EFFECT OF BODY MASS INDEX ON LEFT VENTRICULAR MASS

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Abstract
Background: Increased left ventricular mass (LVM) as determined by 2-dimensioned M-mode echocardiography is a predictor of cardiovascular morbidity and mortality.
Objective: The aim of this study was to investigate the relationship between LVM and body mass index (BMI) categories in cross section study.
Methods: LVM were measured by using M-mode echocardiography in a sample of 160 individuals (male = 71, female = 89) with age ranging from 16-80 years, referred by a physician. Those with a positive history of hypertension (HT), diabetes mellitus (DM), coronary artery disease (CAD) constituted 82 individuals; the remaining 78 were regarded as a control group negative for cardiac apparent problems.
Results: Mean interior ventricular septum diastolic (IVSd), left ventricular posterior wall diastolic (LVPWd) and LVM were increased in cases group (the subjects with one or more of the following illness ((HT), (DM), and (CAD)) compared to normal control.

The mean IVSd, LVPWd showed a statistical of significant weak positive linear correlation with BMI while the mean of the left ventricular interior dimension diastolic (LVIDd) and LVM was significantly higher among obese subjects compared to the subjects with normal BMI among the total sample. Among the subgroup of controls, only the LVM retained its positive linear correlation with BMI.
Conclusions: LVM was positively associated with BMI and this association seems to be independent of other cardiac diseases associated with BMI.The remaining three parameters showed a weak association after adjusting for age, gender, and presence problems.

Keywords: Left ventricular mass (LVM), Body mass index (BMI), Interior ventricular septum diastolic (IVSd), left ventricular posterior wall diastolic (LVPWd), left ventricular interior dimension diastolic (LVIDd).

Introduction
Left ventricular mass (LVM) is a strong predictor of cardiovascular morbidity and mortality (1). Epidemiological studies demonstrate a general rise in LVM with advancing age, but whether this phenomenon is independent (i.e., of the aging process) or a function of coexisting disease states that accompany the aging process is not clear (2, 3 & 4).

Obesity is related to several disturbances in cardiac structure (5). Obese people have greater LVM, greater wall thickness and larger chamber size than those who are not obese (6). These aberrations in LVM and structure are great importance. Left ventricular hypertrophy (LVH) is one of the strongest rise factors of cardiovascular morbidity and mortality and an increase in relative wall thickness has been shown to increase cardiac vascular risk (7).

The relationship between obesity and coronary heart disease has been a subject of some dispute for many years. Results of the seven countries study revealed little correlation between body weight and incidence of coronary heart disease (8). In contrast, results from other studies that have shown increasing degrees of obesity are accompanied by greater rates of coronary heart disease (9, 10 & 11).

Systolic blood pressure and body mass index (BMI) as well as a series of hemodynamic and metabolic factors have been clearly identified in the development of an increased left ventricular (LV) thickness, as measured by two dimensional echo-cardiography (12, 13 & 14). Despite these known relationships,current use of non-invasive tools tends to underestimate the presence of increased left ventricular thickness, particularly among these individuals as noted in previous reports(15). Echocardiography has consistently been the most accurate non-invasive method for assessing left ventricular wall thickness in hypertensive individuals (16).

Objectives: the present study was designed with the aim to study the association between BMI and four cardiac parameters (Interior ventricular septum diastolic (IVSd), left ventricular posterior wall diastolic (LVPWd), left ventricular interior dimension diastolic (LVIDd) and left ventricular mass (LVM)). An attempt will be made to substation the possible effect of BMI on cardiac measurements whether it is independent of the effect of BMI on cardiac disease such as (Hypertension (HT), Diabetes mellitus (DM) and coronary artery disease (CAD).

Methods

The population consists of 160 samples. eighty two of them were cases group (subjects with one or more of the following illness (HT, DM, CAD) referred for a routine transthoracic echocardiogram at Ibn Al-Bitar Hospital for cardiac surgery between August 2008 to January 2009.BMI equal weight (kg)/(body height)^2 (m^2). Once a candidate was identified, a basic questionnaire was used to document clinical demographics including current or past treatment for hypertension, diabetes and coronary artery disease.

Hypertension was defined as systolic blood pressure of greater than or equal to 140 mmHg at rest, a diastolic blood pressure of greater than or equal to 90 mmHg at rest, or treatment with antihypertensive medication. Diagnosis of diabetes mellitus was determined on the use of medication by the patients. A history of coronary artery disease was considered a positive, when there were documented hospitalizations for myocardial infarction, unstable angina, or history of coronary bypass surgery. Height and weight were obtained to calculate the body mass index (Kg/m^2). Patients were categorized into three groups, groups I consisted of lean individuals with a normal BMI of < 25 Kg/m^2, group II of overweight individuals with BMI of 26-29.9 Kg/m^2 and group III were obese Individual with BMI of > 30 Kg/m^2.

Echocardiographic methods: echo-cardiographic studies were performed at rest with the patient at steady state in the left lateral position,using Philips medical Ultrasonograph. (Philips Envisor, ultrasound system). Two dimensional and Doppler Transthoracic were performed with a 2-5 MHZ transducer, guided M-mode measurements of left ventricular interior dimension diastolic (LVIDd)., Interior ventricular septum diastolic (IVSd) and left ventricular posterior wall diastolic (LVPWd) were measured. Left ventricular mass calculated using measurements of LVIDd, IVSP & LVPWd by using the following formula (17).

$$LVM = 0.8\times1.05\times[(IVSd + LVPWd + LVIDd)^3 - (LVIDd)^3].$$

Statistical analysis: Nominal variables were described as percentage, whereas continuous variables were described as mean ±standard deviation and range. Comparisons between groups for pre-test differences in independent variables were made using students t-test for unpaired samples. Bivariate analysis was performed calculating Pearson's linear correlation coefficient and analysis of variance (ANOVA) was used to test for differences in the outcome variables. A P value of less than 0.05 was considered significant and 95% confidence intervals calculated. All statistical analysis was performed using the Statistical Package for Social Sciences (SPSS).Multiple linear regression analysis were used to adjust for age, gender and study group in studying the association between BMI and cardiac measurements.

Results

The mean age of the study population was (46 ± 1.12 years), 55.6% were females. In this study 50% of the population was classified as obese, 31.9% as overweight and 18.1% normal weight based as body mass index(BMI) calculations(average BMI was 30.7 ± 0.5 Kg/m^2),range (18.1-57.1 Kg/m^2). Among these subjects, 51.3% had hypertension (HT), type -2 diabetes mellitus (DM) and coronary artery disease (CAD). Specific description of the demographic profile of the studied population is shown in Table (1).

Table (1)
Demographic of the study group.

	N	%
BMI-categories (Kg/m^2)		
Normal (<25)	29	18.1
Overweight (25-29.9)	51	31.9
Obese (30+)	80	50
Range	(18.1-57.1)	
Mean+/–SE	30.7+/–0.5	
Study group		
HT, DM, CAD	82	51.3
Controls	78	48.8
Gender		
Females	89	55.6
Male	71	44.4
Age group (years)		
< 40	46	28.8
(40-59)	84	52.5
60+	30	18.8
Total	160	100
Range	(16 - 80)	
Mean+/–SE	46.4+/-1.12	

body mass index (BMI) hypertension (HT), diabetes mellitus (DM), coronary artery disease (CAD).

The mean age of controls (39.1 years) was significantly lower than case group (53.3 years). BMI was also significantly lower among controls (28.9 Kg/m^2) compared to case group (32.4 Kg/m^2) (table 3).As shown in Table (2), a significantly higher proportion of obese had hypertension (55%) compared to 20.7% of normal BMI subjects.

Table (2)
Case group and body mass index categories.

	BMI-categories (Kg/m^2)						
	Normal (<25) (n = 29)		***Overweight (25-29.9) (n = 51)***		***Obese (30+) (n = 80)***		
	N	***%***	***N***	***%***	***N***	***%***	***P***
Hypertension	6	20.7	21	41.2	44	55	0.005
diabetes mellitus	2	6.9	12	23.5	13	16.3	0.16 [NS]
Coronary artery disease	4	13.8	14	27.5	15	18.8	0.29 [NS]

P < 0.05 body mass index (BMI).

Table (3)
Correlations between case group, controls and age, body mass index.

	Study group		***P (t-test)***
	HT, DM, CAD (n = 82)	***Controls (n = 78)***	
Age in years			<0.001
Range	(24 - 80)	(16 - 71)	
Mean+/–SE	53.3+/–1.29	39.1+/-1.46	
BMI (Kg/m^2)			<0.001
Range	(20.5 - 57.1)	(18.1 - 44.4)	
Mean+/–SE	32.4+/–0.75	28.9+/-0.6	

P<0.05 significant hypertension (HT), diabetes mellitus (DM), coronary artery disease (CAD).

The mean of IVSd was significantly higher among cases group (1.3 cm) compared to controls (1.1 cm). The mean of LVPWd was significantly higher among case group (1.3 cm) compared to controls (1.2 cm). The mean of LVM was significantly higher among case group (239.8 g) compared to controls (202.7 g). The mean of LVIDd showed no important or statistically significant in case controls difference (Table (4)).

Based on a sample size of 78 apparently healthy controls, the normal range of values based on the 95%confidence interval for value IVSd (0.71-1.5) cm, LVPWd (0.81-1.6) cm, (LVIDd) (3.5-5.9) cm & LVM (83.5-321.9) g (Table (5)).

Table (4)
Selected Echocardiography measurements in case group and control subjects.

	Study group		
	HT, DM, CAD (n = 82)	***Controls (n = 78)***	***P (t-test)***
IVSd (cm)			<0.001
Range	(0.8 - 1.7)	(0.7 - 1.7)	
Mean+/–SE	1.3+/–0.02	1.1+/-0.02	
LVPWd (cm)			0.004
Range	(0.7 - 1.7)	(0.8 - 1.6)	
Mean+/–SE	1.3+/–0.02	1.2+/–0.02	
LVIDd (cm)			0.27[NS]
Range	(3.6 - 6)	(3.2 - 6)	
Mean+/–SE	4.8+/–0.06	4.7+/–0.06	
LVM (g)			<0.001
Range	(133 - 451.6)	(97.7 - 419.7)	
Mean+/–SE	239.8+/–6.87	202.7+/–6.88	

P<0.05 significant Interior ventricular septum diastolic (IVSd), left ventricular posterior wall diastolic (LVPWd), left ventricular interior dimension diastolic (LVIDd) and left ventricular mass (LVM).

Table (5)
The range of normal values among controls for selected measurements based on the 95% confidence interval for values (mean +/– (1.96 X SD)).

IVSd (cm)	(0.71 - 1.5)
LVPWd (cm)	(0.81 - 1.6)
LVIDd (cm)	(3.5 - 5.9)
LVM (g)	(83.5 - 321.9)

Interior ventricular septum diastolic (IVSd), left ventricular posterior wall diastolic (LVPWd), left ventricular interior dimension diastolic (LVIDd) and left ventricular mass (LVM)

As shown in Table (6) the mean IVSd & LVPWd should very small &statistically insignificant increase with BMI order categories.The BMI however showed a statistically significant weak positive linear correlation (trend) with IVSd and LVPWd. The mean (LVIDd) was significantly higher (4.9 cm) among obese subjects compared to the subjects with normal BMI (4.7 cm). Also the mean of LVM was significantly higher (237.2 g) among obese subjects compared to the subjects with normal BMI (206.2 g). The association between BMI ordered categories and selected cardiac measurement may test in the overall sample.

Among apparently healthy controls (Table (7)) the mean of each of the three cardiac measurements (IVSd, LVPWd, and LVIDd) among obese controls were either slightly higher or not different from that with normal BMI.The observed linear correlation between the parameters (IVSd, LVPWd and LVIDd) & BMI was small & not significant statistically except for LVM.

Table (6)
Selected echocardiography measurements with body mass index categories in all study group.

Total sample (Mean =/–SE)	*Normal (<25) (n = 29)*	*Overweight (25-29.9) (n=51)*	*Obese (30+) (n=80)*	*P (ANOVA)*
IVSd (cm) r=0.176, P=0.026	1.1+/–0.04	1.2+/–0.03	1.2+/–0.02	0.22[NS]
LVPWd (cm) r=0.171, P=0.031	1.1+/–0.03	1.2+/–0.03	1.2+/–0.02	0.06[NS]
LVIDd (cm) r=0.256, P=0.001	4.7+/–0.11	4.6+/–0.08	4.9+/–0.06	0.037
LVM (g) r=0.336, P<0.001	206.2+/–11.71	206.3+/–8.11	237.2+/–7.29	0.009

P<0.05 significant Interior ventricular septum diastolic (IVSd), left ventricular posterior wall diastolic (LVPWd), left ventricular interior dimension diastolic (LVIDd) and left ventricular mass (LVM).

Table (7)
Selected echocardiography measurements with body mass index categories in control only.

Controls only	*Normal (<25) (n=20)*	*Overweight (25-29.9) (n=26)*	*Obese (30+) (n=32)*	*P (ANOVA)*
IVSd (cm) r=0.18, P=0.11[NS]	1.1+/–0.04	1.1+/–0.04	1.1+/–0.04	0.37[NS]
LVPWd (cm) r=0.177, P=0.12[NS]	1.1+/–0.04	1.2+/–0.04	1.2+/–0.03	0.43[NS]
LVIDd (cm) r=0.167, P==0.14[NS]	4.7+/–0.14	4.6+/–0.12	4.8+/–0.09	0.52[NS]
LVM (g) r=0.244, P=0.032	192.5+/–14.71	197.3+/–11.59	213.5+/–10.45	0.42[NS]

P<0.05 significant Interior ventricular septum diastolic (IVSd), left ventricular posterior wall diastolic (LVPWd), left ventricular interior dimension diastolic (LVIDd) and left ventricular mass (LVM).

After adjusting for age, gender & study group, the BMI had a statistically significant &positive association with LVM. An increase in BMI from normal to overweight is expected to increase the LVM by 22.2 g. A further increases in BMI to obese will result in another 22.2 g increase in LVM (Table (8)).

Table (8)
Partial regression coefficient for cardiac parameters.

BMI	*Partial regression coefficient for BMI*	*P*	*P (Model)*	R^2
IVSd (cm)	0.04	0.06[NS]	<0.001	0.251
LVPWd (cm)	0.05	0.008	<0.001	0.17
LVIDd (cm)	0.14	0.02	<0.001	0.13
LVM (g)	22.2	<0.001	<0.001	0.35

P<0.05 significant Interior ventricular septum diastolic (IVSd), left ventricular posterior wall diastolic (LVPWd), left ventricular interior dimension diastolic (LVIDd) and left ventricular mass (LVM).

Discussion

In this study we analyzed the effect of BMI on LVM in cross sectional study.Obesity was the strongest predictor of LVM in this population, and its effects on LVM were additional to the clear and independent effects of age, (Hypertension (HT), Diabetes mellitus (DM) and cornary artery disease (CAD).

As shown in the results of this study, there is a significant increase in IVSd & LVPWd as measured by two dimension echocardiography among cases group (HT,DM&CAD) compared to control these results were in agree with other study (18). Achille et al. (19) found the LVPWd and mean IVSd were increased in hypertensive patients compared to normal.Previous study (20) shows diabetic, hypertensive patients had greater interventricular septal thickness, LVPWd than nondiabetic hypertensive patients. LVM in the present study was significantly higher among case group compared to controls as previous study showed the LVM were greater in the hypertensive patients than in the normotensive control subjects (21). In our study the large no. of cases group were with hypertension. In hypertension, inappropriate development of wall stress with eventual compromise in left ventricular fiber shortening is a well-characterized mechanism. In addition; several other humoral mechanisms have also been recognized in the development of adverse cardiovascular risk (22).

Results of the present study found weak correlation between BMI and IVSd and LVPWd, these results partly agree with the study of Rajini et al. (22) who found no correlation between BMI and IVSd and LVPWd the weak or absent association between BMI and these parameters could be attributed to the small number of severely obese subjects in the study sample. Lack of knowledge regarding the duration of the weight status were critical determinants in an attempt to explain the lack of an increased left ventricular thickness.

The results of our study showed that LVM was associated with increased BMI.The relationship between LVM & obesity has been well documented (23) and this relationship in other studies has been confirmed (24, 25). Results of the previous study found LVM was strongly related to obesity in normotensive adults especially in female (26) and the study of Micheal et al. (27) Found the BMI was strongly correlated with LVM after adjusting for age & blood pressure.

Pathological examination of the gross & microscopic anatomy of heart of patients with marked chronic obesity showed the heart weight to be considerably greater than predicted by extrapolation from ideal body weight, with LV dilation and hypertrophy and occasionally right ventricular hypertrophy (28). This increase was due mostly to myocardial hypertrophy, occasionally associated with myocardial fibrosis, and not to excess epicardial fat or fat infiltration of the myocardium, previously thought to be principle features of the obese heart (29).

In summary LVM was positively associated with BMI and this association seems to be independent of other cardiac disease associated with BMI. The remaining three parameters showed a weak association after adjusting for age, gender, and presence problems. Therefore, on the results of this study, a prospective study is needed to further define the sequence of cardiac abnormalities that do occur with increasing BMI in order to identify associated clinical manifestation of these cardiac abnormalities but also evaluate the potential use of echocardiography in the follow –up of these patients with aggressive therapeutic interventions.

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الخلاصة

تعتبر تقنية تخطيط صدى القلب بالموجات الفوق الصوتية من نوع ام مود أحدى الطرق الشائعة لحساب كتلة البطين الأيسر إن اي زيادة في كتلة البطين الأيسر تعتبر مؤشر مهم في تحديد الحالة المرضية لعضلة القلب.

الهدف من الدراسة :تهدف هذه الدراسة أيجاد علاًقة بين كتلة البطين الأيسرLVM وبين معامل كتلة الجسم BMI .

طريقة العمل : تم قياس بواسطة جهاز تخطيط صدى القلب بالموجات الفوق الصوتية لـ 160 شخص (71 من الذكور، و 89 من الأناث) و بأعمار تتراوح ما بين 16-80 سنة.تم تقسيم عينة الأشخاص الى مجموعتين :مجموعة تمثل 82 شخص مصابين بأمراض القلب وهي :ضغط الدم العالي (HT)،البول السكري (DM)، و مرض الشريان التاجي (CAD). ومجموعة عددهم (78) شخص تتمثل بالأشخاص الأصحاء السليمين من أمراض القلب.

النتائج : تبين الدراسة أن كل من :معدل الفاصل الأمامي لأنبساط البطيني الأيسر IVSd و المعدل الجدار الخلفي للأنبساط البطيني LVPWd و كتلة البطين الأيسر LVM كانتا تظهر زيادة مؤشرة عند مجموعة الأشخاص المرضى بأمراض القلب.أما معدل قيمتي كل من IVSd وLVPWd

فقد أظهرتا علاقة أرتباط ضعيفة مع معامل كتلـــة الجـــسم BMI. أن قطر البطين الأيسر في حالـــة أنبـــساط عـــضلة القلب (LV1Dd) وكتلة البطين الأيـــسر (LVM) كانتـــا عالية جداً عند الشخص البدين مقارنـــة مـــع الـــشخص ذو الوزن الطبيعي. كما و بينت الدراسة و جود علاقة أرتبـــاط أيجابية بين LVM و BMI عنـــد مجموعـــة الاشـــخاص الأصحاء.

الأستنتاجات: نستنتج من هذه الدراسة أن هناك علاقة أرتباط أيجابية بين LVM والـــBMI ، وأن هذه العلاقة لا تعتمـــد على وجود امراض في القلب لها علاقة مـــع BMI. لهـــذا نقترح الى المزيد من البحث لمعرفة تأثير BMI على وجود أمراض قلبية.

مفتاح الكلمات : كتلة البطين الأيـــسر (LVM) ، معامـــل كتلة الجسم (BMI) ، الفاصل الامامي البطيني فـــي حالـــة إنبساط القلب (IVSd) ، الجدار الخلفي لأنبـــساط البطـــين الأيسر (LVPWd)، أبعاد البطين الأيسر في حالة إنبـــساط القلب (LVIDd).