

## A comparative study of anthropometric parameters and their relation to arterial blood pressure and fasting blood glucose in type -2 diabetes mellitus patients and non-diabetic controls

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### Abstract

**Background:** Patients of Diabetic Mellitus (DM) are more prone for cardiovascular disease. Concomitant chronic diabetes mellitus and cardiovascular disease can have devastating consequences which can worsen the future outcomes of these diseases related to mortality and morbidity. Hence constant follow up of the patient with effective prognostic indicators is very important in modulating the disease outcome either by medical or surgical intervention. At the same time it is even more important in identifying appropriate indicators for assessing the status of the patient. Even though few available indicators are useful in accurately predicting the disease status of the patients, considering the socioeconomic status of countries like India it is desirable to find alternative approaches having qualities of affordability, adoptability, accessibility and applicability. **Objectives:** To assess Body mass index (BMI), Waist circumference (WC), Arterial Blood pressure (BP) and Fasting blood glucose (FBS) in persons of 40-60 years having Type 2 diabetes mellitus and in age and sex matched healthy persons. To compare the parameter in the above two groups and also to find correlation between anthropometric parameters like BMI and WC with FBS and BP. **Materials and methods:** Anthropometric measures (BMI, WC), Fasting blood sugar (FBS) and blood pressure (BP) were measured, compared and their correlation was studied in male patients with type 2DM (Group 2) and normal healthy male subjects (Group1) of age group 40-60 years. Results on continuous measurements are presented on Mean  $\pm$  SD and significance was assessed at 5 % level of significance. Student t test (two tailed, independent) has been used to find the significance of study parameters. Pearson correlation has been used to find the correlation of BMI and WC with FBS and BP. **Result:** In the present study, there was significant increase in DBP in diabetics and not much difference in SBP when compared to healthy individuals. Also, it is observed that BMI is positively correlated with FBS, and SBP. It is also observed that WC is strongly positive correlated with SBP and DBP and a weakly positive correlated with FBS. **Conclusion:** From the findings of the present study it is concluded that both BMI and WC had a positive correlation with FBS and BP. Thus simple anthropometric measures like BMI and WC can independently contribute to the prediction of risk factors of CVD and can be routinely used to identify those at risk.

**Keywords:** Body Mass Index, Waist Circumference

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### Introduction

Diabetes mellitus (DM) is a cluster of chronic metabolic diseases distinguished by high blood sugar resulting from fault in insulin secretion, insulin effect, or both[1]. The occurrence of type 2 diabetes mellitus (Type2DM) is seeing a robust growth across the globe and it has become a great health concern in both developed and developing nations[2]. It is now evident that both hereditary and environmental aspects are of significant in the occurrence of Type2DM. Factors like obesity (mainly central obesity), sedentary lifestyle, and nutrition with abundance of saturated fatty acids increase the risk of type2DM[3]. Cardiovascular disease (CVD) is one of the important causes of rise in morbidity and mortality in patients with diabetes mellitus (DM). It is estimated that diabetics will have 2 - 4 times higher chances of establishing CVD when compared to normal individuals. Notably, diabetics are more prone for cardiovascular complication occurs at an earlier age resulting in rise in mortality mainly in younger population[4].

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Many elements like dyslipidemia, overweight, sustained rise in blood pressure, and insulin resistance contribute to accelerated atherosclerosis in type2DM[5-7]. The use of simple anthropometric measurements seems to diagnose obesity in early stages due to its benefits in routine monitoring and assessment in patients. Few of the anthropometric parameters like Body mass index (BMI), Waist circumference (WC), Waist to hip ratio (WHR) are useful to diagnose obesity in initial stages because of their availability and applicability in routine monitoring of patients[8]. Even though BMI is routinely used for differentiation of various types of obesity, it may not be useful in identifying variation of fat distributions. WC appears to be better anthropometric indicator of central visceral adipose tissue and remarkable parameter in estimating CVD risks[9]. In India half of the diabetic population have hypertension (HTN). The incidence of HTN in diabetics is almost double when compared to normal people[5]. Atherosclerosis occur much faster and followed by spike in its adverse events is observed in Hypertensive patients with diabetes[10]. It is to be noted that both HTN and type2DM are identified as separate CVD risk factors[11]. Dietary modifications and lifestyle changes can significantly prevent the occurrence of these risk factors. In developing countries like India there is urgent need for developing cost effective prognostic approach in dealing with diabetic population mainly effected by type 2 Diabetes mellitus (DM).

It is now evident that type 2 DM will have severe consequences if left untreated or poorly managed. For optimal management of Type 2 DM routine screening of patients is of paramount importance and on the other hand approach for screening should be effective, feasible and cost effective. Anthropometric measurements like waist circumference (WC) and Body mass index (BMI) are relatively easy to perform, non invasive nature and at the same time may have significant correlation with parameters like lipid profile. Generally lipid profile estimation is performed routinely in diabetic patients to assess their Cardio Vascular Disease (CVD) risk. Even though the findings of invasive procedures like Lipid profile estimation will have greater value in estimating CVD risk in type 2 DM, there is a need for finding alternative approach having attributes of applicability, adoptability, accessibility and affordability. The purpose of this study is to determine the association between anthropometric measurements (BMI, WC), blood pressure, and fasting blood glucose. This study is to estimate the CVD risk factors in type 2 DM.

**Aims and objectives**

- To assess Body mass index (BMI), Waist circumference (WC), Arterial Blood pressure (BP) and Fasting blood glucose (FBS) in persons of 45-60 years having Type 2 diabetes mellitus and in age and sex matched healthy persons.
- To compare the parameter in the above two groups and also to find correlation between anthropometric parameters like BMI and WC with FBS and BP.

**Materials and methods**

This study comprises of total 216 male subjects categorized in to two groups. Group 2 consists of 108 Type2 DM patients (Test Group) and Group 1 consists of 108 age and sex matched healthy normal subjects (Control Group). Ethical clearance was obtained from the Shri.B.M.Patil Medical College ethical committee for human research to conduct the study. The present study is a comparative study in which 108 type 2DM cases (Group 2) recruited from those attending OPD of Medicine. Group 1(108 healthy) subjects were recruited by history, questionnaire and by clinical examination from general population. An informed written consent was obtained from all the subjects.

**Inclusion criteria**

- Healthy males of age group 40-60yrs with no major illness. (Group 1)
- Physician diagnosed and those on treatment for type-2 Diabetes mellitus of 45-60 years age group. (Group 2)

**Exclusion criteria**

- Subjects with history of hypertension.
- Subjects with history of ischaemic heart disease.
- Subjects with history of cerebro vascular accidents.
- Subjects on drugs like diuretics, B-blockers, and glucocorticoids

**Procedure**

The subject were informed about the procedure in brief and made comfortable for 5min in silent room.

➤ **Parameters used for comparison**

1. BMI
  2. WC
  3. BP
  4. FBS
- **Assessment of Body mass index[12]:** Weight and height was measured using standard calibrated balance scale with vertical measuring rods. Height of the subject was measured without shoes in meters and weight in kg. The BMI was calculated as  

$$\text{BMI} = \frac{\text{Weight in kgs}}{(\text{Height in meters})^2}$$
  - **Assessment of waist circumference[13]:** WC was measured with subject standing, bare midriff, after the subject exhales ,with both feet touching and arms hanging freely, the measuring tape is placed perpendicular to the long axis of the body and horizontal to the floor at the midpoint between the lowest rib and iliac crest in centimetres.
  - **Recording of blood pressure** -The subject rested for 5 min in supine position. Blood pressure was measured in the right arm using Diamond Regular Sphygmomanometer. At least 3 blood pressure measurements were taken at an interval of 5 mins. The first and fifth korotkoff phase used to define systolic and diastolic blood pressure. The mean of 3 measurements were considered.

**Statistical analysis**

Statistical software SYSTAT 11.0 was used for analysis of the data. Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and significance is assessed at 5 % level of significance. Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis). Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two groups. Pearson correlation has been used to find the correlation of BMI and WC with Fasting Blood Sugar (FBS) and Blood pressure (BP). P<0.05 was considered as statistically significant and p≤0.01 is considered as strongly significant. Correlation Co-efficient (r) value between 0.5 -0.9 considered as large correlation and r value at ‘1’ is considered as perfect correlation.

**Results**

In the present study, anthropometric measures (BMI, WC), BP and FBS were compared and their correlation was studied in patients with type2 DM and normal healthy male subjects of age group 40-60 years. The results obtained as mean ± Standard deviation. Table 1 depicts the age distribution of both the groups. Most of the subjects belong to 50 to 54 years of age group.

**Table 1: Comparison of age distribution**

Age	Healthy group		Diabetic group	
	No	%	No	%
40-44	5	4.5	14	12.96
45-49	25	23.2	20	18.56
50-54	49	45.4	41	37.94
55-60	29	26.9	33	30.57
Total	108	100.0	108	100.0
Mean ± SD	52.60±5.18		53.09±6.52	

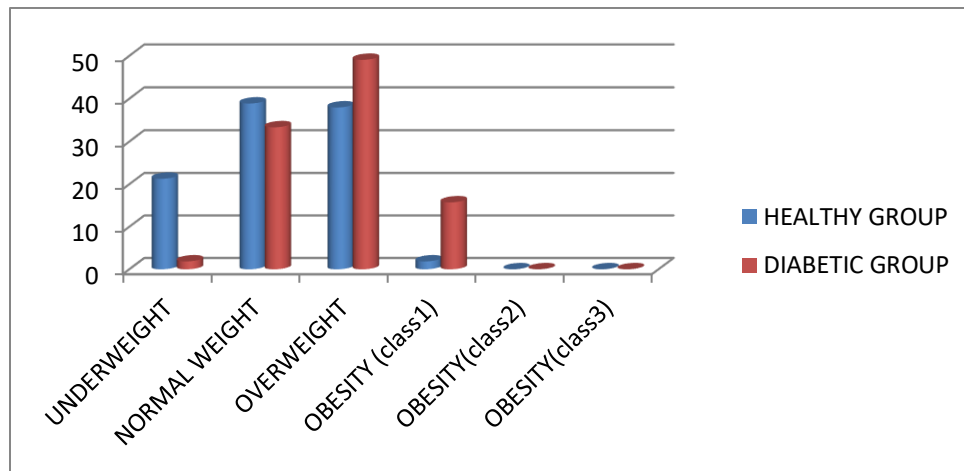
Samples are age matched with P<0.468

Table 2 depicts the comparison of BMI in both the groups. From Graph 1 it is observed that most of the subjects are having normal weight in healthy group and overweight in diabetic group.

**Table 2: Comparison of BMI**

BMI (kg/m <sup>2</sup> )	Healthy group		Diabetic group	
	No	%	No	%
Underweight	23	21.29	02	1.85
Normal weight	42	38.88	36	33.33
Over weight	41	37.96	53	49.07
Obesity (class 1)	02	1.85	17	15.74
Obesity (class2)	0	0.0	0	0.0
Extreme obesity (class 3)	0	0.0	0	0.0
Total	108	100.0	108	100.0
Mean ± SD	23.08±3.83		26.12±3.35	

P<0.001\*



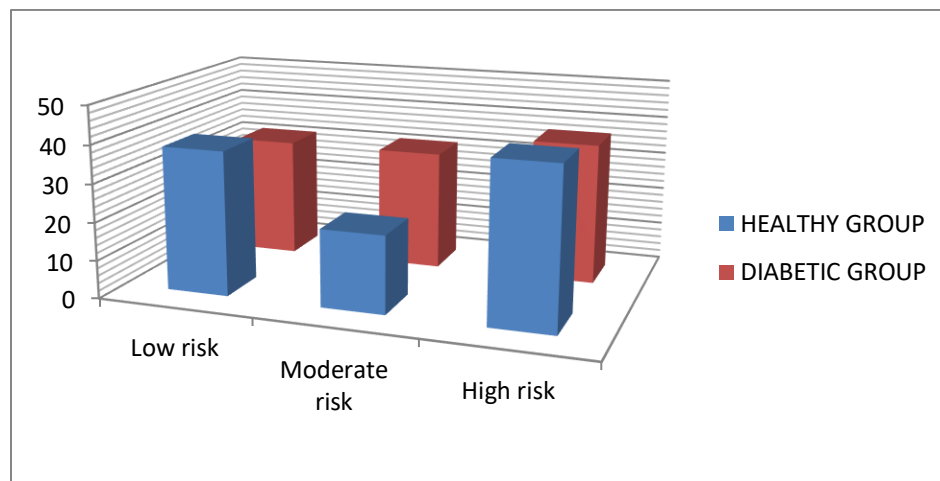
**Figure-1: Comparison of BMI (kg/m<sup>2</sup>)**

From the Table 3 and Graph 2, it is evident that 37.03% of diabetic subjects are having high risk of waist circumference (WC) and 41.66 % of normal subjects are having high risk WC.

**Table-3: Comparison of WC distribution**

Waist circumference (cm)	Healthy group		Diabetic group	
	No	%	No	%
Low risk	41	37.96	34	31.48
Moderate risk	22	20.37*	34	31.48
High risk	45	41.66	40	37.03
Total	108	100.0	108	100.0
Mean ± SD	85.07±10.15		96.83±8.92	

P<0.001\*\*



**Figure-2 Comparison of WC distribution (in centimeters)**

Table 4 depicts the comparison of values of Systolic blood pressure (SBP), Diastolic Blood pressure (DBP) and FBS in healthy and diabetic groups.

**Table 4: Comparison of Blood Pressure and fasting Blood glucose**

Variables	Healthy group	Diabetic group	P value
SBP (mm Hg)	130.16±10.25	133.80±13.64	0.135
DBP (mm Hg)	83.04±5.11	89.00±10.17	<0.001**
FBS (mg/dl)	94.76±16.64	143.53±41.88	<0.001**

Each of the Table 5 and Table 6 shows the correlation of BMI and WC with Blood pressure and FBS respectively. It is observed that both BMI is positively correlated with FBS, and SBP. It is also observed that WC is strongly positive correlated with SBP and DBP and a weakly positive correlated with FBS.

**Table 5: Correlation of BMI with FBS and BP**

Pair	Diabetic	Healthy
	r value	r value
BMI vs FBS	0.470**	0.184
BMI vs SBP	0.253	0.110
BMI vs DBP	0.034	-0.183

**Table 6: Correlation of Waist circumference (WC) with FBS and BP**

Pair	Diabetic	Healthy
	r value	r value
WC vs FBS	0.209	0.193
WC vs SBP	0.451**	0.226
WC vs DBP	0.376**	-0.153

**Discussion**

- In the present study, anthropometric measures (BMI, WC), BP and FBS were compared and their correlation was studied in patients with type2 DM and normal healthy male subjects of age group 40-60 years.
- In the present study as depicted in the Table 4, there was significant increase in DBP in diabetics and not much difference in SBP when compared to healthy individuals. This finding of the study is in accordance with previous studies which showed the high prevalence of hypertension and CAD in type2DM when compared to normal's[14].
- The present study results of correlation of BMI and WC with Blood pressure and FBS respectively are depicted in the Table 5 and Table 6. It is observed that BMI is positively correlated with FBS, and SBP. It is also observed that WC is strongly positive correlated with SBP and DBP and a weakly positive correlated with FBS.
- Some of the possible mechanisms contributing to dyslipidemia support the concept that visceral adipocytes release an excess amount of FFAs and which are very resistant to antilipolytic effect of insulin. FFAs are important regulators of glucose metabolism and that elevated FFAs are associated with insulin resistance at the level of liver and muscles. It is been postulated a preferential influx of FFAs via portal circulation to the liver can induce or augment hepatic insulin resistance, in particular by enhancing gluconeogenesis. Also a recent study showed that obese persons have greater release of FFAs and glycerol into portal circulation than do non-obese persons.
- Some of the possible physiological mechanisms contributing to HTN in type2DM include insulin is a vasodilator with secondary effects on sodium reabsorption in the kidney. However, in the setting of insulin resistance, the vasodilatory effect of insulin is lost, but the renal effect on sodium reabsorption is preserved[3].
- Table 7 shows the differences of the outcomes of the present study and the study done by Ali Checheri et al 2007[15].

**Table 7: Correlation of BMI and WC with FBS and BP**

Parameters	Present study		Ali Chechari et al 2007	
	BMI	WC	BMI	WC
FBS	0.470**	0.209	0.300**	0.570**
SBP	0.253	0.451**		
DBP	0.034	0.376**		

**Limitations of study**

Even though anthropometric indicators are relatable to blood pressure (BP) and FBS, there are many other factors which may independently alter them. It was understood that sustained hypertension and improper glycemic control in diabetic population can act independently or in combination may significantly pose the person to CVD risk.

**Conclusion**

Type2DM often coexist with lipid abnormalities, hypertension and obesity particularly abdominal obesity and simultaneously increases the risk of development of CVD. From the results of the present it is concluded that both BMI and WC had a positive correlation with FBS, and BP. Thus simple anthropometric measures like BMI and WC can independently contribute to the prediction of risk factors of CVD and can be routinely used to identify those at risk. This study leaves the scope for future studies like 'effect of introduction of lifestyle modification on CVD risk factors in type2 DM patients'.

Even there is possibility to study the relation between anthropometric parameters and HbA1c levels in type 2 DM.

#### Conflict of interest statement

Nil.

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