Online ISSN: 2581-3935
Print ISSN: 2589-7837

International Journal of Medical Science and Diagnosis Research (IJMSDR)

Available Online at www.ijmsdr.com

Volume 2, Issue 3; May-June: 2018; Page No. 26-37

ASSOCIATION OF ANTHROPOMETRIC MEASURMENTS WITH HBAIC IN TYPE-2 DIABETES MELLITUS PATIENTS

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INTRODUCTION

The term Diabetes Mellitus refers to a group of metabolic disorders characterized by chronic hyperglycemia. These disorders usually result from defects in secretion of insulin, action of insulin or both. Sustained hyperglycemia is associated with complications in the microvasculature like diabetic nephropathy, diabetic retinopathy, peripheral and autonomic neuropathy, microvasculature and nerves, causing protracted morbidity and premature mortality (1, 2, 3). Macrovasculature complications, particularly coronary artery disease and stroke are increased two-to-four-fold, and diabetic patients have a higher prevalence of peripheral vascular disease. Microvascular complications such as retinopathy and neuropathy and peripheral and autonomic neuropathy are also common (4,5,6,7,8).

Two main categories of diabetes are distinguished.

Type 1 Diabetes:

It is formally called as insulin dependent diabetes mellitus (IDDM) or juvenile onset diabetes mellitus, usually manifested before adulthood and account for 5% of all cases of diabetes. Type 1 diabetes mellitus arises mainly through autoimmune destruction of pancreatic beta cells which results in severe insulin deficiency and extreme hyperglycemia (9,10). If untreated insulin deficiency culminates in fatal ketoacidotic coma hence patients depend on exogenous insulin administration for their survival (11,12).

Type-2 diabetes:

Formerly known as non-insulin dependent diabetes (NIDDM) or maturity-onset diabetes-usually manifests in later adult life and accounts for about 95% of all cases. Type 2 diabetes is the most common form of diabetes on a global scale (13,14,15.16). During the past few decades, type 2diabetes has reached epidemic proportion in many parts of the world, this increases is closely associated with the development of obesity. This type of diabetes develops mostly through of combination of insulin resistance and defective Beta-cell function. This causes less severe hyperglycemia that is not usually life threatening. However, the catalogue of chronic complications of type 2 diabetes represents a serious clinical burden, eroding quality of life and reducing life expectancy (17,18,19). The progressive and heterogeneous nature of type 2 diabetes adds to the complexity of treatment, which usually requires one or more oral antidiabetic agents and may also necessitate of insulin (20,21).

The world Health Organization (WHO) has predicted that the global prevalence of all diabetes increases from ~194 million in 2003 to~330 million in 2025 and that this increases will affect both industrialization and developing countries (22,23,24). The impact on less developed countries is disproportionately high. Some of the countries expecting the greatest increase are India (38 million to 73 million), China (22 million to 46 million), Pakistan, Indonesia and Mexico and Their public health implications are formidable (25).

Social and behavioral changes are regarded as key factors in the recent global explosion of type 2

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diabetes, of these, the most important appear are: Decreased levels of physical activity and Over-consumption of energy-dense food. Ethnicity is an important determinant of susceptibility to insulin resistance, obesity, type 2 diabetes mellitus and other cardiovascular risk factors such as dyslipidemia (26,27,28).

Anthropometric measures have served as non invasive markers because obesity, particularly abdominal obesity (29), is closely associated with insulin resistance. However, studies using direct methods revealed that only ~25–50% of all obese subjects are clinically significantly insulin resistant (30,31) and that waist girth or waist-to-hip ratio (WHR) was not better than BMI in identifying insulin resistance (31) The waist to hip ratio is commonly used as an indirect measure of lower and upper body fat distribution. Young adults with waist to hip ratio in excess of 0.94 for men and 0.82 for women are at high risk for adverse health consequences (32). (33) body mass index and waist circumference independently contributed to the prediction of abdominal, subcutaneous and visceral fat. Association of lipid profiles is reported with lifestyle (34) age (35), intra-abdominal adiposity (36), Obesity (37), BMI (38) and Waist to hip ratios (39). The waist: hip ratio (WHR) is a proxy marker of central obesity that is measured easily in clinical practice. Visceral adipocytes display several metabolic differences from their sub cutaneous counterparts that may partly explain the higher risk of feature of the insulin resistance (or metabolic) syndrome. According to some recent studies, low hip circumference may be an independent marker of insulin resistance. More recently, “abdominal height” or sagittal abdominal diameter (SAD) has shown to be strongly associated with glucose intolerance (40), cardiovascular risk (40-44), and mortality (45,46) (SAD was divided by thigh girth (45) independently of other anthropometric measures. SAD is also an excellent estimate of visceral fat (47,48,49), implying that SAD might be a particularly good marker of insulin resistance (29,50). Despite these compelling data, the role of SAD has been overlooked, whereas waist girth has received more attention (40,51,52). Given that insulin resistance is a major health culprit, there are surprisingly little data comparing different anthropometric measures as correlates to insulin resistance determined by gold standard techniques.

HbA1c is a glycated hemoglobin, formed by the post-translational non-enzymatic glycation of the N-terminal valine residues of the beta chain of hemoglobin. It is expressed as a percentage of the hemoglobin (normal level 4-5.8%) but in diabetic HbA1c level more 6 %. It indicates average glycemia over 90 days and gives most useful indicator of glycemia over the 3 months (53-55). Glycated hemoglobin (HbA1c) is a routinely used marker for long-term glycemic control. In accordance with its function as an indicator for the mean blood glucose level, HbA1c predicts the risk of diabetic complications in diabetes patients. Therefore, regardless of classical risk factors like dyslipidemia, elevated HbA1c has now been regarded as an independent risk factor for atherosclerotic cardiovascular disease in subjects with or without diabetes. Estimated risk of atherosclerotic cardiovascular disease has shown to be increased by 18% for each 1% increase in absolute HbA1c value in diabetic population (53). Ahmad khan in 2007 suggests that HbA1c can predict serum lipid levels in both male and female diabetic patients and HbA1c was regarded as an independent risk factor for coronary heart disease (57). He observed a direct correlation between HbA1c and the severity of coronary artery disease (CAD) in diabetic patients. Whereas, improving the glycemic control could reduce the risk of cardiovascular events in diabetic patients. Moreover, reducing cardiovascular risks resulted in the improvement of HbA1c even in the absence of any specific intervention targeted at improving glycemic control (56). Another study in 2011 showed that cardiovascular disease (CVD) is significantly higher in people with high levels of HbA1c (57). Purpose of this study is to evaluate correlation between HbA1c, and anthropometric measurements in type 2 diabetes.

AIMS AND OBJECTIVES

- To measure HbA1c level in patients having type 2 Diabetes Mellitus in the blood.
- To measure anthropometric parameters in patients having type 2 Diabetes Mellitus.
- To associate the level of HbA1c with anthropometric parameters in type 2 Diabetes Mellitus.

This observational cross-sectional study includes 113 consecutive type 2 diabetics who have attended diabetic clinic OPD in the department of medicine, King George medical university, Lucknow. These patients are satisfied the inclusion criteria.

Inclusion criteria:

- All type 2 diabetic patients of attending diabetic clinic OPD irrespective of age and sex.

Exclusion criteria:

- Any condition affecting haemoglobin levels
- Anemia
- Polycythemia
- Hemoglobinopathy
- Chronic alcoholism
- Drugs like Beta blocker, steroid, lipid lowering agents etc

Informed written consent was obtained from every participant and the study was approved by the institutional ethics review committee of King George medical university Lucknow. After taking a medical history, a detailed physical and systemic examination was conducted for all participants and the data was recorded in a predesigned questionnaire.

Weight, height, WC, hip circumference and sagital abdominal diameter were measured. BMI, waist-hip ratio(WHR) were calculated. The threshold cut off values adopted for anthropometrical parameters were BMI $\Rightarrow$25 kg/m^2, WC$\Rightarrow$90 cm for males and $\Rightarrow$85 cm for females, WHR$\Rightarrow$0.90 for males and $\Rightarrow$0.85 for females.

Weight: was measured to the nearest 0.1 kg in light clothing and standing barefoot by using a weighing machine.

Height: was measured to the nearest 0.5 cm using a wooden meter fixed on the wall while the subject was standing relaxed, barefoot and heels together touching the wall.

Waist (WC) and hip circumference(HC): were measured twice to the nearest 0.5 cm, with a flexible but non-elastic measuring tape. Waist circumference was measured at level of the natural waist (the narrowest part of the torso) or one finger width below the umbilicus. Hip circumference was measured at the maximum circumference of the buttocks posteriorly and the symphysis pubis anteriorly, in a horizontal plane with the subject in the standing position and breathing normally

BMI: was calculated by dividing the body weight (in kilograms) by the height (in meters squared)

The internationally accepted range of BMI as shown below was used:

Class	BMI (kg/m2)
Underweight	<18.5
Normal	18.5-24.9
Overweight	25-29.9
Obese Class-I	30-34.9
Obese Class-II	35-39.9
Obese Class-III	≥40

Sagittal Abdominal Diameter (SAD) or abdominal height was measured after a normal expiration to nearest 0.1 cm in supine position with straight legs on a firm examination table, without clothes in the measurement area. At the level of iliac crest. SAD was measured using a ruler and water level. SAD was the distance between the examination table up to the horizontal level. Intraobserver variation (coefficient of variation) for SAD was 1.6%, and intra subject variation was 2.7%. Waist girth was measured according to the WHO in underwear in standing position after normal expiration, midway between the lower rib margin and the iliac crest and hip girth was measured at symphysis trochanter level.

Under aseptic precautions Blood samples were drawn from clinically diagnosed cases of Diabetes Mellitus. Then the blood sample was divided into different test tubes and analyzed respectively for blood glucose (FBS & PPBS) and HbA1c.

Plasma Glucose Estimation:

- Test tube 1 containing 2ml of blood with anticoagulant was used for estimation of blood glucose

Fasting blood sugar is obtained by fasting blood sample, postprandial blood sugar is measured by taking another blood sample 2 hrs after taking carbohydrate diet.

- Plasma Glucose was estimated by autozyme stat glucose test based on enzymatic method using glucose oxidase and peroxidase as enzyme.

Principle: Glucose oxidase (GOD) converts glucose to gluconic acid. Hydrogen peroxide formed in this reaction in presence of peroxidase (POD) oxidatively couples with 4 amino antipyrine, to produce red quinoneimine dye.

This dye has absorbance maximum at 505 nm. The intensity of the colour complex is directly proportional to the glucose in specimen.

$$\beta\text{-D-glucose} + O_2 + H_2O \xrightarrow{GOD} \text{Gluconic acid} + H_2O_2$$

$$H_2O_2 + \text{4-amino antipyrine} + \text{phenol} \xrightarrow{POD} \text{Red dye} + H_2O$$

HBA1C Estimation

Glycosylated haemoglobin (HbA_1C) was tested by Immunoturbidimetric procedure. The normal value for A_1C varied from 4 to 6% in our laboratory.

OBSERVATION AND RESULTS

A total of 113 patients were included in the study.

5.1 Demographic profile

5.1.1 Age

Table-1: Age distribution of the subjects

Age in years	No. (n=113)	%
<30	4	3.5
31-40	22	19.5
41-50	42	37.2
51-60	31	27.4
>60	14	12.4
Mean±SD (Min.-Max.)	48.20±10.51 (22-82)	

Min.: Minimum, Max.: Maximum

More than one third (37.2%) of the patients were between 41-50 years followed by 51-60 (27.4%), 31-40 (19.5%), >60 (12.4%) and <30 (3.5%) years. The mean age of the patients was 48.20 (±10.51) years (Table-1 .

5.1.2 Gender

Table 2: Gender distribution of the subjects

Gender	No. (n=113)	%
Male	72	63.7
Female	41	36.3

5.2 Anthropometric parameters

Table 3: Distribution of the subjects according to anthropometric parameters.

Anthropometric parameters	No.(n=113) (Mean±SD)	Minimum	Maximum
Height in cms	164.72±9.88	148.00	189.00
Weight in kg	70.41±9.24	52.00	98.00
BMI in kg/m^2	26.71±7.13	17.35	41.08
WC in cm	95.27±11.73	72.5	122.50
HC in cm	98.72±12.84	70.0	130.00
WC/HC	0.98±10.72	0.72	1.29

Table-3 & Fig.3 presents the distribution of the subjects according to anthropometric parameters. The average height of the patients was 164.72 (±9.88) cms with weight 70.41 (±9.24) kg. The BMI was 26.71 (±7.13) kg/$m^2$with minimum of 17.35 and maximum of 41.08. The WC, HC and WC/HC were 95.27 (±11.73), 98.72 (±12.84) and 1.98 (±10.72) respectively.

5.3 SAD

Table 4: Distribution of the subjects according to SAD

SAD	No. (n=113)	%
<23	46	40.7
≥23	67	59.3
Mean±SD, Median	22.74±3.66, 23.00	

The mean of SAD was 22.74 (±3.66) with median of 23.00. According to median cutoff, 40.7% were below 23 SAD (Table-4).

5.4 HbA1C

Table-5: Distribution of the subjects according to HbA1C

HbA1C	No. (n=113)	%
<7.5	18	15.9
≥7.5	95	84.1
Mean±SD, Median	9.34±1.80, 9.40	

The average value of HbA1C was found to be 9.34 (±1.80) with median of 9.40. The standard cutoff of HbA1C showed that 84.1% of the patients had HbA1C level ≥7.5 (Table-5)

5.6 Comparison of SAD with age

5.6.1 Age

Table 7: Comparison of SAD with age

Age in years	SAD (Mean±SD)
<30	26.50±0.57
31-40	22.18±2.51
41-50	22.64±2.40
51-60	22.63±3.87
>60	23.14±6.87

ANOVA p=0.30 (Insignificant)

The comparison of SAD with age is given in the Table-7 . There was no significant (p>0.05) difference in the SAD level among different age groups. However, SAD was higher in the patients of age<30 years than other age groups.

5.6.1 Gender

Table 8: Comparison of SAD with gender

Gender	SAD (Mean±SD)
Male	22.65±3.40
Female	22.93±4.13

Unpaired t-test p=0.70 (Insignificant)

The level of SAD was insignificantly (p>0.05) was higher among female (22.93±4.13) patients males (22.65±3.40) (Table-8).

5.6.2 Correlation of SAD with anthropometric parameters

Table 9: Correlation coefficient (r) between SAD and anthropometric parameters.

Anthropometric parameters	SAD	
	r	p-value
BMI	0.16	0.08
WC	0.42	0.001*
HC	0.40	0.001*
WC/HC	-0.56	0.001*

*Significant

Table-9 & Fig. 9-11 presents the correlation coefficient (r) between SAD and anthropometric parameters. There was mild positive correlation between SAD and WC (r=0.42, p=0.001) & HC (r=0.40, p=0.001). However, the WC/HC ratio was negatively correlated with SAD (r=-0.56, p=0.001). There was poor positive correlation between BMI and SAD.

5.7 Comparison of HbA1C with age

5.7.1 Age

Table-11: Comparison of HbA1C with age

Age in years	HbA1C (Mean±SD)
<30	7.63±1.39
31-40	9.71±1.89
41-50	9.17±1.92
51-60	9.25±1.56
>60	10.02±1.61

ANOVA p=0.13 (Insignificant)

The HbA1C was higher among the patients of age >60 (10.02±1.61) and lowest among <30 (7.63±1.39) years. However, there was no significant (p>0.05) difference in the level of HbA1C among all the age groups (Table-11).

5.7.2 Gender

Table 12: Comparison of HbA1C with gender

Gender	HbA1C (Mean±SD)
Male	9.39±1.76
Female	9.26±1.88

Unpaired t-test p=0.71 (Insignificant) The level of HbA1C was similar (p>0.05) in male (9.39±1.76) and female (9.26±1.88) patients (Table-12).

5.7.3 Correlation between HbA1C and anthropometric parameters

Table 13: Correlation coefficient (r) between HbA1C and anthropometric parameters.

Anthropometric parameters	HbA1C	
	r	p-value
BMI	0.01	0.85
WC	-0.17	0.06
HC	-0.20	0.06
WC/HC	0.06	0.47

There was no correlation between HbA1C and anthropometric parameters (Table-13).

5.8 Comparison of anthropometric parameters by HbA1C cutoff

Table 15: Comparison of anthropometric parameters by HbA1C cutoff

Anthropometric parameters	HbA1C		p-value1
	<7.5 (n=18)	≥7.5 (n=95)	
BMI	27.38±3.57	26.58±7.63	0.66
WC	100.69±9.88	94.25±11.81	0.03*
HC	103.63±11.95	97.79±12.85	0.07
WC/HC	0.97±0.03	2.16±11.69	0.66

[1]Unpaired t-test, *Significant

Table-15 & Fig. 18 depicts the comparison of anthropometric parameters by HbA1C cutoff. There was no significant (p>0.05) difference in the BMI, HC and WC/HC between HbA1C <7.5 and ≥7.5. However, WC was significantly (p=0.03) higher in the patients of HbA1C <7.5 (100.69±9.88) than ≥7.5 (94.25±11.81).

5.10 Correlation between SAD and HbA1C

Table 17: Correlation between SAD and HbA1C

HbA1C	SAD (mean±SD)
<7.5	23.33±2.44
≥7.5	22.63±3.85
Correlation coefficient (r), p-value	-0.07, 0.44

[1]Unpaired t-test p=0.46

The level of SAD was similar in the patients of HbA1C <7.5 and ≥7.5 and there was no correlation between HbA1C and SAD

Table 18: Distribution of blood sugar fasting and BS PP

	Mean±SD
Blood sugar Fasting	194.14±52.47
BS PP	305.71±64.40

The blood sugar fasting was 194.14±52.47 and BSPP was 305.71±64.40.

Table 19: Correlation of HbA1C with fasting blood sugar and BS PP

	HbA1C
Fasting blood sugar	0.87, p=0.0001*
BS PP	0.80, p=0.0001*

A significant positive correlation was observed between HbA1C and fasting blood sugar (r=0.87, p=0.0001) & BS PP (r=0.80, p=0.0001)

DISCUSSION

In the present study, we have evaluated the association of pattern of HbA1c and anthropometric parameters in type 2 diabetic patients. In the present study 113 patients were registered. Age of most of diabetic patients was 41-50 years (37.2 %), out of which 63.7 % were male. A significant positive correlation was observed between HbA1C and fasting blood sugar (r=0.87, p=0.0001) and post prandial blood sugar (r=0.80, p=0.0001) The significant correlation between HbA1c and FBG , BS PP is in agreement with earlier reports (*Ito C et al* 2000) , Ko GT et al (1998) Rosediani M et al (2006) (58-60).

HbA1C was highest among the patients of age >60 (10.02±1.61) and lowest among <30 (7.63±1.39) years. However, there was no significant (p>0.05) difference in the level of HbA1C among all the age groups. Doruk et al (2005) was also stated absence of a significant correlation between HbA1c and age (61).

Level of HbA1C was almost similar (p>0.05) in male (9.39±1.76) and female (9.26±1.88) patients. Thus, there was no significant (p>0.05) difference between HbA1C with gender. The results of previous study clearly showed that the levels of HbA1c are not affected by patients' gender as neither of these parameters differed significantly between male and female diabetic patients (Wexler DJ et al 2005).

Earlier, it was noticed that type 2 diabetic patients without CHD had the same HbA1c levels irrespective of gender whereas female patients with CHD had higher HbA1c than respective male controls (62).

A low correlation between HbA1C and anthropometric parameters (Table-13) was seen in present study. Table-15 & Fig. 18 depicts the comparison of anthropometric parameters by HbA1C cutoff.

There was no significant (p>0.05) difference in the BMI, HC and WC/HC between HbA1C <7.5 and ≥7.5. However, WC was significantly (p=0.03) higher in the patients of HbA1C <7 (100.69±9.88) than ≥7.5 (94.25±11.81). Literature reveals that there is lacuna about the correlation between HbA1c and anthropometric parameters.

The level of SAD was similar in the patients of HbA1C <7.5 and ≥7.5 and there was no correlation between HbA1C and SAD (Table-17 & Fig.20) seen in present study. Literature reveals that there is lacuna about the correlation between HbA1c and sagital abdominal diameter.

The comparison of SAD with age is given in the table-7 and figure-7. There was no significant (p>0.05) difference in the SAD level among different age groups. However, SAD was higher in the patients of age<30 years than other age groups. The level of SAD was insignificantly (p>0.05) was higher among female (22.93±4.13) patients males (22.65±3.40) (Table-8 & Fig.8) in present study.Lílian R et al (2010) had seen (63) positive and statistically significant correlations of age with SAD in both sex.

SAD is also strongly correlated with the anthropometric variables, especially with waist circumference and BMI (Lílian R et 2010). Table-9 and figure 9-11 presents the correlation coefficient (r) between SAD and anthropometric parameters. There was mild positive correlation between SAD and WC (r=0.42, p=0.001) & HC (r=0.40, p=0.001) is supported by different study.

However, the WC/HC ratio was negatively correlated with SAD (r=-0.56, p=0.001). There was no positive correlation between BMI and SAD is against of previous study.

Anthropometric parameters above the threshold cut off values were found to be predictors of diabetes and other cardiovascular risk factors in various populations even though it is not clear which anthropometric parameter is ideal for a particular population.

CONCLUSION

In this study we concluded that there was no correlation between HbA1C and anthropometric parameters and comparison of anthropometric parameters by HbA1C cutoff , there was no significant difference in the BMI, HC and WC/HC between HbA1C <7.5 and ≥7.5. However, WC was significantly higher in the patients of HbA1C <7.5 than ≥7.5 .

To seen better correlation among these parameters further research is required because this study is having very small amount of sample size.

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