Anthropometric Measurements as Cardio-Metabolic Risk Factors Did Not Associate with Echocardiography Determinants in Type 2 Diabetes

Ismail Ibrahim Hussein* PhD

ABSTRACT

Background: Obesity and type 2 diabetes are risk factors for cardiovascular events. Anthropometric measurements are considered as independent risk factors for these events.
Objectives: To assess the link between anthropometric measurements that are considered as risk factors for cardiovascular events and echocardiography determinants in type 2 diabetes.
Methods: A total number of 50 type 2 diabetes patients (20 males and 30 females) with a mean age of 58.8 years were included in this study. Anthropometric measurements that related to the cardio-metabolic risk factors were determined. These included height, weight, waist circumference, hip circumference, neck circumference and mid-thigh. Echocardiography investigation using B-mode (2-4 MHz frequency) was established. The following echocardiography data were obtained: shortening fraction (%), stroke volume (ml), ejection fraction (%), end systolic volume (ml), end diastolic volume (ml), left ventricular posterior wall (systole). Left ventricular diastolic function assessed by measuring E/A ratio using pulse wave Doppler.
Results: Forty seven (94%) patients have value of BMI 32.5 kg/m^2 and 64% have waist circumference ≥ 102 cm. Low mid-thigh and high neck circumferences were found in 88% and 72%, respectively. Echocardiography data showed the patients have the lower limit of normal ejection fraction (%). Abnormal E/A ratio have been observed in 10% of cases. Ejection fraction, stroke volume, end systolic, and diastolic volume did not correlate with anthropometric measurements which are related to cardio-metabolic risk factors.
Conclusion: Abnormal echocardiograph data in type 2 diabetes are unlikely to be attributed to the impact of obesity or to the any anthropometric measurements that linked to cardio-metabolic risk factors.
Keywords: Type 2 diabetes mellitus, Body mass index.

Iraqi Medical Journal Vol. 65, No. 1, January 2019; p.30-36.

There are several risk and predisposing factors for cardiovascular events. One of these is the anthropometric measurements. Obesity as determined by body mass index is associated with hypertension, ischemic heart diseases, heart failure and cardiac arrhythmias(1). Body mass index (BMI) predicted coronary artery disease, stroke and peripheral arterial disease, but these associations were no longer statistically significant after adjustment for hypertension, diabetes and dyslipidemia(2). Morbid obesity (BMI ≥ 40 kg/m^2) altered the systolic and diastolic function of the heart.

Wierzbowska-Drabik *et al.* reported that systolic and diastolic circumferential; and systolic radial strain; and strain rate were declined in the obese subjects(3). Central obesity as determined by waist circumference and/or waist hip ratio is included as a criterion of metabolic syndrome. Abdominal (or metabolic) obesity is an independent risk factor for the development of heart failure and once heart failure is established, obesity is regarded as a better prognostic factor; this phenomenon is called "obesity paradox"(4). Tissue significantly associated with metabolic derangement including insulin resistance, small dense particle of low-density lipoprotein and increased low-density lipoprotein particle number as well

*Al-Mustansiriya University, College of Medicine, Department of Physiology.

as associated with prevalent diabetes, metabolic syndrome, hepatic steatosis, and aortic plaque(5). In patients complained from coronary artery disease, normal weight with central obesity (metabolically obese with normal weight) was associated with the highest risk of mortality(6). Measurement of neck circumference is a predictor of cardiovascular events. In one recent study, neck circumference is positively correlated with blood pressure, serum glucose, triglycerides and high sensitive C-reactive protein and inversely correlated with high-density lipoprotein(7). Androutsos et al. 2012 found that neck circumference is associated with other anthropometric measurements that are linked with cardiovascular events in children(7,8). Thigh subcutaneous adipose tissue is positively associated with insulin sensitivity and patient with decrease thigh adipose tissue are the most insulin resistant(9). Heitmann and Frederiksen, 2009 found that a small thigh circumference was associated with an increased risk of ischemic heart disease and mortality in both men and women. Type 2 diabetes (T2D) is associated with obesity and is considered as a strong risk factor for ischemic heart disease(10). The aim of this study is to look for the association between anthropometric measurements that considered as risk factors for cardiovascular events and echocardiography determinants in T2D.

Methods

This study was done in Department of Physiology, College of Medicine, Al-Mustansiriya University in cooperation with the Unit of Echocardiogaphy at Al-Yarmouk Teaching Hospital in Baghdad, Iraq during 2011. This study is approved by an institutional review committee and the informed consent has been obtained from each patient prior to enrollment in the study. This study is designed as an observation in cohort patients with T2D. The criteria of inclusion were patients with T2D of both genders. The criteria of exclusion were patients with a history of renal, hepatic or thyroid diseases. A total number of 50 patients (20 males and 30 females) with a mean age 58.8 years were included in this study.

Anthropometric measurements related to the cardio-metabolic risk factors were determined. These included height (m), weight (kg), waist circumference (cm), hip circumference (cm), neck circumference (cm) and mid-thigh (cm). Waist circumference measured at midpoint between the lowest rib and the iliac crest. Hip circumference measured at the maximum borders of buttock that is at the groin level (in women) and about 5-10 cm below the navel (in men). The neck circumference is determined just above the thyroid cartilage at a position head up and looking straight ahead. Mid-thigh measurement is determined on the right side of the body by asking the subject to stand and the circumference measure is taken at the level of the mid-point on the lateral (outer side) surface of the thigh, midway between trochanterion (top of the thigh bone, femur) and tibias later (top of the tibia bone). All the measurements were determined to nearest 0.1 cm. The body mass index (BMI), waist/hip ratio (W/H) and waist /height ratio (W/He) were calculated. The anthropometric measurements categorized as shown in Box 1(10-12). The blood pressure was recorded on sitting position and the mean of three readings was taken. The pulse and mean arterial blood pressures were calculated using the following equations:

Pulse pressure (mmHg) = Systolic blood pressure-diastolic blood pressure

$$\text{Mean arterial blood pressure (mmHg)} = \text{Diastolic blood pressure} + 1/3 \text{ pulse pressure}$$

The systolic left ventricle function is assessed by echocardiography (B mode). The echocardiography performed from the patient's left side so that the transducer (with a frequency of 2-4 MHz) is at the long axis of the heart. Echocardiography data that related to systolic left ventricular dysfunction were recorded and these included shortening fraction (%), stroke volume (ml), ejection fraction (%), end systolic volume (ml), end diastolic volume (ml), left ventricular posterior wall (systole).

Fractional shortening of the left ventricle is determined using the following equation:

$$\frac{\text{End diastolic dimension} - \text{End systolic dimension}}{\text{End diastolic dimension}} \text{x}100$$

The diastolic left ventricle function is assessed by sample volume (size 2 mm) of the pulsed wave. Doppler was placed between the tips of the mitral leaflets in the apical four-chamber view. Early (E) and late (A) trans mitral flow velocities. The ratio of early to late peak velocities (E/A) was obtained. E denotes the trans-mitral early diastolic rapid filling whereas A denotes the trial contraction at filling.

The data are presented as means ± SD. Unpaired Student's t-test and multi-variant correlation test were used for evaluation. For all tests, a two-tailed $p \le 0.05$ was considered statistically significant. All calculations were made using Excel 2003 program for Windows.

Results

A total number of 50 patients (20 males and 30 females), their mean ±SD age was 58.8±8.0 years and mean fasting serum glucose level 201±7.3 mg/dl were admitted in the study. Tables 1 and 3 show the anthropometric measurements of patients enrolled in the study. Forty-seven (94%) patients were overweight-obese with a mean ±SD value of body mass index was 32.47±5.62 kg/m^2. Thirty-two (64%) patients have waist circumference ≥ 102 cm. indicated central obesity. The majority of cases have a waist/hip and waist/height ratios more than the cut-off level of healthy subjects. Mid-thigh and neck circumferences were higher than the normal levels in 88% and 72%, respectively.

Table 2 shows that the mean systolic and diastolic blood pressures were in the hypertensive level. The mean arterial and pulse pressures were 112.4 mmHg and 55 mmHg respectively. Echocardiography data showed the patients have the lower limit of normal ejection fraction (%), (Table 2).

Echocardiography data including ejection fraction (%), stroke volume, end systolic or diastolic volume did not correlate with anthropometric measurements as a cardio-metabolic risk factors; body mass index (Figure 1); waist/hip ratio (Figure 2); neck circumference (Figure 3); and mid-thigh circumference (Figure 4). Peak E and A velocity of the mitral inflow, the peak E velocity decreased and peak A velocity increased, therefore the mean E/A ratio reversed (i.e. was < 1) were observed in five patients only (2 male and 3 female).differences between the two groups.

Table 1: Categorization of anthropometric measurements.

Anthropometric Measurement or Index	**Normal**	**Overweight**	**Obese**
Body mass index (kg/m^2)	< 25	25-29	≥ 30
Waist /hip ratio			
Male	<0.90	0.90-0.94	≥0.95
Female	<80	80-87	≥ 88
Neck circumference (cm)			
Male		>41.6	
Female		>37	
Mid-thigh (cm)	> 60		

Table 2: Anthropometric measurements.

Weight (kg)	85.02±14.02
Height (m)	1.621±0.094
Body mass index (kg/m²)	32.47±5.62
< 25 kg/m²	3(6%)
25-29 kg/m²	13(26%)
≥ 30 kg/m²	34 (68%)
Waist circumference (cm)	102.56±14.1
Hip circumference (cm)	107.84±13.0
Waist/Hip ratio	0.956±0.124
Male (0.9)	17(85%)
Female (0.8)	29(96.7%)
Waist/Height ratio	0.634±0.096
Mid-thigh circumference (m)	47.56±11.75
< 0.6 m	44(88%)
Neck circumference	48.96±11.01
Male (> 41.6 cm)	13(65%)
Female (> 37.0 cm)	23(76.7%)

Table 3: Hemodynamic data including blood pressure measurements and echocardiography determinants.

Blood pressure measurements (mmHg)	
Systolic	149.1±22.4
Diastolic	94.1±15.5
Pulse	55.0±13.4
Mean	112.4±17
Echocardiography determinants	
Ejection fraction (%)	57.2±10.5
Stroke volume (ml)	67.9±30.5
End systolic volume (ml)	52.8±25.2
End diastolic volume (ml)	119.3±55.2

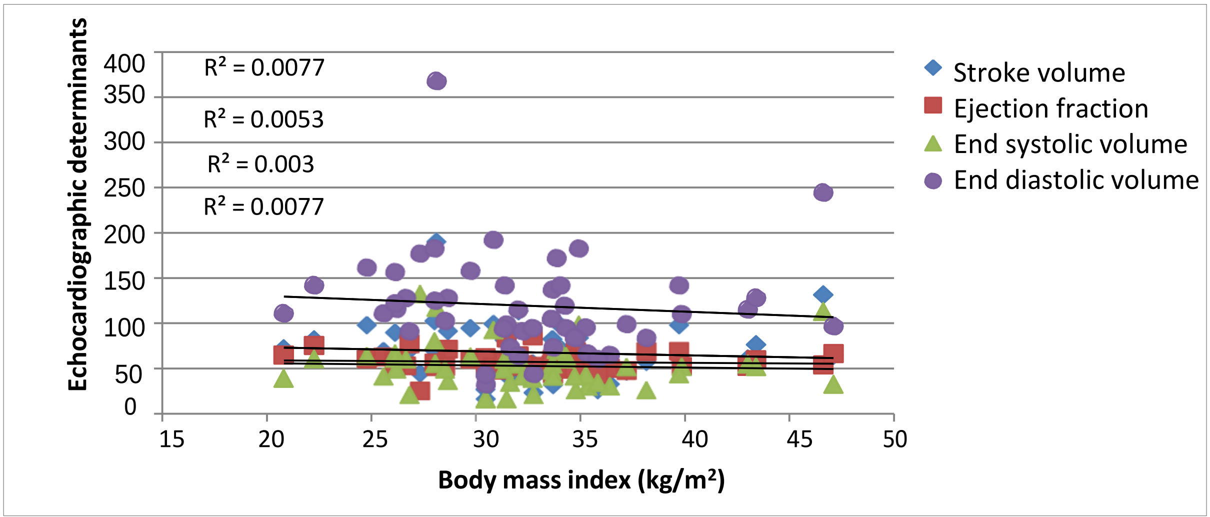

Figure 1: Non-significant correlation between body mass index and echocardiography determinants.

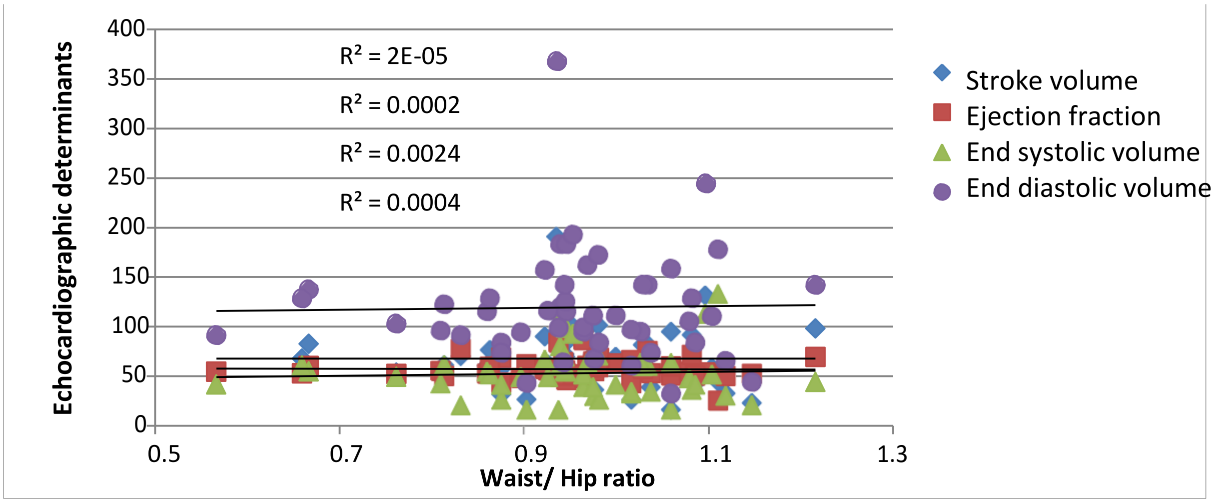

Figure 2: Non-significant correlation between waist/hip ratio index and echocardiography determinants.

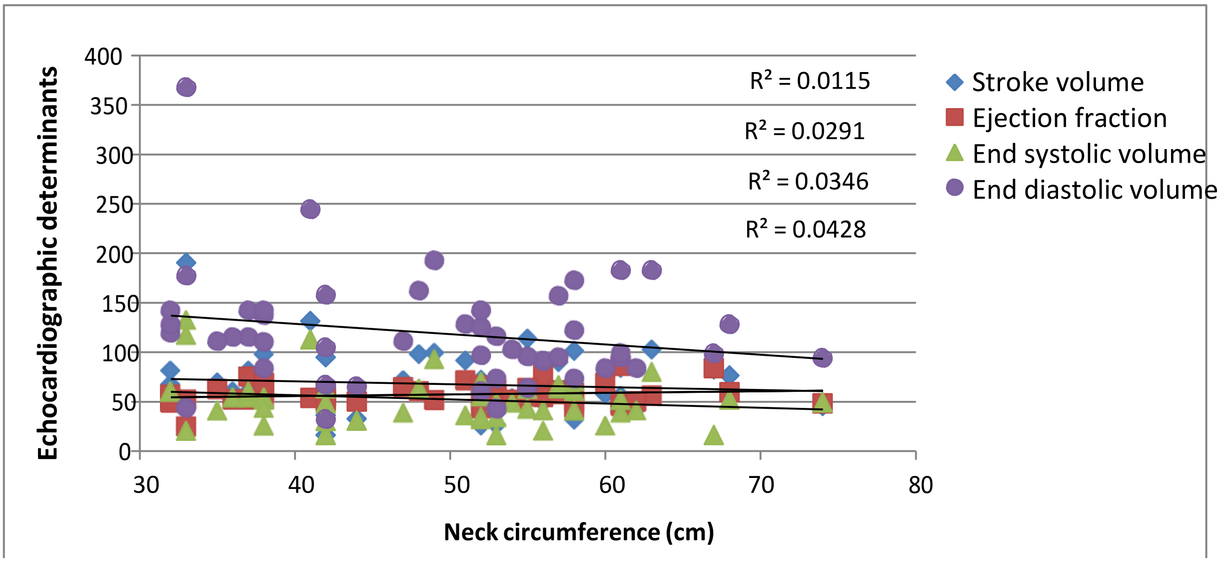

Figure 3: Non-significant correlation between neck circumference and echocardiography determinants.

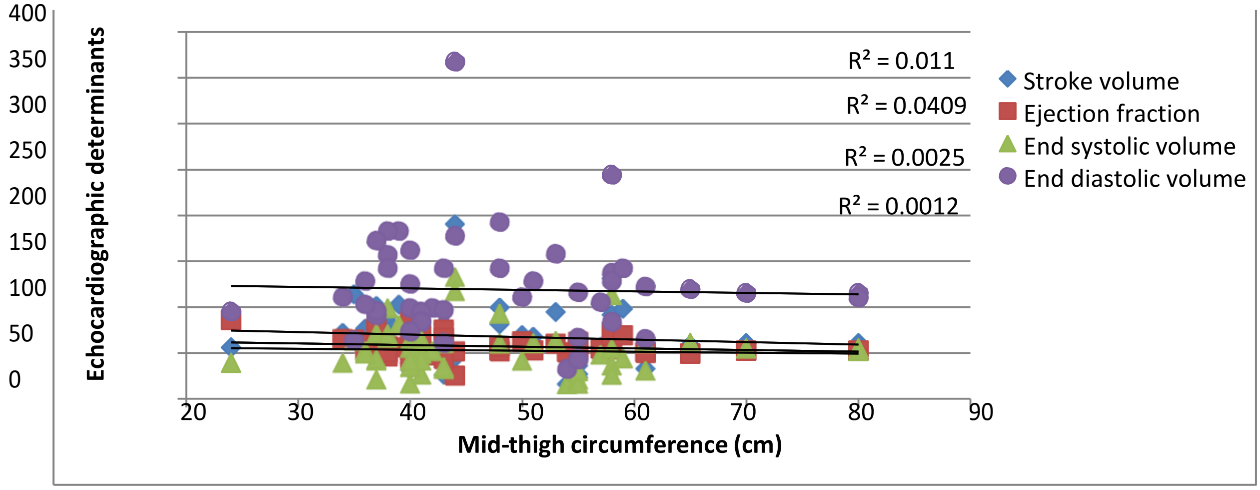

Figure 4: Non-significant correlation between mid-thigh circumference and echocardiography determinants.

Discussion

The results of this study show the changes in anthropometric measurements in T2D patients who are not associated in parallel with echocardiography determinants. The results of this study do not agree with the data reported by Kossaify and Nicolas, 2013 who found that diastolic dysfunction, assessed by E/A ratio using Doppler echocardiography, was significantly higher in non-diabetic overweight/obese subjects compared to the normal BMI subjects(13). Russo *et al., 2011* reported that the left ventricle diastolic function is impaired as the body mass index increased in 950 participants allocated from the (Cardiovascular Abnormalities and Brain Lesions) study(14). In one study conducted on the 2,228 participants using logistic regression analysis revealed that BMI, hypertension and diabetes mellitus were independent predictors of left ventricle dysfunction(15). Therefore, the small size number of this study as well as the methodology and the other characteristics of patients could explain the disagreement of this study with others. Ventricular remodeling following acute myocardial infarction is influenced by central obesity (waist circumference ≥ 102 cm) rather than BMI(16).

Alkatib *et al., 2014* found that a significant correlation between left ventricular posterior wall thickness and each of BMI and neck circumference in sleep-disordered breathing using multivariable linear regression analysis(17). The non-significant correlation between each of anthropometric measurements and each of echocardiography determinants in T2D indicated that obesity did not impact the echocardiography findings in T2D and the abnormalities in echocardiography in T2D may be related to the diabetes. In one study, using two-dimensions speckle tracking echocardiography, diastolic dysfunction and subclinical left ventricle longitudinal dysfunction is frequently observed in diabetic patients(18). Further study demonstrated high waist circumference and high waist to hip ratio had statistically significant diastolic dysfunction with normal systolic functions in T2D patients with complications; autonomic neuropathy and retinopathy(19). Small sample size of this study is a limitation of the results obtained herein.

In conclusion; This study concludes that the abnormal echocardiograph data in T2D are unlikely to be attributed to the impact of obesity or to the any anthropometric measurements that linked to cardio-metabolic risk factors.

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IMJ 2019;65(1):30-36.