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EFFECTS OF BODY MASS INDEX ON LEFT VENTRICULAR FUNCTION AND STRUCTURE AMONG A SAMPLE OF APPARENTLY HEALTHY ADULTS IN ERBIL CITY-IRAQ.

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Abstract

Background and objectives

Increasing body mass index (BMI) can affects left ventricular (LV) structure and function. This study was arranged to determine the effects of BMI on LV structure and function among a sample of apparently healthy adults in Erbil-Iraq.

Subjects and Methods: *This cross-sectional study was conducted on two-hundred apparently healthy adults with different BMI. The participants were classified into four groups according to their BMI as normal weight (group 1), overweight (group 2), obese (group 3), and extreme obese (group 4). LV structure and function were assessed by echocardiography .The effects of BMI on LV structure and function were evaluated on all studied groups.*

Results: *Compared to group1, all other groups had significant higher LV structures, LV mass (LVM) and LVM index (LVMI) . LV structures , LVM and LVMI were significantly increased with increasing BMI. LV diastolic dysfunction (DD) was significantly higher in all obese groups (2,3 and 4) compared to group 1. The prevalence, but not the indices, of LV DD were significantly increased with increasing BMI. LV systolic function showed no significant changes between all studied groups. LVDD was significantly seen in both genders, but in females more than males.*

Conclusion

In the present study, increasing BMI was associated with abnormalities in LV structure and subclinical diastolic dysfunction, more evident in females than in males.

Key Words: Body Mass Index, Left Ventricular Function, Diastolic Dysfunction.

Introduction

Obesity is a chronic and multifactorial disease, which represents a high risk for health[1]. It is a public health problem that has reached epidemic proportion in adults and children[2].It is often associated with conditions that increase cardiovascular risk, including: dyslipidemia, systemic arterial hypertension (SAH), glucose intolerance, and left ventricular hypertrophy (LVH). [3] Obese individuals have a 104% increase in the risk of developing heart failure (HF) compared with nonobese ones[4].

Recently, there is a growing number of studies on the relation of body weight to left ventricular structure and function.[5] The impairment in left ventricular relaxation is one of the effects of obesity on left ventricular function, regardless of the existence of other comorbidities[6]. The presence of diastolic dysfunction of the left ventricle (LV), in the general population, is associated with the development of HF and shorter survival[7].

The high prevalence of obesity, increased risk of Diastolic Heart failure (DHF), the frequent association with comorbidities that increase cardiovascular risk and the fact that it is an independent and modifiable risk factor for the development of several diseases, require a thorough echocardiography investigation in obese individuals, in order to identify patients at higher risk, so that intervention measures can be carried out early. The aim of this study is to evaluate the effect of BMI on Left ventricular function and structure among a sample of apparently healthy adults in Erbil city –Iraq.

Subjects and methods

This prospective, cross-sectional study was carried out in the Rizgary and Erbil teaching hospitals from April 2015 to April 2016. A convenience sample of 200 consecutive apparently healthy adults (78 males and 122 females), aged 18 to 50 years were enrolled in this study. All patients were assessed by a detailed history and physical examination. Patients with hypertension, diabetes mellitus, mechanical heart failure, and established ischemic heart disease were excluded.

BMI (Body Mass Index, weight/height^2) was calculated, and according to a standard definition, normal weight was defined as BMI =18.5-24.9 kg/m^2, an overweight as BMI = 25-29.9 kg/m^2, an obesity as BMI = 30 -39.9kg/m^2 , and extreme obese as BMI ≥40 kg/m^2. [9]

According to BMI, the study subjects were classified into four groups: group I, normal weight included 50 subjects (BMI=18.5-24.9 kg/m^2); group II, overweight group included 62 subjects (BMI= 25 and 29.9 kg/m^2); group III, obese group included 48 subjects (BMI = 30- 39.9kg/m^2) and group IV, extreme-obese included 40 subjects (BMI≥40 kg/m^2). Demographic, clinical, and echocardiographic characteristics were evaluated for all groups.

All echocardiograms were performed by two expert cardiologists using an appropriate echocardiography device. M-mode, Two-dimensional and Doppler (pulsed, color and tissue) echocardiography in the parasternal (longitudinal and transverse) and apical (two, four and five chambers) windows was used to evaluate cardiac chamber dimensions and LV systolic and diastolic functions in the study groups. The LV structures [interventricular septum (IVS), posterior wall (PW) and left atrium (LA)] left ventricular mass (LVM), LVM index (LVMI), and relative wall thickness (RWT) were assessed properly. LV systolic function was assessed by ejection fraction (EF) while LV diastolic function was assessed by maximum velocity of passive transmitral inflow (E), maximum velocity of active transmitral inflow(A), ratio of passive to active velocity (E/A), isovolumetric relaxation time(IVRT) (ms), deceleration time (DT) (ms) and E/e' ratio. Diastolic dysfunction was classified as **grade I** (impaired or slow relaxation) when E/A < 0.8, DT > 200 ms , prolonged IVRT(>100) and E/e' <8 ; **grade II** (pseudo-normalized pattern,) when E/A=0.8 to 1.5, DT=150-200 ms ,normal IVRT (50-100)and E/e' =9-13; and **grade III** (restrictive pattern,) when E/A ≥2, DT < 150 , IVRT≤60 and E/e' ≥13. All diameters were measured according to established standards of the American Society of Echocardiography[10, 11]

The data were collected by interviewing the patients using a questionnaire designed by the researchers. The questionnaire included information about socio-demographic data (age, gender, marital status, …), hypertension, risk factors like (hyperlipidemia, IHD, DM), and history of smoking and alcoholism.

Ethical considerations: The study protocol was approved by the ethics committee of the College of Medicine of Hawler Medical University. This study was conducted by using an informed verbal consent from the patients prior to participation in the study. The purpose of the study was carefully explained to each patient.

Statistical analysis of data

Data were analyzed using the statistical package for social sciences (SPSS, version 19). Student's t test for two independent samples was used to compare means. A 'P' value of ≤ 0.05 was considered as statistically significant.

Results:

The study population consisted of 200 participants; 82 (41%) males, and 118 (59%) females, with mean (SD) age 39.9±9.3 years, ranging from 18 to 50 years. They were classified according to BMI into four groups. Table 1 describes the baseline, biochemical, and echocardiographic data of the study population and compares between different measurements.

As shown in Table 1, The left ventricular structures (IVS, RW, LA), LVM, and LVMI were significantly higher (P <0.001) in the obese groups(II, III and IV) compared to the normal weight group (I), while EF showed no significant difference (P= 0.89).

Most of left ventricular diastolic function indices show significant differences. E/A ratio was significantly lower (P<0.001) while A, IVRT, DT and E/e' ratio were significantly higher (P<0.001, 0.003, 0.002 and 0.004 respectively) in the obese groups compared to normal weight group.

Table 2 compares between different measurements among the obese groups only. IVS, PW, LA, LVM and RWT showed a significant increase (P= <0.001, <0.001, 0.006, 0.026 and 0.001 respectively) with increasing BMI.

No significant differences were found among left ventricular diastolic function indices apart from significant increase (P=0.045) in E/e' ratio with increasing BMI.

Table 3 shows the distribution of diastolic dysfunction according to BMI in males and females. Abnormal diastolic dysfunction (DD) was prevalent in 42(21%) participants, 20 of them (47.6%) with G1DD and 22 (52.3%) with G2DD. No case was detected with G3DD.

According to BMI groups, there was no diastolic dysfunction (DD) in group I (normal weight group), while from 62 subjects of group II (overweight group), DD was present in 8 (12.9%) participants, 5 of them (62.5%) with G1DD and 3 (37.5%) with G2DD. From 48 subjects in group III (obese group), 15 (31.25%) participants had DD, 6 of them (40%) with G1DD and 9(60%) with G2DD. In group IV (extreme obese), 19 (47.5%) subjects out of 40 had DD. From those 19 subjects, 10 (52.6%) had G1DD and 9 (47.4%) had G2DD.

Out of 42 subjects with DD, 31(73.9%) subjects were females and 11(26.1%) were males. From 20 subjects with GIDD, 13 (65%) subjects were females and from 22 subjects with G2DD, 18 (81.8%) subjects were females. Female gender was also predominant in all study groups.

From five subjects of group II with G1DD, 4(80%) of them were females while the three (100%) subjects with G2DD were all females. In group III (obese group), there were 6 subjects with G1DD, 4(66.6%) of them were females while the 9 subjects with G2DD, 6 (66.6%) of them were females. In group IV subjects, there were 9 subjects with G1DD, 5 (55.5%) of them were females while the 10 subjects with G2DD, 9 (90%) of them were females.

Discussion

In this study, our obese participants who were apparently healthy showed many abnormalities in both LV structures (IVS, PW, LA, and RWT) and diastolic function. This is in parallel to many other studies who had reported a close correlation between degree of obesity (represented by BMI) and alterations in both cardiac function and structures.[5-7] In addition; the present study showed that LV structures and LVM were increased consistently with BMI. This is compatible with Peterson et al study[12] and Valocik et al study.[13] Many causes of the increased LV mass in obese persons had been suggested, those include; increase in the total blood volume as a result of an increase in the size of vascular bed, which will lead to an increase in cardiac output and resultant increased after load, subsequently, those changes may induce cardiac hypertrophy and alterations in LV structure. [12-14] In the present study, our obese participants showed significant alterations in LV diastolic, but not systolic, function, as compared to normal BMI participants. All LV diastolic indices, apart from E-wave velocity, showed significant changes. The results of present study were similar to other studies[15]and unlike othres[16]. Our study also showed that the prevalence of LV DD was significantly increased with increasing BMI. Although the precise mechanisms by which BMI affects cardiac function are still not well understood, nevertheless, with increasing body adiposity, changes in cardiac metabolism occur, leading to myocardial fatty infiltration, inflammation and cardiac toxicity, with end result of DD.[4, 17]

In addition, our study showed that E, A, E/A, IVRT and DT values did not change with increasing BMI, and this agrees with other studies[13, 18]. In this study, no significant relationship was found between LVEF and BMI. This is in accordance with other studies[19, 20] and against others.[14] In the present study, LVDD was significantly seen in both genders, but in females more than males. This is in accordance with study done by Giovanni et al which found that obesity influenced LV function more in females than in males and was explained by the possibility of biological factors associated with female adiposity.[21]

Conclusion

In the present study, increasing BMI was associated with abnormalities in LV structure and subclinical diastolic dysfunction, more evident in females than in males.

Conflicts of interest

None declared.

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Table1. Baseline, biochemical and echocardiography characteristics of study population.

Variables	Total study Sample (n=200)		Group I (Normal) (n=50)		Group II, III and IV (Over weight, obese and extreme obese) (n=150)		p
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Age	39.9	9.3	38.7	8.4	41.1	9.9	0.09
Weight	74.21	14.7	62.3	3.9	86.05	11.71	<0.001
height	159.1	6.9	160.4	5.1	157.8	6.8	0.71
BMI	29.1	6.8	23.4	0.9	35	5	<0.001
SBP	125	8.8	120.5	8.29	130	6.5	<0.001
DBP	79.8	4.7	78	2.8	81.2	5.6	<0.001
HR	74.3	2.4	73.7	2.2	74.9	2.81	0.19
Cholesterol	167.1	29.3	145.4	20.5	188.9	18.6	<0.001
TG	119.7	32	99.5	19.1	140	29.5	<0.001
LDL	80.9	17.9	71.5	4.3	90.3	21.1	<0.001
HDL	39.6	4.6	41.8	1.8	36.5	6.1	0.01
LVDD	44.27	3.8	41.25	1	47.3	3.2	<0.001
LVSD	28.9	2.2	28.8	1.27	29.1	2.96	0.58
EF	62.1	3.6	62.4	3.5	61.8	3.9	0.89
IVS	9.22	0.97	8.25	0.5	9.85	0.9	<0.001
PW	8.5	0.89	7.86	0.3	9.14	0.82	<0.001
Left atrium	29.24	4.5	25.12	1.25	33.6	2.2	<0.001
LVM	128.8	31.3	102	9.18	156.7	20.4	<0.001
LVMI	71	12.9	60.66	5.3	84.8	9.4	<0.001
RWT	0.38	0.03	0.38	0.01	0.38	0.04	0.5
E	0.79	0.1	0.8	0.03	0.78	0.13	0.4
A	0.66	0.1	0.6	0.02	0.72	0.12	<0.001
E/A	1.21	0.24	1.3	0.05	1.11	0.31	<0.001
IVRT	91.75	10.6	89.16	1.56	95.32	14.7	0.003
DT	194.1	12.7	190.98	3.1	197.38	17.41	0.002
E/e'	7.34	1.57	6.97	0.1	7.71	2.2	0.004

Table-2. Baseline, biochemical and echocardiographic characteristics of overweight, obese and extreme obese patients.

Variables	Group II (Overweight) (n=62)		Group III (Obese) (n=48)		Group IV (Extreme obese) (n=40)		p
	Mean	SD	Mean	SD	Mean	SD	
Age	43.1	7.1	40.7	10.4	42.7	11.7	0.66
Weight	74.2	6.3	89.16	10.7	101.5	12.4	<0.001
Height	160.2	4.16	156	7.3	152.1	5.4	0.006
BMI	28.3	1	36.6	4.1	44.78	3	<0.001
SBP	129.2	6	129.7	7	133.4	3.8	0.35
DBP	78.8	7.7	82.2	4.6	84	2.1	0.046
HR	73.1	0.8	74	0.76	74.7	1.41	0.064
EF	60.9	5.9	61.2	5.9	61.9	4.2	0.058
IVS	9.2	0.5	10	0.89	10.85	0.3	<0.001
PW	8.96	0.63	9.3	0.75	10	0	<0.001
Left atrium	31.7	1.9	33.8	2.4	34.4	2.5	0.006
LVM	145.6	9.4	158.2	22.6	170.2	20.2	0.026
LVMI	80.8	5.6	82.54	10.5	84.8	7.1	0.56
RWT	0.36	0.05	0.39	0.04	0.42	0	0.001
E	0.8	0.05	0.78	0.15	0.75	0.16	0.72
A	0.69	0.1	0.72	0.13	0.78	0.17	0.32
E/A	1.18	0.16	1.11	0.34	1.03	0.4	0.55
IVRT	92	7.2	95.7	15.6	99.2	14.8	0.2
DT	194.4	6.7	198	18.9	202.2	14.9	0.58
E/e'	7.13	0.38	8.1	2.4	9.7	3.7	0.045

Table-3.Distribution of diastolic dysfunction (DD) according to BMI in males and females

Gender	BMI groups								**P-value**
	Group I		Group II		Group III		Group IV		
	Normal n. (%)		Overweight n.(%)		Obese n.(%)		Extreme Obese n.(%)		
Males	24 (12)		22 (11)		20 (10)		16 (8)		**<0.001**
	DD		DD		DD		DD		
	Present	Absent	Present	Absent	Present	Absent	Present	Absent	
	0(0)	0(0)	1(4.55)	21(95.5)	5(25)	15(75)	5(31.25)	11(68.75)	
Females	26 (13)		40(20)		28(14)		24(12)		**<0.001**
	DD		DD		DD		DD		
	Present	Absent	Present	Absent	Present	Absent	Present	Absent	
	0(0)	0(0)	7(17.5)	33(82.5)	10(35.7	18(64.3)	14(58.3)	10(41.7)	
Total	50 (25)		62 (31)		48 (24)		40 (20)		**<0.001**
	DD		DD		DD		DD		
	Present	Absent	Present	Absent	Present	Absent	Present	Absent	
	0(0)	0(0)	6(9.7)	44(90.3)	15(31.2)	33(68.8)	19(47.5)	21(52.5)	