction:

Echocardiography has been clinically employed for more than 30 years, becoming one of the most important noninvasive imaging methods evaluations of cardiac morphology and dynamics [1, 2].

Left ventricular mass (LVM) is generally calculated as the difference between the epicardium delimited volume and the left ventricular chamber volume multiplied by an estimated myocardial density. Following this principle, several methodologies have been used to calculate left ventricular mass and to define hypertrophy with its own flaws and strength on each resulting in a wide range of values [1].

Both M-mode and two dimensional imaging can be employed to calculate the left ventricular mass. We focused our project on M- mode estimation of LVM since most epidemiological reports use this imaging modality. Both body size and body habitus are clearly associated with left ventricular dimensions and mass. Divers normalization indexes were created and tested to adjust for three different sources of physiologic in variation LVM: lean body mass index, obesity, and gender [2].

Several indexes for body size correction have been proposed, such as height, diverse allometric height adjustments, weight, body surface area ,body mass index and free-fat mass. The best way for normalization of LVM is still controversial and another source of confusion [3].

This study was conduct to establish the effect of sex on left ventricular echocardiographic measurements for normal obese subjects (free from cardiovascular disease). We also sought to explore the effect of age and anthropometric measurements on left ventricular mass and left ventricular mass indexed to body surface area (BSA) and height$^{2.7}$.

Material and method:

75 normal obese Iraqi volunteers examined for M-mode echocardiography at Ibn Al-Bitar hospital for

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cardiac surgery, between August 2009 to November 2009.There were 44 females and 31 males, their ages ranged from 18-71 years with standard error of mean 37.05±1.71 and 41.45±2.7 for women and men respectively. Their weight (kg), height (m) is measured to calculate the body mass index [dividing the body weight in (kg) by the square of height in (meter)], and body surface area in square meters (m²) calculated according to the following equation:

$BSA\ (m^2) = 0.007184 \times weight\ (kg)^{0.425} \times height\ (cm)^{0.725}$ [4]

The analysis restricted to the normal subjects participants; any pathology of cardiovascular system was excluded approved by both history and physical examination.

Additionally valvular was excluded with echocardiographic examination. No patients had a history of hypertension or used of cardiovascular drugs. All subjects had a normal electrocardiogram (ECG) and blood pressure (systolic blood pressure (SBP) $\leq$ 140 mmHg and diastolic blood pressure (DBP) $\leq$ 90mmHg) with no history of systolic or diastolic hypertension. SBP and DBP obtained in the supine or seated position by auscultation using a brachial cuff.

Echocardiographic methods

Echocardiographic examinations (M-mode) and the two dimensional image were obtained for all subjects at rest on the left lateral position using commercially available Philips medical ultrasound system, with 2.5 MHZ transducer. The two dimensional image was employed to obtain the optimum position and angulations of the M- mode line measurements of the Diastolic interventricular septum(IVSTD),the left ventricular internal dimension(LVIDs) at end systole and end diastole(LVIDD),left atrial diameter (LAD), posterior wall thickness in diastole (PWTD) and fractional shortening(FS%),were made according to the standards established methods by the American society echocardiography (ASE) [5] and with the recommendations proposal by Devereux et. al.[6].

LVM is calculated from measurements of the left ventricle (LV) by modified American Society of Echocardiography (ASE) formula [6].

$LVM\ (ASE) = 0.8[1.04(LVIDD+PWTD+IVSTD)^3 - (LVIDD)^3] + 0.6g$. The recommendation of Devereux et. al. [[6] considers measurements at the end of diastole, including endocardial thickness measures of the septum and posterior wall. This fact justifies the use of the American Society of Echocardiography (ASE) formula modified by Devereux et. al. [6]. Relative wall thickness (RWT) can be calculated as twice the posterior wall thickness divided by left ventricular end diastolic diameter [7].

Left ventricular systolic function was assessed by the ejection fraction (EF (%)), and by LV fraction shortening (FS (%)). Stroke volume (ml)= End diastolic volume (ESV) -End systolic volume (EDV)

Left ventricular mass indexed for body surface area, was calculated according to the Dubois formula [4]. LVM/BSA and also for height$^{2.7}$ (LVM/h$^{2.7}$), as proposed by Simone. et. al. [8]. The LVM (in grams) was divided by the height $^{2.7}$(in meters) and divided by BSA, because of the association observed between LVM and BSA in previously defined healthy reference group [9, 10].

Statistical analysis: All statistical analysis was done using the statistical package for social science (SPSS) version 15. The difference in mean between the two groups (male and female) associated for statistical significant by independent sample t-test.

The statistical significance, strength and direction of linear correlation between two quantitative normally distributed variables were assessed by person's linear correlation coefficient. Multiple liner regression model was used to assess the independent association of a set of explanatory variables on a quantitve outcome variable.

Stepwise multiple linear regression analysis was used to identify which factor of anthropometric measurements has the most important effect on LVM, LVM/BSA and
LVM/h$^{2.7}$.

Results:

75 healthy adults were studied, 44 females with mean age 37 years (range 16-65 years) and 31 males with mean age 41.5 years (range 18-71 years).The mean of body height for females is 1.6 m was significantly lower than males 1.7 m .The females mean of body weight was lower but statistically not significant . BMI was significantly higher in females 30.4 kg /m^2 as compared to males 27.2 kg /m^2. BSA was also significantly higher for males 1.89 m^2 as compared to females 1.74 m^2 .The characteristic of the subjects studied are presented in table 1.

Table 1: Sex difference in mean age and anthropometric measurements

Parameters		Female (N=44)	Male (N=31)	P (t-test)
Age (years)	mean±SE.	37 ± 1.7	41.5 ± 2.7	0.15[NS]
	Range	16 - 65	18 to 71	
Body height (m)	mean±SE.	1.6±0.01	1.7±0.01	0.0001
	Range	1.465 -1.705	1.55 to 1.865	
Weight (kg)	mean±SE.	74.4 ± 1.94	78.56 ± 2.75	0.209 [NS]
	Range	53 - 103	53.5 -109.2	
BMI (Kg/m^2)	mean±SE.	30.4 ± 0.83	27.2 ± 0.83	0.01
	Range	21 - 44.4	18.1 - 35.3	
BSA(m^2)	mean±SE.	1.74±0.02	1.89 ± 0.035	0.0001
	Range	1.51 -2.09	1.58 -2.29	

Body mass index (BMI), Body surface area (BSA), P<0.05

The mean value of IVSTD, PWTD was significantly higher among males compared to females as shown in table 2. The mean LVIDD,LVIDS and LAD was slightly but not significantly higher in males .The mean RWT, End diastolic volume (EDV) , end systolic volume (ESV) was higher in male subjects but the difference is not statistically significant.

The mean of fractional shortening FS (%) and ejection fraction EF (%) were higher in female subjects but the difference is not statically significant.

Table (2) Echocardiographic parameters according to sex: mean (standard Error).

Parameters		Female (N=44)	Male (N=31)	P (t-test)
LVM (ASE)	mean±SE.	181±8.02	223.63 ± 10.9	0.002
	Range	97.36-416.26	118.2 - 387.9	
LVM/BSA	mean±SE.	103.11±3.69	118.34 ± 5.65	0.02
	Range	61.5-199.1	72.65 - 230.1	
LVM(ASE)/$h^{2.7}$	mean±SE.	53.8±2.2	54.04 ± 2.91	0.95 [Ns]
	Range	29.05-106.8	27.3 - 106.3	
IVSTD (cm)	mean±SE.	1.04 ± 0.03	1.2 ± 0.04	0.001
	Range	0.7- 1.6	0.8 - 1.7	
PWTD (cm)	mean±SE.	1.1 ± 0.02	1.2 ± 0.03	0.003
	Range	0.8 - 1.5	0.9 - 1.6	
LVIDD	mean±SE.	4.6 ± 0.08	4.8 ± 0.12	0.374 [NS]
	Range	3.5 -5.9	3.2 - 6	
LVIDS	mean±SE.	2.8 ± 0.07	3 ± 0.08	0.086
	Range	1.7 - 3.8	1.9 - 3.8	
RWT	mean±SE.	0.48 ± 0.01	0.53 ± 0.023	0.05
	Range	0.34-0.67	0.35 -0.94	
EF (%)	mean±SE.	70.26 ± 1.23	67.58 ± 0.94	0.11 [NS]
	Range	45.08-87.27	60.3 - 80.79	
FS (%)	mean±SE.	40.1±0.99	37.74 ± 0.75	0.08 [NS]
	Range	22 - 56	31- 49	
ESV	mean±SE.	30.32 ± 1.77	35.22 ± 2.2	0.08 [NS]
	Range	8.39-61.95	11.17 - 61.95	
EDV	mean±SE.	101.12± 3.97	108.24 ± 5.86	0.30 [NS]
	Range	50.87 - 173.21	40.96-180.0	
LAD	mean±SE.	3± 0.09	3.3 ± 0.08	0.052 [NS]
	Range	2 - 4.5	2.3 - 4	

Left ventricular maass (LVM), left ventricular mass corrected by body surface area LVM/BSA (g/m^2), left ventricular mass corrected by height $^{2.7}$ LVM / h $^{2.7}$ ($m^{2.7}$), posterior wall thickness in diastole (PWTD), interventricular septum in diastole (IVSTD),the left ventricular internal dimension(LVIDs) at end systole and end diastole(LVIDD) , Relative wall thickness (RWT), ejection fraction (EF (%)),fraction shortening (FS (%)),End diastolic volume (ESV), End systolic volume (EDV), left atrial diameter (LAD). P<0.05

The mean of LVM (ASE) and LVM (ASE)/BSA was significantly higher in males compared to females while mean LVM/h $^{2.7}$ was slightly but not significantly higher in males, Table 2.

Body height had the strongest independent association with LVIDD .For each one meter increase in body height, the LVIDD increased by 2.56 cm after adjusting the remaining independent variables included in this model.

BMI was a statistically significant increased in LVIDD for each one kg/m^2 increase in BMI, the LVEDD is expected to increase by 0.03 cm after adjusting the age , height and gender. The overall model was statistically significant and able to explain 11% of variation (Table 3).

Table (3) :Multiple linear regression model with LVIDD (cm) as the dependent (response) variable and age , sex and anthropometry as independent variables.

independent variables	Unstandardized Partial regression coefficient	P	Standardized Partial regression coefficient	r
Male gender compared to female	-0.113	0.55[NS]	-0.098	0.104
Age in years	0.000049	0.99[NS]	0.001	-0.01
Body height (m)	2.56	0.011	0.423	0.252
BMI (Kg/m2)	0.032	0.014	0.303	0.188

Adjusted R^2 = 0.11 , P (Model) = 0.019 ,Body mass index (BMI) .

Table(4):The relation of M-mode echocardiographic measurements to age and body habitus.

parameter	Age (years)	Height(m)	BMI (kg/m^2)	BSA (m^2)
LVM (ASE)	r = 0.288* p= 0.012	r = 0.345* p= 0.002	r = 0.28* p= 0.015	r = 0.553** p= 0.000
IVSTD (cm)	r= 0.387* p=0.001	r= 0.219 p= 0.059	r= 0.203 p= 0.08	r= 0.388* p= 0.001
PWTD (cm)	r= 0.338* p=0.003	r= 0.219 p= 0.059	r= 0.209 p=0.072	r= 0.392** p= 0.0001
RWT	r= 0.269* p= 0.02	r= 0.015 p= 0.895	r= 0.042 p= 0.722	r= 0.073 p= 0.534
LVIDD	r= - 0.01 p=0.932	r= 0.252* p=0.029	r= 0.188 p= 0.106	r= 0.368* p= 0.001
LVIDS	r= - 0.05 p=0.673	r= 0.334* p= 0.003	r= 0.055 p= 0.642	r= 0.342* p= 0.003
EF(%)	r = 0.057 p= 0.626	r = - 0.227 p= 0.05	r = 0.114 p= 0.330	r = - 0.122 p= 0.298
FS (%)	r = 0.056 p= 0.636	r = - 0.228* p= 0.049	r = 0.133 p= 0.255	r = - 0.108 p= 0.357

Abbreviations as in table 2 *P< 0.05 **p<0.001

As shown in table (4) left ventricular mass was strongly correlated with BSA (r=0.532, p< 0.001) and height (r=0.345, p<001). Left ventricular mass was moderately correlated with BMI (r=0.28, and p<0.05) and was correlated with age ($r=0.288$, $p<0.05$). Therefore, to assess for possible confounding of association between (age, anthropometric measurements) and LVM, stepwise multivariate liner regression were carried out. The results of these analysis showed that both age and BSA remained a highly significant predictors of left ventricular mass($R^2= 0.371$ $p< 0.001$).

Table 4 indicates the statistically significant linear correlation between IVSTD, PWTD, and RWT with age.

As shown in table (5), LVM/h $^{2.7}$ has a frankly positive correlation to the BMI (0,479 ,p<0.001). Both LVM/BSA and LVM/h $^{2.7}$ correlated with age, Table 5.

Table(5):The correlation between two cardiac mass correction(LVM/BSA, LVM / h$^{2.7}$) with age and the body habitus measurements.

	Age (years)	Height (m)	BMI (kg/m^2)	BSA (m^2)
LVM / h$^{2.7}$	r= 0.371* p=0.001	r = -0.178 p= 0.126 [N.S.]	r = 0.479** p= 0.0001	r = 0.216 p= 0.062
LVM / BSA	r=0.334* p=0.003	r = 0.143 p= 0.220 [N.S.]	r = 0.132 p= 0.259 [N.S.]	r= 0.244* p= 0.035

***p<0.05 , **p<0.001**

To assess the independent association between LVM/BSA and these parameters stepwise multivariate regression analyses were performed , the age and BSA remained strongly associated with LVM /BSA($R^2=0.162$,$p<0.05$).

To understand which of the anthropometric parameters (BSA ,BMI, height) and age has the most important effect on LVM/ h $^{2.7}$. Stepwise multiple liner regression model was employed. This model showed clearly that age and BMI had the most important effect on the LVM/ h $^{2.7}$.

Discussion:

This study based on a sample of 75 normal obese subjects. All with no cardiovascular disease, the cardiac dimensions found in this work, may be used in routine echocardiographic assessments in Iraq. In spite of remarkable advances in ultrasound technology, M-mode is still routinely used in all echocardiography units in Iraq. This study, sought to establish sex effect on left ventricular echocardiographic measurements, and also determine the influence of age and anthropometric measurements on LVM, left ventricular mass indexed to both BSA and height $^{2.7}$. Since few studies in our country have addressed this important and very useful aspects in clinical practice of cardiology.

In this work, the left ventricular mass values were significantly higher in men than in women even after indexation for body surface area, which is consistent with previous findings [11, 12]. After indexation for height $^{2.7}$, LVM values were found to be higher in male subjects. This indicates that left ventricular mass values are higher in men, regardless of the indexation method used. LVM calculation derived from American Society Echocardiography (ASE) convention depends on measurements of left ventricular internal dimension (LVIDD), and on final cubed estimation of (LVIDD) [3]. Multiple liner regression model was employed to study the most important factor affect on LVIDD. The outcome of this model shows that the body height had the strongest relation with LVIDD. Our results illustrate that the mean of the body height for females were significantly lower than males. In addition there was no statistically significant difference in body weight between females and males. Therefore, our results emphasizes that the gender difference in LVM due to difference in body height between females and males. This result in accordance with various workers has recently reported that heart size and the rates of LVM /height are larger in boys than girls. And that LVM is greater in younger adults men versus women [13, 14]. On the other hand, the differences in LVM due to gender, independent of question related to body size, may have pathological implications. Women have been shown to have an increased parietal hypertrophic response to pressure overload, [15] even after body size correction. This adaptive pattern demonstrated also in animal models [16, 17]. In this study we found robust correlation between LVM and age ($r=0.288$, $p= 0.012$) i.e. among normal obese participants LVM increases with increasing age. This results confirm with other studies [18,19,20].This study has also shown that there is a significant increase in IVSTD and PWTD with age as it have given a significant r and p-values table (2). We also have shown that not surprisingly, a positive significant relationship of age and left ventricular relative wall thickness in our study ($r=0.26$, $p<0.05$), the results agreed with previously reported results [20, 21, 11]. These results in agreement with other authors who established that aging in normal obese, healthy subjects is associated with structural arterial changes, including arterial dilation and loss of vascular compliance, that influence ventricular load and induces geometric remodeling leading to increased relative wall thickness without increase in overall LVM [22, 23]. The definition of normal left ventricular mass implies its correction by influencing physiological factors. Thus, sex, body habitus, and possibly age important in this correction .The best index of left ventricular mass that obtained using the physiological scale of weight and height variables, regarding both men and women. Therefore, the ideal index would be lean body mass [24] but this method is not practical and has not been used. Thus, indexing ventricular mass by body surface area (BSA) is preferred. In the present study correlation was found between LVM and BSA , similar to the findings of Deverux et.al [10],and other investigators [19, 25] , they found that the body surface area, using the Dubois formula [4], reduces variability due to body size and gender [10], but this index under estimated LVM in upper range of body surface distribution [9]. Because of greater number of overweight (no:26) and obese subjects(no=32) in our study sample, indexing of LVM to weight or body surface area allow an increased LVM to be interpreted erroneously as normal. These results are in accordance with other studies [10, 19, 25, 26].

Our results shows LVM/h $^{2.7}$ has a frankly positive relation to the BMI (r=0.479, p<0.001). In multiple regression models, showed clearly that age and BMI had the most important effect on LVM/h $^{2.7}$. Height $^{2.7}$,derived from regression models in normal samples from De Simone and coworkers [9], appears to offer the most accurate estimation of left ventricular hypertrophy and risk factors for pathologic changes in the heart structure, particularly in obese subjects. Many studies that evaluated of Height $^{2.7}$ (in meters) have been validated as indicator of lean BMI and have been recommended for indexing LVM [9, 27, 28, 29]. Employment of height $^{2.7}$ indexing allowed to use cut point of 51g/m $^{2.7}$ for both genders [9] , reducing gender effect in LVH interface [9,17].In our study LVM indexed to height $^{2.7}$ minimizes the interface of obesity and gender in LVM estimates. We used M-mode echocardiography because our study sample consisted of apparently healthy subjects with no history of coronary or valvular disease. To minimize possible errors, we followed the measurements standardization in accordance to the American Society of echocardiography, corroborated by the recommendations of the latest international guidelines of LV quantification [30]. Necropsy studies have yielded formula for anatomically accurate estimation of left ventricular mass in patients with normally shaped ventricle using left ventricular measurements by either Penn or American Society of Echocardiography convention. Left ventricular dimensions ventricle in adults differs significantly on American Society of Echocardiography and Penn conventions. Therefore, the slight difference of left ventricular volumes and masses which should be taken into account when these echocardiographic parameters are used for the assessment of patients with left ventricular hypertrophy/ dilatation [30].

Conclusions:

Left ventricular mass (LVM) is age and body surface area dependent. Considering that age and BMI were the best predictors of LVM/h $^{2.7}$ in normal obese Iraqi adults. Left ventricular mass is larger in men, corrected or not for an anthropometric variables. LVM/height $^{2.7}$ minimizes the interface of obesity and gender in LVM estimates.

The results of this study is strongly indicate the needing for a large- scale study to further establish ethnic- specific and gender specific echocardiographic reference values for Iraqi population.

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