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Research Paper

# Study of Height, Weight and BMI in Type 2 Diabetes Mellitus in Western Maharashtra

Medical Science

**KEYWORDS :** Type 2 Diabetes Mellitus (DM), Anthropometric Indices, Height, Weight, Body Mass Index (BMI)

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## ABSTRACT

*Purpose: To study height, weight and BMI in patients of Type 2 Diabetes Mellitus.*

*50 patients (27 males, 23 females) above age of 30 years and history of minimum 1 year of Diabetes were examined (history taken with case study form) and investigated for presence of Diabetes and its complications. Anthropometric indices (Ht, Wt, BMI) were taken in each patient. Fasting, Post-prandial BSL and Lipid profile were measured. Increased height of the patient was associated with increased duration of diabetes. A higher weight was found in patients with macro vascular complications (cardiac). Patients with a higher body weight showed lower levels of Serum Triglycerides and Serum VLDL levels. The BMI did not show similar significant associations.*

*Measurement of height and weight will help assess the duration and macro vascular complications of Diabetes. The relationship between dyslipidemia and anthropometric Indices seen was not the same as documented in literature reviewed.*

**Introduction:**

India is experiencing an epidemic of Type-2 Diabetes Mellitus and related disorders (1). With an estimated 50.8 million diabetic people, India has the world's largest diabetes population. Individuals with Type 2 DM are at particular risk of the adverse consequences of obesity. The interaction of both disorders with other components of the metabolic syndrome culminate in an increase in macrovascular and microvascular complications and associated reduction in quality of life (2). With such a large population of Diabetics in our country, there is a growing need to develop simple & economic methods of identifying a patient of diabetes and monitoring his disease throughout his lifetime.

Diabetes, as a part of the Metabolic Syndrome, is related to Obesity. Several obesity-related anthropometric indices have been devised to help the clinicians to predict the risk of developing Type 2 Diabetes Mellitus like Height, Weight and Body Mass Index(1). These Indices can be measured on an Outpatient basis. They don't require special equipment or training. If these are correlated with Diabetes, it will be much easier to improve the quality of life of our Diabetic population.

Previous studies have shown that increasing BMI is associated with increased risk of Diabetes (3). An inverse correlation has also been formed between these anthropometric indices and the cardiovascular risk of the diabetic patient (4,5).

Studies correlating Anthropometry and Diabetes and associated complications have not yet been conducted at our hospital. Through this study, we wished to see whether the same implications, as those suggested in existing literature, are seen in Diabetic patients here.

**Review of Literature:**

The Third round of National Family Health Survey, an Indian version of Demographic and Health survey revealed that 14.8% women and 12.1% men are obese in India (8). Obese people are more likely to develop hypertension, type 2 diabetes and dyslipidemia which together further compound their risk for heart disease and stroke.

The recent WHO Malawi national STEP wise approach to surveillance (STEPS) survey estimated a prevalence of Diabetes of 5.6% in adults aged 25 to 64 years of age (9,10).

There has been a rising epidemic of diabetes mellitus in India in recent years and an alarming increase in the rate of mortality and morbidity due to coexisting dyslipidemia, atherosclerosis and coronary artery disease. Diabetic microvascular complications have become a major cause of chronic kidney disease, blindness and diabetic foot problems. Many risk factors, like the duration of diabetes, degree of glycemic control and age of the patient, are identified in causation of diabetic microvascular complications (11).

The waist-hip ratio and BMI are powerful predictors of NIDDM in men and women (1,12,13,14). As the duration of diabetes mellitus increases, the anthropometric parameters and the incidence of cardiovascular risk increase. Hence, a check has to be kept on the much easily measurable anthropometric parameters, which could warn about the future risks (1).

BMI is traditionally honoured as an anthropometric benchmark to determine obesity(8). Abdominal fat rather than the general obesity is more related with cardiovascular morbidities. This is measured by Waist Circumference (WC) and Waist Hip Ratio (WHR) and BMI (8).

The fundamental basis of the association between obesity and Type 2 DM is a subject under intense scrutiny. Genetic susceptibility, environmental and dietary factors, and sedentary life style are all implicated. Type 2 DM patients are at particular risk of the adverse consequences of obesity (2, 15). BMI, which relates weight to height, is the most widely used and simple measure of body size and the prevalence of obesity within a population. BMI does not reflect body fat distribution, whereas the intra-abdominal deposition of adipose tissue is a major contributor to the development of hypertension, insulin resistance, DM and dyslipidemia (2,16).

Adediran et al found a strong correlation between BMI and WC in both diabetic patients with and without metabolic syndrome (17). Wei et al. found that BMI, WHR, and waist were independent predictors for Type 2 diabetes in the Mexican Americans (18). Traditionally, BMI and WHR are the most cited indices in literature because they approximate adiposity and fat distribution (14,19).

There are a number of potential explanations for a weaker association of body composition measures with diabetes risk among individuals 75 years of age and older. Among older adults, standard anthropometric measures may not adequately quantify body fat due to age-related changes in body composition, including decreases in skeletal muscle mass and height (20,21). A second possibility is that regional fat distribution is more important in the etiology of diabetes than absolute fat mass.

Another explanation for the effect modification by age is that the pathophysiology of diabetes in older adults differs from that of young and middle-aged adults. While possible, we know of no data that support a different pathophysiology of diabetes in older adults (20).

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Diabetic Retinopathy is the 5th leading cause of global blindness, affecting an estimated 1.8 billion people and is responsible for 4.8% of blindness (13). Association between systemic factors including poor glycemic control and hypertension and progression of retinopathy is well-known (22, 23).

**Objectives:**
1. Establishment of a correlation between Height and the Duration, Severity and Complications of Type 2 Diabetes Mellitus.
2. Determination of any correlation between the Weight and the Duration, Severity and Complications of Type 2 Diabetes Mellitus.
3. Establishment of a correlation between Body Mass Index and the Duration, Severity and Complications of Type 2 Diabetes Mellitus.

**Methodology:**
The study was a Unicentric study, conducted at Sassoon General Hospitals Pune, a tertiary care centre. The inclusion criteria for the 50 patients selected were:

1. Age above 30 years
2. History of Type 2 Diabetes Mellitus for at least 1 year.

Informed consent was obtained from each subject. The history of Diabetes Mellitus, its control, medication, presence of associated risk factors and presence of complications was noted by oral questioning, using a case study form. Other demographic information, smoking status, physical activity, and diet (including alcohol consumption) was taken based on self-report.

The patient was made to stand without shoes. The Height was measured from barefoot to the nearest 0.1cm by using a wall fixed stadiometer. The Body Weight was recorded to the nearest 0.1 kg by using a portable weighing machine. To ensure that intra-observer variation was <5%, the measurements were taken 3 times and their average was taken as the final value.

The Body Mass Index was calculated as Weight divided by Height squared (kg/m$^2$). Cutoff values for BMI: 18.5-25 kg/m$^2$. Values beyond these- abnormal.

Fasting Blood Sugar Level and Lipid Profile of all patients were determined by standardized methods. Lipid Profile of the patients included:

**Table 1: Normal Range Values**

| | Parameter | Normal Range |
|---|---|---|
| 1. | Total Cholesterol | 150-250 mg% |
| 2. | Triglycerides | 50-170 mg% |
| 3. | HDL Cholesterol | 30-60 mg% |
| 4. | LDL Cholesterol (calculated) | 60-170 mg% |
| 5. | VLDL (calculated) | <25 mg% |

In patients showing signs and symptoms of complications, detailed examination was carried out to diagnose the presence and severity of these complications:

1. ECG, Chest X-Ray, 2D-ECHO - Coronary Artery Disease.
2. Urine examination for Albumin, Ultrasonography of Kidney, RFTs- Diabetic Nephropathy
3. Fundus Examination- Diabetic Retinopathy
4. Complete clinical examination, Nerve Conduction Studies- Neuropathy
5. Peripheral Doppler- Peripheral Vascular Disease.

The analysis was done using SPSS Software, using appropriate tests of Significance - t-Test. Spearman's Correlation method and the Partial Correlation method (after adjusting for confounding variable like age) were used. P values <0.05 were taken as statistically significant.

**Observation and Result:**
50 patients were selected for this study. 27 were males and 23 were females.

**Table 2: Agewise distribution of the patients**
On being questioned about the duration of diabetes, majority of our patients gave a history of diabetes for less than 10 years (Table 3).

**Table 3: Duration of diabetes in our patients**
We now measured the anthropometric indices of our patients (Table 4).

**Table 4: Anthropometry of patients**
The heights varied from 1.40m to 1.72m. Female patients were shorter than male patients.

The weights varied from 40kg to 88kg. Female patients were heavier than male patients.

We calculated the BMI of each patient and classified the values as normal (<25kg/m2) and abnormal (>= 25 kg/m2) (Table 5).

**Table 5: Comparison of BMI in the patients**
More male patients had normal BMI. There were an almost equal number of female patients with normal and abnormal BMI.

We first classified the patients into two groups according to duration of Diabetes and compared the anthropometric indices between these groups and then individually (Table 6).

**Table 6:**

| Comparison of anthropometric parameters between two groups of duration of diabetes | | | |
|---|---|---|---|
| Parameters | Duration of Diabetes <10 years (n=30) | Duration of Diabetes >10 years (n=20) | P-value |
| Ht(m) | 1.59±0.09 | 1.56±0.08 | 0.160 (Non-Significant) |
| Weight(kg) | 61.9±10.6 | 60.7±10.0 | 0.661 (Non-Significant) |
| BMI(kg/m$^2$) | 24.1 ± 4.1 | 25.2 ± 4.4 | 0.396 (Non-Significant) |

| Correlation analysis of anthropometric with duration of diabetes | |
|---|---|
| Anthro\ Duration of Diabetes | Duration of diabetes |
| Height (m) | -0.30 (0.032) **(Significant)** |
| Weight (kg) | -0.18 (0.203) (Non-Significant) |
| BMI (kg/m$^2$) | 0.08 (0.588) (Non-Significant) |

None of the anthropometric parameters differ significantly between two groups of duration of diabetes. Individually, only height correlates significantly with duration of diabetes.

We measured the Fasting and Post-Prandial blood sugar levels in our patients, shown below (Table 7):

**Table 7: BSL of Patients**
To assess the severity of Diabetes, we compared the fasting BSL of patients. The American Diabetes Association has set a value of fasting BSL =126mg/dl. Our second objective was to find a correlation between the anthropometric indices and the severity of diabetes. We first compared the parameters between the two groups of patients and then individually (Table 8).

**Table 8:**

| Comparison of anthropometric parameters between two groups of fasting glucose | | | |
|---|---|---|---|
| Parameters | Fasting glucose < 1 2 6 (n=9) | Fasting glucose >=126 (n=41) | P-value |
| Ht(m) | 1.57 ± 0.10 | 1.58 ± 0.09 | 0.952 (Non-Significant) |

| | | | |
|---|---|---|---|
| Weight(kg) | 63.4 ± 15.5 | 61.0 ± 8.9 | 0.535 (Non-Significant) |
| BMI(kg/m$^2$) | 25.6 ± 6.4 | 24.3 ± 3.6 | 0.406 (Non-Significant) |
| | | | |
| Correlation analysis of anthropometric with blood glucose levels | | | |
| Anthro\Blood Glucose Level | Fasting glucose | PP glucose | |
| Height (m) | -0.02 (0.893) (Non-Significant) | 0.04 (0.788) (Non-Significant) | |
| Weight (kg) | -0.09 (0.506) (Non-Significant) | -0.12 (0.445) (Non-Significant) | |
| BMI (kg/m$^2$) | -0.07 (0.621) (Non-Significant) | -0.17 (0.273) (Non-Significant) | |

None of the anthropometric parameters differ significantly between two groups of fasting glucose or correlate significantly with fasting glucose or PP glucose.

**Table 9: Lipid Profile of patients**

As per our Objective, we wanted to see if there was any correlation between the anthropometric Indices and lipid profiles of patients in the presence of diabetes.

**Table 10: Correlation analysis of anthropometric parameters with the lipid profile after adjusting for age**

| Anthro \ Lipids | Cholesterol | Triglycerides | HDL | LDL | VLDL |
|---|---|---|---|---|---|
| Height (m) | -0.19 (0.185) (Non-Significant) | -0.21 (0.145) (Non-Significant) | -0.06 (0.700) (Non-Significant) | -0.17 (0.234) (Non-Significant) | -0.17 (0.227) (Non-Significant) |
| Weight (kg) | -0.21 (0.149) (Non-Significant) | -0.29 (0.036) **(Significant)** | -0.15 (0.291) (Non-Significant) | -0.19 (0.170) (Non-Significant) | -0.31 (0.028) **(Significant)** |
| BMI (kg/m$^2$) | -0.03 (0.857) (Non-Significant) | -0.08 (0.584) (Non-Significant) | -0.05 (0.744) (Non-Significant) | -0.05 (0.733) (Non-Significant) | -0.11 (0.450) (Non-Significant) |

Body weight was significantly and inversely correlated with triglycerides and VLDL levels after adjusting for age.

We observed that patients had both microvascular and macrovascular complications. 14 patients showed multiple complications. These 14 patients had cardiovascular complications along with the microvascular complications. 11 patients showed complications that appeared to be aggravated by the state of Diabetes- non-healing ulcers, abscess, cataracts, keratitis, iridocyclitis. One patient came with Diabetic Ketoacidosis as his presenting complaint. 2 patients had unrelated conditions for which they were admitted. 8 patients had no complications. They were admitted for uncontrolled BSL.

To see if there was any significant correlation between the anthropometric Indices and the complications, we compared the anthropometric indices according to the presence or absence of microvascular and macrovascular complications (Table 11).

**Table 11:**

| Comparison of anthropometric parameters according to the presence or absence of microvascular complications | | | |
|---|---|---|---|
| Parameters | Micro vascular disease present (n=21) | Micro vascular disease absent (n=29) | P-value |
| Ht(m) | 1.57 ± 0.08 | 1.58 ± 0.09 | 0.676 (Non-Significant) |
| Weight(kg) | 62.7 ± 10.5 | 60.5 ± 10.2 | 0.452 (Non-Significant) |
| BMI(kg/m$^2$) | 25.6 ± 4.9 | 23.8 ± 3.5 | 0.143 (Non-Significant) |
| | | | |
| Comparison of anthropometric parameters according to the presence or absence of macrovascular complications | | | |
| Parameters | Macro vascular disease present (n=17) | Macro vascular disease absent (n=33) | P-value |
| Height (m) | 1.59 ± 0.08 | 1.57 ± 0.09 | 0.339 (Non-Significant) |
| Weight (kg) | 65.8 ± 10.1 | 59.2 ± 9.8 | 0.031 **(Significant)** |
| BMI (kg/m$^2$) | 25.3 ± 4.7 | 24.2 ± 3.9 | 0.351 (Non-Significant) |

Microvascular complications - retinopathy, nephropathy, neuropathy. Macrovascular complications- CAD, IHD, abnormal ECG, MI.

None of the anthropometric parameters were significantly different between the cases with or without microvascular complications.

The average weight was significantly higher among the cases that had macrovascular complications compared to the cases that did not have macrovascular complications.

**Discussion:**

In this study we have correlated anthropometric parameters with the duration, severity and complications of type 2 diabetes.

**Duration of the type 2 diabetes:**

Group A - less than 10 years (30 patients) Group B - more than 10 years (20 patients)

On comparison of the duration of Type 2 diabetes with height of the patients, following inferences were drawn:

1. On comparing the height in the two groups, there was no significant difference found statistically (p value 0.160).
2. On correlating the height of all the 50 patients with the duration of diabetes, the correlation was significant (p value 0.032).

Lawlor et al have shown that total height was weakly and inversely associated with diabetes (20). Our study showed that taller persons showed an increased duration of diabetes and contradict this view.

On comparison of the weight of the patients between the two groups:

1. There was no significant difference between the weights in the two groups (p value 0.661)
2. On correlating the weight of all patients and the duration of their diabetes, there was no significant correlation found (p value 0.203)

**We derived the BMI from height and weight.**

1. On comparison, no significant difference was found in the BMI of the two groups (p value 0.396).
2. Correlation of the BMI of each patient with the duration of his diabetes was non-significant (p value 0.588).

Wanamethee and Shaper have shown that the risk of Type 2 Diabetes increased progressively and significantly with increasing levels of initial BMI and also with the duration of overweight and obesity (3). Since our study did not include follow-up of the patient, we cannot comment on the effect of changes in the BMI on the disease in type 2 diabetes. Our observation does not support the findings of the above study. Wei, Haffner, Gaskill et al suggested that BMI was independent predictors for type 2 diabetes (18). We could not establish any such relationship. This difference may be attributed to the difference of culture, lifestyle and eating habits of the two groups of patients.

On comparison of Anthropometry and blood sugar levels, none of the anthropometric indices differed significantly between the two groups or individually.

On examining patients for the presence of complications of Diabetes Mellitus, we found that 17 patients showed macrovascular complications (IHD, Cerebrovascular accidents, PVD) and 21 patients showed microvascular complications (retinopathy, nephropathy, neuropathy).

On comparing the anthropometric parameters, there was no significant difference in the heights (p value 0.339), BMI (p value 0.351) for presence or absence of microvascular complications. Weight of patients with microvascular complications was significantly higher than that of patients without them (p value 0.031).

The parameters did not differ significantly in the presence or absence of macrovascular complications– height (p value 0.676), weight (p value 0.452), BMI (p value 0.143).

Chowta et al studied the correlation of microalbuminuria with age, sex, duration of diabetes, BMI, and creatinine clearance in type-2 diabetics in Indian population. They found that there is no effect of BMI on the prevalence of microalbuminuria (25). This result is in agreement with our observation. None of the patients with microalbuminuria or nephropathy were found to have higher anthropometric indices.

To see the correlation of anthropometric indices and the Lipid Profile of patients with Type 2 Diabetes, we considered each component of the Lipid profile differently because existing data shows that each of the components is affected differently by the disease. We found that Ht and BMI did not significantly correlate with any of the lipid components.

The weight of each patient was found to be significantly and inversely correlated with:

1. Triglyceride levels (p value 0.036)
2. VLDL levels (p value 0.028) (Table 10)

The varied results obtained from this study can be explained by the fact that the sample size includes only 50 patients. Each patient was thoroughly examined once. From the history taken, we concluded that the patients were regular with their treatment (oral hypoglycemics or insulin). It was not possible to take newly diagnosed cases as ours is a Tertiary Care Centre with most patients being referrals. Therefore, the effect of the regular anti-diabetic medication may have been seen in the form of deviation from the expected results.

The genetics, socio-economic status, the education, the culture and lifestyle of an individual will have an effect on his Anthropometry and Diabetes. Many of studies mentioned above are from the West, where the structure of living is different. Thus, such non-modifiable and modifiable factors may have also led to different results.

**Conclusion:**

1. Increased Height of a patient is associated with longer duration of Diabetes.
2. Patients with macro vascular complications have a higher weight than those who do not have these complications.
3. Diabetic patients with a higher body weight will show lower levels of Serum Triglycerides and Serum VLDL levels.

Evaluation of the Anthropometric Indices of every Diabetic patient is important. Baseline readings followed by measurements on every succeeding visit will provide a charting for further management of the patient. Measure like controlling the weight can delay development of macro vascular complications like CAD, IHD, and AMI. The weight was associated with dyslipidemia.

A further study on a larger scale must be undertaken to see if the same results can be extrapolated into the community here.

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