DETERMINATION OF LEFT VENTRICULAR MASS BY ECHOCARDIOGRAPHY IN NORMAL ARAB PEOPLE

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SUMMARY: Echocardiographic data from 168 normal (18–75 years of age) were pooled and analyzed to obtain normal echocardiographic values in the Arab people. The purpose of this study was to measure the normal values of left ventricular mass (LVM) in Arab people and to compare them with values obtained in Europe and North America.

LVM was estimated by M-mode echocardiography in normal male and female subjects. These values were related to age, sex, height, weight and body surface area. In men (N=82) the LVM was 186±34 grams (mean±SD). Data showed significant correlation between LVM with weight, body surface area ($p<0.05$), but not significantly associated with height and age ($p>0.05$). In female (N=86) the LVM value was 168±17 grams (mean±SD). Data also showed significant correlation of LVM with weight, body surface area and also with age ($p<0.05$) but not with height. Our results demonstrated that values of LVM in the Arab people are not different from values obtained in other parts of the world including Europe and North America. More studies are still essential in different Arab countries.

Key Words: Echocardiography, left ventricular mass.

INTRODUCTION

Left ventricular mass (LVM) plays an essential role in determination of left ventricular hypertrophy (LVH). The degree of hypertrophy indicates the severity of volume overload of the systemic circulation (1–3). Electrocardiogram infrequently predicts left ventricular hypertrophy (4), but M-mode echocardiography provides an accurate assessment of LVM that is more sensitive and specific than the electrocardiogram for detecting LVH (5). Left ventricular hypertrophy is an important prognostic finding to evaluate the high risk of subsequent cardiovascular morbidity and mortality (4, 6).

The invasive biplane angiographic method of Rackley *et al.* (6) is the most accurate method for assessment of LVM in man by comparison with autopsy, but it has been of limited use because it is an invasive nature and requires complex techniques.

The non-invasive wide application of echocardiography makes it a useful method for serial determinations of LVM and to evaluate the LVH if present. Several studies have estimated a close statistical relationship between echocardiographic and angiographic calculations of LVM (7–9).

Devereux *et al.* (9) found good correlation between echocardiographic LVM and true anatomic LVM. Our estimated values of LVM calculated by M-mode echocardiography were compared to the normal values obtained by other Western and American populations (1-9). The aim of the present study is to develop normal data for LVM based on age, sex, body weight and height and to look if these data are significantly different from their estimated values by M-mode echocardiography method for Arab people.

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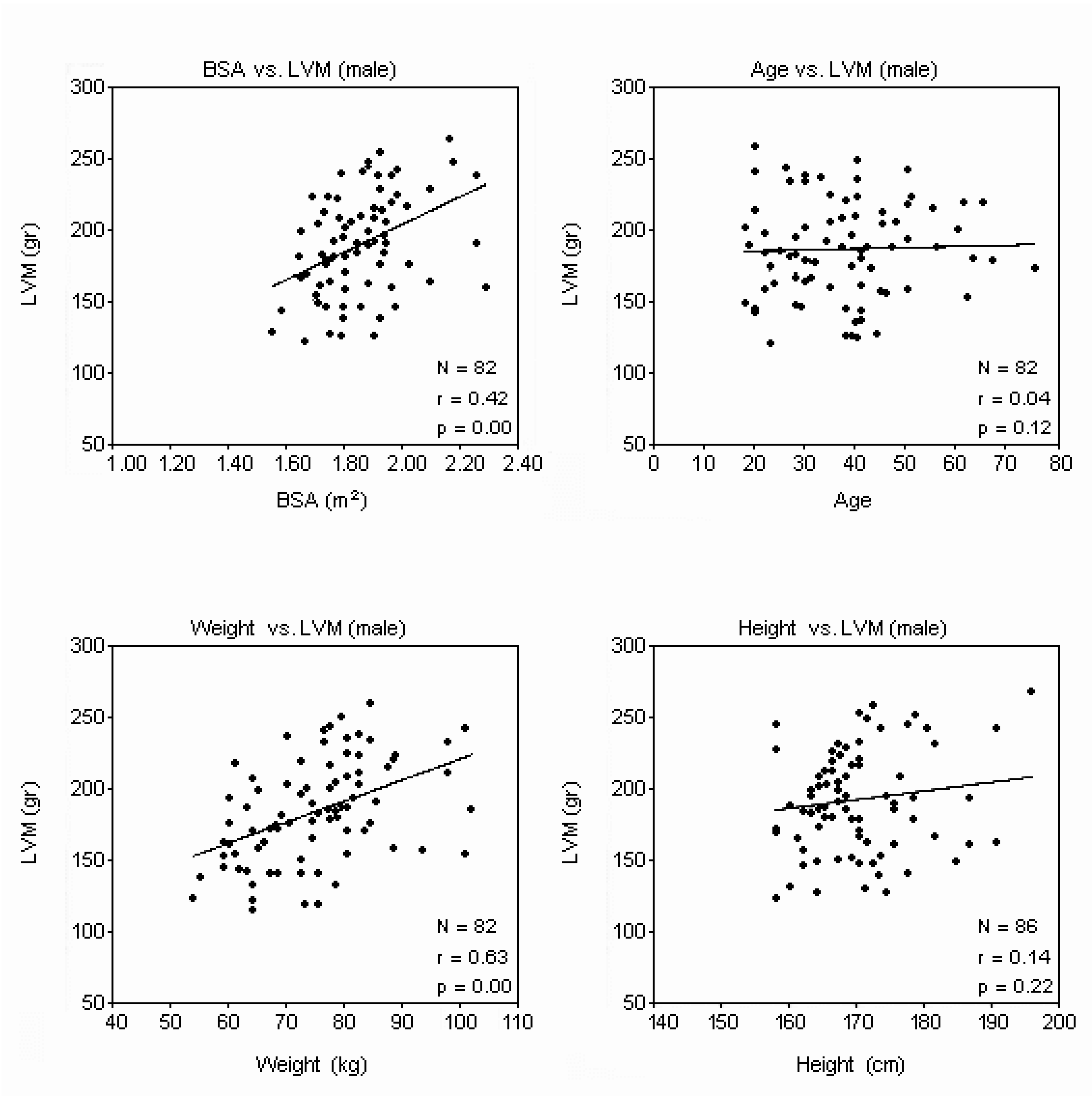
Figure 1: Left ventricular mass (LVM) by echocardiography (vertical axis) plotted against body surface area (BSA), age, weight and height in male (horizontal axis).



MATERIALS AND METHODS

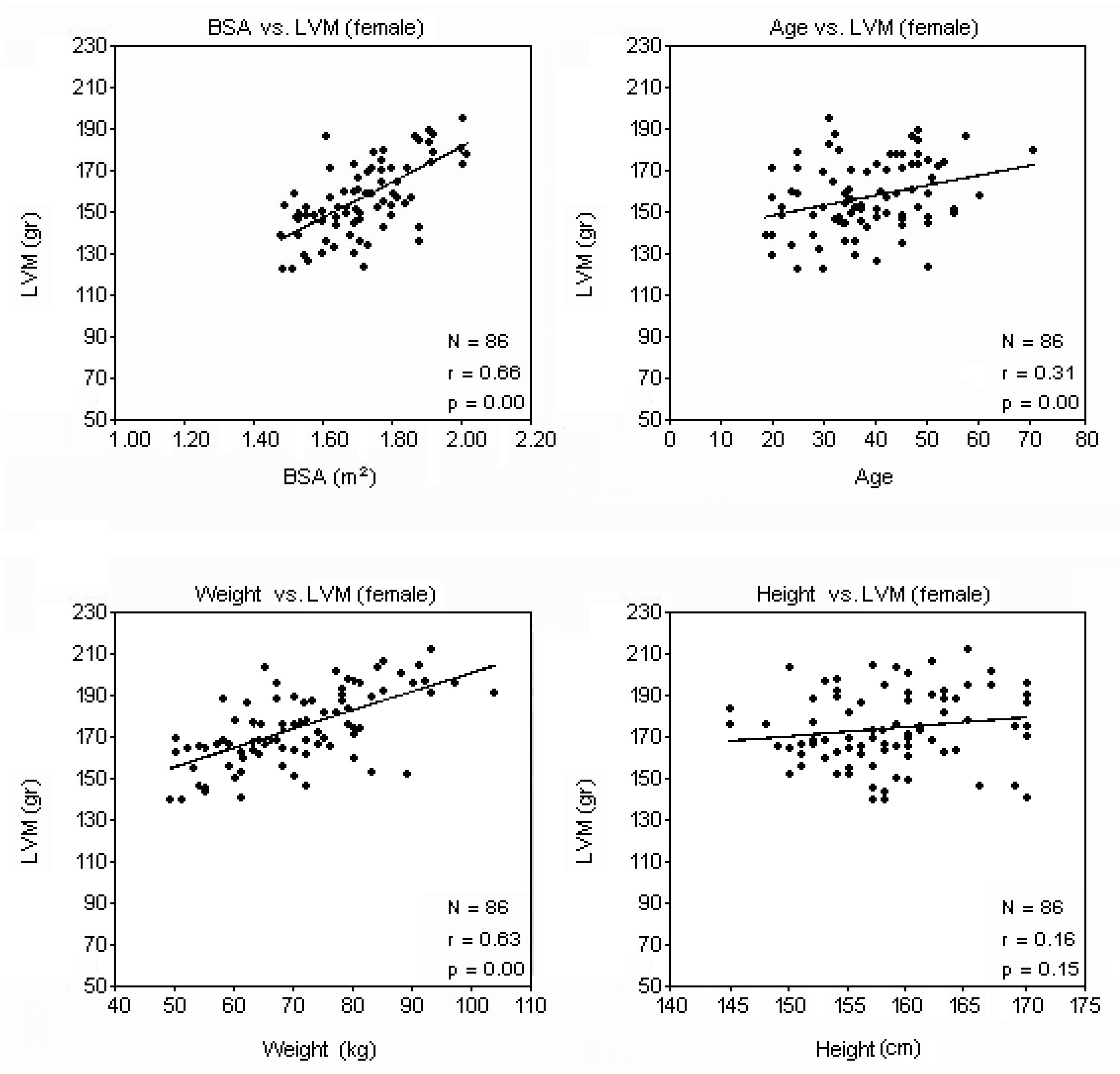
Study samples

One hundred sixty eight normal subjects were studied, 82 males and 86 females. Their ages ranged from 18 to 75 years in men and women (mean±SD, 37.1±12.7 years in men and 37.9±10.6 years in women). Any subject with evidence of heart disease, hypertension or other systemic disease was excluded.

The subjects fulfilled the following criteria:

1. Normal physical examination.
2. Normal blood pressure, systolic blood pressure <150 mmHg and diastolic blood pressure <90 mmHg.
3. No use of anti-hypertensive or cardiovascular medication.
4. No diabetes mellitus.
5. Normal standard electrocardiography.
6. Normal chest X-ray.
7. No oral contraceptive.
8. Adequate echocardiogram to assess LVM.
9. Baseline measurements: Examinations routinely included measurements of blood pressure, height, weight and body surface area (BSA) were calculated using the following formula (10). Body surface area (BSA in m^2) = (0.0001) x (71.84) x (weight in kg) 0.425 x (height in cm) 0.725.

Figure 2: Left ventricular mass (LVM) by echocardiography (vertical axis) plotted against body surface area (BSA), age, weight and height in female (horizontal axis).



Echocardiographic measurements

Two-dimensionally guided M-mode echocardiograms were recorded using available equipment. Kontron Instrument, sigma iris 880, with 3.5 MHz transducer. M-mode recordings of the left ventricle were obtained with the subject in the supine and left lateral decubitus position. Measurements on the echocardiograms were obtained according to the recommendations of the American Society of Echocardiography (11). The internal dimensions of the left ventricle at end diastole were measured at the onset of the QRS complex. All the subjects had a lead II ECG recorded simultaneously with the echocardiogram. The thickness of the ventricular septum and posterior wall were measured in the same portion of the record used to measure the left ventricular internal dimensions. Two measurements were made and averaged LVM was derived from the following formula described by Devereux and associates (12):

$$LVM\ (grams) = 0.80 \times 1.04\ [(VSTd + LVIDd + PWTd)^3 - (LVIDd)^3] + 0.6$$

where VSTd is ventricular septal thickness at end diastole, LVIDd is LV internal dimension at end diastole, and PWTd is LV

Table 1: Characteristics of the study subjects.

	Men	Women
Age (year)	37.1 ± 12.7	37.9 ± 10.7
Weight (kg)	74.7 ± 10.7	70.5 ± 12.2
Height (cm)	169.6 ± 7.8	158.3 ± 12.2
Body surface area (m^2)	1/85 ± 0.15	1.71 ± 0.14
LVM (g)	186/9 ± 34	168.3 ± 17/5
LVM index (g/m^2)	101.2 ± 16.6	98.8 ± 6.7
Systolic blood pressure (mmHg)	127.6 ± 14.4	121.3 ± 14.7
Diastolic blood pressure (mmHg)	79 ± 8.4	77.3 ± 14.7

Values are mean±SD
LVM: Left ventricular mass.

posterior wall thickness at end diastole. Each of these structures had to be measured for the study to be considered adequate. Global left ventricular function was assessed from 2D-echocardiography images and any patient showed segmental hypokinesia, valvular heart disease, or myocardial hypertrophy was excluded.

Statistical methods

Pearson's correlation coefficients were derived relating indexed and unindexed values of left ventricular mass measured by M-mode echocardiography and measures of body size, weight, height, and body surface area. Left ventricular mass was also correlated to age. Regression diagnostic analyses were conducted separately for men and women. All data are expressed as mean ± standard deviation (M ± SD).

RESULTS

Adequate quality echocardiograms to assess left ventricular mass obtained for 86 of 110 women (79%) and 82 of 110 for men (75%) who were healthy and free of any medical disease. The characteristics of the study population are summarized in Table 1.

Relation of LVM to age, weight, height and body surface area

The absolute values of the left ventricular mass were correlated to age, weight, height and body surface area separately in men and women as shown in figures 1 and 2. Linear regression was used to examine the relation between LVM measurements and body size-specifically, weight, height and body surface area. Our data showed significant correlation between LVM with weight and body surface area in both male and female ($p=0.00$), but LVM was not significantly associated with height ($p > 0.05$) in both male and female. Age was significantly related to LVM only in women ($p<0.05$) but not in men ($p > 0.05$). After adjustment of LVM for body surface area and related to age there was no significant correlation ($p > 0.05$) in both male and female.

DISCUSSION

Our adequate quality of echocardiograms to assess LVM (79% in women and 75% in men) were nearly - similar to that obtained by Levy *et al.* (13) (The Framingham heart study) who obtained records in 80% of normal subjects while Lindros *et al.* (14) reported 87% adequate LVM measurements in population sample. However, Garden *et al.* (15) found that missing data for LVM reached up to 37%. In the present study, LVM as shown in Table 1 was 186 g for male and 168 g for female or 101 g/m and 98.8 g/m in male and female, respectively. These data as compared with results of other studies as by Fagard *et al.* (16) who reported LVM in male was 180 g as measured by echocardiogram while Chuang *et al.*

(17) reported that small sample of both male and female together LVM was 163 g. However, Lauer *et al.* (18) found that LVM was 173 g for men and 114 g for women, and Garden *et al.* (15) reported LVM of 156 g for men and 116 g for women. Celentano *et al.* (19) also found LVM of 135 g, but their total sample includes male and female. These different studies show a rather wide variation of the LVM values estimated by different centers.

Thus the estimated LVM by echocardiogram our results revealed correlation between LVM with weight and body surface area in both male and female populations ($p<0.05$), but not with height ($p>0.05$) in the same groups of patients. Relation to age LVM was only correlated to the age in women ($p<0.05$), but not in men ($p>0.05$). Fagard *et al.* (16) reported that LVM was significantly related to age in women only, but it was significantly associated with height in both male and female.

The attenuation of the age-LVM relation in the healthy subjects of Framingham study suggests that LVM increases with the age not by virtue of an intrinsic myocardial aging process, but rather as a function of extramyocardial events that accompany advancing age. Almost all Framingham study participants are white, therefore their results may not be 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.

Chuang *et al.* (17) demonstrated that LVM was divided by height reduces variation due to body size and sex, but this does not necessarily imply a better corrected form of LVM. Devereux *et al.* (20) reported in 225 subjects (age range 18 to 72 years) that LVM was indexed for body surface area or lean body mass, there was no significant relation of age to LVM as our report for the indexed LVM with age. Although standardized methods have been proposed for echocardiography, they are not uniformly followed. This could explain the wide variation in the result, 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 while populations is not necessarily applicable to the non-white people. However, still left ventricular mass readily determined by echocardiography may provide a better estimate of the extent of the cardiac organ evaluation in normal and disease state than is provided by casual measurement of blood pressure, body weight or even ECG and chest X-ray.

CONCLUSION

Our data for LVM values in healthy Arab male and female subjects (age range 18–75 years), are not significantly different from that found in other countries. Also in this study demonstrated potentially relation of age, sex, weight, height and body surface area to LVM. The data presented in this article are applicable primarily to non-white subjects. Additional studies are also needed with greater sampling population in other parts of the Arab countries.

REFERENCES

1. Badeer HS, Biological significance of cardiac hypertrophy. Am J Cardiol, 14:133, 1964.

2. Sasayama S, Ross J Jr, Franklin D, Bloor CM, Bishop S, Dilley RB : Adaptations of the left ventricle to chronic pressure overload. Circl Res 38, 172, 1971.

3. Linzbach AI : Hypertrophy, hyperplasia and structural dilatation of the human heart. Adv Cardiol, 18:1–13, 1976.

4. Kannel WB, Gordon T, Castelli WP, Margolis JR : Electrocardiographic left ventricular hypertrophy and risk coronary heart disease. The Framingham Study. Ann Intern Med, 72:813–822, 1970.

5. Reichek N, Devereux RB : Left ventricular hypertrophy: relationship of anatomic echocardiographic and electrocardiographic findings. Circulation, 63:1391–1398, 1981.

6. Rackley CE, Dodge HT, Cable YD, Hay RE : A method for determining left ventricular mass in man. Circulation, 24:666, 1964.

7. Troy BL, Pombo J, Rackley CE : Measurement of left ventricular wall thickness and mass by echocardiograph. Circulation, 40:602, 1972.

8. Murray JA, Johnston W, Reid JM : Echocardiographic determination of left ventricular dimensions, volumes and performance. Am J Cardiol, 30:252, 1972.

9. Devereux RB, Reichek N : Echocardiographic determina-

tion of left ventricular mass in man. Circulation, 55:613, 1977.

10. Dubois EP : Basal metabolism in health and disease. Philadelphia. Lea and Febiger, 1936.

11. Sahn DJ, DeMaria A, Kisslo J, Wayman A : The committee on M-mode standardization of the American Society of Echocardiography : recommendation regarding quantitation in M-mode echocardiography: results of a survey of echocardiographic measurements. Circulation, 58:1072, 1978.

12. Devereux RB, Alonso DR, Lutas EM, Gottlieb GJ, Combo E, Sachs I, Reichek N : Echocardiographic assessment of left ventricular hypertrophy: comparison with necropsy findings. Am J Cardiol, 57:450, 1986.

13. Levy D, Savage DD, Garrison RJ, Anderson KM, Kannel WB, Castelli WP : Echocardiographic criteria for left ventricular hypertrophy. The Framingham heart study. Am J Cardiol, 59:956, 1987.

14. Lindros M, Kupari M, Heikkila J, Tilvis R : Echocardiographic evidence of left ventricular hypertrophy in a general aged population. Am J Cardiol, 74:385, 1994.

15. Gardin JM, Siscovick D, Hoda AC, Lynch JC, Smith VE, Kloptenstein HS, Bommer WJ, Fried L, O'Leary D, Manolio TA : Sex age and disease affect echocardiographic left ventricular mass and systolic function in the free-living elderly: The cardiovascular health study. Circulation, 91:1739, 1995.

16. Fagard R, Staessen J, Thijis L, Amery A : Relation of left ventricular mass and filling to exercise blood pressure and rest blood pressure. Am J Cardiol, 75:53, 1995.

17. Chuang ML, Danias PG, Riley MF, Hibberd MG, Manning WJ, Douglas P : Effect of increase body mass index on accuracy of two-dimensional echocardiography for measurement of left ventricular volume, ejection fraction, and mass. Am J Cardiol, 87:371, 2001.

18. Lauer MS, Anderson KM, Larson MG, Levy D : A new method for indexing left ventricular mass for differences in body size. Am J Cardiol, 74:487, 1994.

19. Celentano A, Palmieri V, Espasito ND, Pietropaolo I, Crivaro M, Mureddu GF, Devereux RB, Simone G : Inappropriate left ventricular mass in normotensive and hypertensive patients. Am J Cardiol, 87:361, 2001.

20. Devereux RB, Lutas EM, Asale PN, Kligfield P, Eisenberg RR, Hammond IW, Miller DH, Reis G, Anderman MH, Laragh JH : Standardization of M-mode echocardiographic left ventricular anatomic measurements. J Am Coll Cardiol, 4:1222, 1984.

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