LINEAR REGRESSION MODELS FOR LEFT VENTRICULAR MASS BY ECHOCARDIOGRAPHY IN NORMAL IRAQI SUBJECTS

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Abstract
Left ventricular mass (LVM) is an independent risk factor for cardiovascular outcome. M-mode echocardiography, the most commonly used technique for estimation of LVM. The purpose of this study is to establish the regression models for prediction of LVM, measure the normal values of the LVM in normal Iraqi subjects and to compare them with values obtained in Europe, American and Arab people.

Keyword: left ventricular mass (LVM), Relative Wall thickness (RWT), Echocardiography, Left ventricular mass index (LVMI).

Introduction
It is well known that increased left ventricular mass (LVM) is an independent risk factor for cardiovascular morbidity and mortality (1, 2, 3). Regression of the LVM index has been found to be associated with lower rates of clinical cardiovascular events (4). Several authors suggest that it may be a useful parameter in risk stratification and guiding treatment, especially for hypertensive patients at low or medium risk (5, 6). For these reasons, accurate estimation of LVM has crucial importance.

Echocardiography is the most commonly used technique for the estimation of LVM (7, 8, 9, and 10). Devereux et al (11, 12) proposed a formula for estimation of LVM and found that the LVM calculated by this formula was consistent with the necropsy data. Calculation of LVM by this formula requires some geometric assumptions. Also, it is found good correlation between echocardiography LVM and true anatomic LVM (11).

The relation between race-ethnicity and LVM has not been fully explored (13). Blacks are more likely to have increased LVM than whites (14, 15).While the values of LVM in Arab people are not significantly different from that obtained in Europe and North America (16).

To the best of our knowledge, prediction models for left ventricular mass have not been established in Iraqi people. This study aimed to establishing linear regression models, and to develop normal data for LVM based on age, sex, body weight, height, and body surface area to look if these data are significantly different from their estimated values by M-mode echocardiography method for blacks, whites and Arab-people.

Materials and Method
A total of one hundred Iraqi subjects were studied in Bagdad-teaching hospital/Echocardiography unit between the January-2009 to April-2009. One hundred normal subjects were recruited as 50 males and 50 females. Their ages ranged from 19 years to 70 years with mean ages ± standard deviations of 46.46±15.73 and 43.96±15.44 for men and women respectively. Any subject with evidence of heart disease, hypertension or other systemic disease was excluded. Examination included measurements of blood pressure, height, weight, body surface area (BSA), and body mass index (BMI). The body mass index (BMI) was calculated as (BMI = weight/height) (17). Body surface area (BSA) was calculated by: [BSA in (m²) = 0.0001 * 71.84 (weight in Kg) 0.425 (Height in cm)* 0.725] (18).

Echocardiography was performed with Philips ultrasound system with a 3 MHz transducer and measurements were taken by standard two-dimensional (2-D) protocol according to the guidelines of the American Society of Echocardiography (ASE) (19). Posterior wall thicknesses (PWT) in diastole, Septal Wall thickness (SWT) in diastole and end diastolic diameter (EDD) were measured...
in all subjects. Relative wall thickness (RWT) was calculated as the ratio of 2 [posterior wall thickness / end diastolic diameter] (17).

Left ventricular mass was calculated according to the formula published by Devereux and Reichek (11): LVM = 1.04 [(SWT + LVID + PWT)³ − (LVID)³] − 13.6. LVM was then indexed to body size by dividing raw LVM by height to allometric power of 2.7 and analyzed as a continuous variable (20, 21).

**Data Analysis**

Pearson’s correlation coefficients were derived relating indexed and un-indexed values of LVM measured by M-mode echocardiography and measures body size, weight, height, and body surface area. LVM was also correlated to age. Means ± SD were calculated for continuous variables. Linear regression models for continuous variables were performed. Statistical significance was determined at the α = 0.05 level using two sided-tests. Statistical analyses were conducted using WINKS SDA-statistical Data Analysis Version 6.0.5 computer software.

**Results**

One hundred Iraqi subjects were enrolled in this study. Equal numbers of men and women enrolled into the study (fifty each) were healthy and free of any medical disease. Subjects ages ranged from 19 to 70 years with mean age ±SD of 46.46± 15.73 and 43.96± 15.44 in men and women, respectively. The characteristics of the study subjects are summarized in Table (1).

<table>
<thead>
<tr>
<th>Cardiac parameters</th>
<th>Age (Years)</th>
<th>Height (m)</th>
<th>Weight (Kg)</th>
<th>BMI (Kg/m²)</th>
<th>BSA (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVM (gm)</td>
<td>r = -0.249</td>
<td>r = 0.317</td>
<td>r = 0.213</td>
<td>r = -0.027</td>
<td>r = 0.258</td>
</tr>
<tr>
<td></td>
<td>P = 0.012</td>
<td>P = 0.001</td>
<td>P = 0.034</td>
<td>P = 0.79</td>
<td>P = 0.01</td>
</tr>
<tr>
<td></td>
<td>(S)</td>
<td>(S)</td>
<td>(S)</td>
<td>(NS)</td>
<td>(NS)</td>
</tr>
<tr>
<td>LVM/Height².⁷</td>
<td>r = -0.172</td>
<td>r = 0.057</td>
<td>r = -0.086</td>
<td>r = -0.077</td>
<td>r = -0.087</td>
</tr>
<tr>
<td></td>
<td>P = 0.087</td>
<td>P = 0.574</td>
<td>P = 0.395</td>
<td>P = 0.444</td>
<td>P = 0.389</td>
</tr>
<tr>
<td></td>
<td>(NS)</td>
<td>(NS)</td>
<td>(NS)</td>
<td>(NS)</td>
<td>(NS)</td>
</tr>
<tr>
<td>LVM/BSA</td>
<td>r = -0.225</td>
<td>r = 0.0915</td>
<td>r = -0.036</td>
<td>r = -0.167</td>
<td>r = 0.0034</td>
</tr>
<tr>
<td></td>
<td>P = 0.024</td>
<td>P = 0.365</td>
<td>P = 0.716</td>
<td>P = 0.095</td>
<td>P = 0.973</td>
</tr>
<tr>
<td></td>
<td>(S)</td>
<td>(NS)</td>
<td>(NS)</td>
<td>(NS)</td>
<td>(NS)</td>
</tr>
<tr>
<td>RWT</td>
<td>r = -0.224</td>
<td>r = 0.248</td>
<td>r = 0.146</td>
<td>r = -0.060</td>
<td>r = 0.196</td>
</tr>
<tr>
<td></td>
<td>P = 0.025</td>
<td>P = 0.013</td>
<td>P = 0.147</td>
<td>P = 0.551</td>
<td>P = 0.051</td>
</tr>
<tr>
<td></td>
<td>(S)</td>
<td>(S)</td>
<td>(NS)</td>
<td>(NS)</td>
<td>(NS)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Linear regression equation</th>
<th>P-value</th>
<th>(R²)</th>
<th>S = Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVM = 204.45 - 0.996 * Age</td>
<td>0.012</td>
<td>0.623</td>
<td>S</td>
</tr>
<tr>
<td>LVM = 74.12 + 1.294 * weight</td>
<td>0.045</td>
<td>0.045</td>
<td>S</td>
</tr>
<tr>
<td>LVM = -218.82 + 231.26 * Height</td>
<td>0.001</td>
<td>0.100</td>
<td>S</td>
</tr>
<tr>
<td>LVM = -6.041 + 96.03 * BSA</td>
<td>0.010</td>
<td>0.664</td>
<td>S</td>
</tr>
<tr>
<td>LVM = 185.79 - 1.021 * Age + 0.77BMI</td>
<td>0.042</td>
<td>0.063</td>
<td>S</td>
</tr>
<tr>
<td>RWT = -0.372 – 0.0014 * Age</td>
<td>0.025</td>
<td>0.050</td>
<td>S</td>
</tr>
<tr>
<td>RWT = -0.154 + 0.283 * Height</td>
<td>0.013</td>
<td>0.061</td>
<td>S</td>
</tr>
<tr>
<td>LVM/BSA = 111.159 – 0.478 * Age</td>
<td>0.024</td>
<td>0.050</td>
<td>S</td>
</tr>
</tbody>
</table>

| Table (3) | Pearson’s correlation coefficients (r) and P-values between all the anthropometric variables in normal subjects. |

\[ r = \text{correlation coefficient}, \quad S = \text{Significant}, \quad NS = \text{Not significant} \]

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The values of LVM were correlated to age, weight, height and body surface area in one hundred normal subjects as shown in Figs. (1, 2, 3, 4).

**Fig. (1): Left Ventricular Mass (LVM) by Echocardiography against age.**

**Fig. (2): Left ventricular mass (LVM) by echocardiography against height.**

**Fig. (3): Left ventricular mass (LVM) by Echocardiography against weight.**

**Fig. (4): Left Ventricular Mass (LVM) by Echocardiography against Body Surface Area (BSA).**

Our data showed significant linear relationship between LVM with weight (P< 0.05), height (P<0.05) and body surface area (P< 0.05). Age was significantly related to LVM (P<0.05). No significant correlation were noted between the LVM-indexed to height\(^{2.7}\) (LVM/Height\(^{2.7}\)) with age (P>0.05), weight (P>0.05), and body surface area (BSA) P>0.05. Also the LVM-indexed to body surface area (LVM/BSA) was significantly correlated with age (P<0.05). The results clearly pointed the significant relation between the relative wall thickness (RWT) with age (P<0.05) and height (p<0.05), Fig.s (5) and (6).

**Fig. (5): Relative Wall Thickness (RWT) against the height.**
The attenuation of the age-LVM relation in healthy subjects of Framingham study (28) suggests that LVM increases with age not by virtue of an intrinsic myocardial aging process, but rather as a function of extra-myocardial events that accompany advancing age. Almost all Framingham study participants are white; therefore their results may not applicable to non-white individuals. In addition variation in LVM may be explained in part by variables not assessed in those studies such as genetic, neurohormonal and endocrine factors.

The methods of correcting LVM for body size have varied between studies. LVM has been adjusted for height, body surface area, weight, and height rose to various powers. Height\(^2.7\) (in meters) has been validated as an indicator of lean body mass and has been recommended for indexing LVM (20, 21). Use of Height\(^{2.7}\) to index LVM also minimizes the effect of age, gender, and race (20, 31). Other studies demonstrated that LVM-indexed to height (LVM/Height) reduces variation to the body size and sex (16, 24). In the present study; There were no relation between the LVM/Height\(^{2.7}\) with age (P>0.05), whereas a significant negative correlation between (LVM/BSA) with age, (r = -0.224, P = 0.025) Table-3. Similar to our findings, one study found that the LVM/Height in Arab people was not significant related with age (16). Mean while, other studies were reported that (LVM/BSA) was significant related with age in Southeast Asian population (23), while in white individuals the (LVM/BSA) was not relation of age to LVM.

Relative wall thickness (RWT) has the strongest correlation with blood pressure in hypertensive subjects (31). In this study a linear regression equations of RWT shows a significant correlation between RWT with age P<0.05 and height P<0.05. No relation was observed between the RWT with body surface area (BSA) P>0.05. These results are not in agreed with other studies in African American population (31, 32). Studies comparing the left ventricular structure and function among black and white subjects had suggested that RWT and LVM are higher in blacks (33). This observation could have attenuated the age related changes in Left ventricular geometric
patterns that have been observed in Caucasians (34). On other hand, patients with a normal clinic blood pressure may show abnormalities on ambulatory blood pressure monitoring. This phenomenon of “masked hypertension” may have more clinical relevance because ambulatory blood pressure has a stronger impact than damage and cardiovascular outcomes (15).

Although standardized methods have been proposed for echocardiography, they are not uniformly followed. This could explain the wide variation in the results, in addition to different ways of analysis and also different ways of correlation between the measured values of LVM with different parameters of the body including size, height, weight, age, and body surface area. On the top of all these factors, any parameter obtained from white populations is not necessarily applicable to the non-white people.

Conclusion

Despite these problems, this study offers valuable information about the LVM in Iraqi subjects;
1. This study established prediction formulas for normal LVM and RWT both of which would be useful in the assessment of cardiomyopathies.
2. Our data for LVM values in healthy Iraqi subjects (age range 19-70 years), are not significantly different from that found in other countries, especially in Arab people.
3. Also in this study demonstrated potentially relation of age, weight, height and body surface area to LVM.

References


[28] Levy D, Savage DD, Garrison RJ, Anderson KM, Kannel WB, Castelli WP: Echocardiographic criteria for left


