# ASSOCIATION OF ANTHROPOMETRIC PARAMETERS LIKE BODY MASS INDEX, WAIST CIRCUMFERENCE, WAIST-HIP RATIO AS PREDICTORS OF TYPE 2 DIABETES MELLITUS

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**ABSTRACT**

**BACKGROUND**
Overweight and obesity have reached epidemic proportions globally with the adoption of westernised lifestyle. The prevalence of Type 2 Diabetes is showing a rapid progression worldwide, a phenomenon largely contributed by increasing prevalence of obesity, body mass index, waist circumference and waist-hip ratio have been shown to be associated with type 2 diabetes.

**OBJECTIVES**
To study the association of anthropometric parameters like body mass index, waist circumference and waist-hip ratio as predictors of type 2 diabetes mellitus.

**METHODS**
This cross-sectional study included 125 cases of diabetes compared with 125 age and sex matched controls who visited the Medicine Outpatient Department of JSS Hospital, Mysore, for diabetic care, between November 2007 to June 2009 fulfilling the inclusion and exclusion criteria.

**RESULTS**
57.1% of the diabetics had BMI in the overweight category and 22.2% were obese, while 41.1% of the controls were in the normal range whereas 51.6% of the female diabetics had BMI in the overweight range and 38.7% were obese, while 44.9% in the control group were in the overweight range and 33.3% had a normal BMI.

**CONCLUSION**
The present study demonstrated consistently strong associations of body mass index, waist circumference, and waist-hip ratio with diabetes.

**KEYWORDS**
Diabetes, Waist-Hip Ratio, Body Mass Index.

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**INTRODUCTION:** Overweight and obesity have reached epidemic proportions globally along with the adoption of a westernised lifestyle characterised by a combination of excessive food intake and inadequate physical activity. The dramatic rise in the prevalence of obesity has resulted in an alarming increase in the incidence and prevalence of Type 2 Diabetes. India is considered the diabetes capital of the world. It is estimated that there are about 39 million diabetics in our country and it is expected to reach 70-80 million by 2030 AD.[1]

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Nowhere is the diabetes epidemic more pronounced than in India as the World Health Organization (WHO) reports show that 32 million people had diabetes in the year 2000.[2] The International Diabetes Federation (IDF) estimates the total number of diabetic subjects to be around 40.9 million in India and this is further set to rise to 69.9 million by the year 2025.[3] A study published in the noted medical journal Lancet says India is just behind US and China in this global hazard list of top 10 countries with highest number of obese people.[4]

In 2008, 35% of adults aged 20+ were overweight (BMI ≥25 kg/m$^2$) (34% men and 35% of women). The worldwide prevalence of obesity has nearly doubled between 1980 and 2008. In 2008, 10% of men and 14% of women in the world were obese (BMI ≥30 kg/m$^2$), compared with 5% for men and 8% for women in 1980.[5]

Obesity and overweight are closely associated with development of type 2 diabetes in many studies. Obesity leads to insulin resistance and subsequently type 2 diabetes. The risk of development of diabetes increases two to eight folds at a BMI of 25 kg/$m^2$. This risk rises dramatically to 40-90 folds at a BMI above 35 kg/$m^2$.[6] The increased prevalence of type 2 diabetes in obese and overweight individuals is also dependent upon ethnicity. As a race, Asians have a higher risk at a lower BMI, and higher incidence of insulin resistance for given abdominal adiposity. Obesity is determined by an interaction between genetic, environmental and behavioural factors acting through the physiological mediation of energy intake and energy expenditure. Hence, this study was conducted with the objective of studying the association of anthropometric parameters like body mass index, waist circumference and waist-hip ratio as predictors of type 2 diabetes mellitus.

**AIMS & OBJECTIVES:**

1. To study the association of anthropometric parameters like body mass index, waist circumference and waist-hip ratio as predictors of type 2 diabetes mellitus.
2. To study the association of other risk factors with diabetes.

**Methodology:** This study included 125 cases of diabetes that were compared with 125 age and sex matched controls who visited the Medicine Outpatient Department of JSS Hospital, Mysore for diabetic care, between November 2007 to June 2009 fulfilling the inclusion and exclusion criteria. The study sample was obtained by simple random sampling technique from the list patients who visited the outpatient department during the defined period.

**Inclusion Criteria:** All type 2 diabetics of both genders fulfilling WHO diagnostic criteria for diabetes with duration of disease less than 5 yrs. age above 18 yrs. and below 50 yrs., and controls were healthy non-diabetic individuals of both genders.

**Exclusion Criteria:** Diabetics with complications, patients aged above 50 yrs. and below 18 yrs. pregnant, type 1 diabetics and duration of type 2 diabetes more than 5 yrs. were excluded. Applying statistical calculations, 125 diabetes mellitus cases and equal number of age and sex matched controls were studied. Height was measured to the nearest 0.5 cm by asking the study group to stand with heels, buttocks and shoulders resting lightly against the wall so that the Frankfurt plane is horizontal. Weight is measured to the nearest 0.1 kg by using Doctors Beli Ram and Sons' weighing scale.

Body mass index was calculated by using Quetlet's index (BMI=Weight in Kg/Height in $m^2$).

Waist circumference was measured at halfway between the lower border of the ribs and the iliac crest in a horizontal plane.

Hip circumference is measured at the widest point over the buttocks. Waist-hip ratio is calculated by dividing the mean waist circumference by mean hip circumference. FBS and PPBS were measured by using glucose oxidase method. HbA1C was estimated by using Resin uptake method. By using enzymatic end point method, cholesterol level was measured. HDL was measured by using direct precipitation method and by using Friedewald formula, LDL and VLDL was estimated. Glycerol 3 phosphate oxidase-phenol-aminophenazone method was used to estimate triglycerides. The statistical methods employed in the study were frequencies, descriptive statistics, Chi-square and contingency table analysis.

**RESULTS:** In this study, comparison of BMI, WC and WHR were done between diabetics and age and sex matched controls. 72.5% of patients belonged to age group range of 41-50 yrs. Among the diabetics, 50.4% were males and 49.6% were females. It was found that 56% of patients had diabetics of less than 1 yr. duration and 16.8% had it for 2-3 yrs. 36.8% of the patients were on dietary treatment and 34.4% on oral hypoglycaemics. 8.8% of diabetics had smoking history whereas in controls it was 24.8%. And this difference was statistically significant (p=0.001). 12.8% of diabetics had history of alcohol consumption whereas in controls it was 8.8% (p=0.308). Family history of diabetes mellitus was present in 63.2% of the cases, and only 17.6% of the controls and the difference was statistically significant.

Analysis of body mass index in males showed that 57.1% of the diabetics had BMI in overweight category and 22.2% were obese, while 41.1% in the control group were in the normal range of body mass index whereas analysis of body mass index in females revealed that 51.6% of the diabetics had BMI in the overweight range and 38.7% were obese, while 44.9% in the control group were in the overweight range and 33.3% were in normal range and the difference was statistically significant (Table 1).

Analysis of waist circumference in males showed that 44.4% of the diabetics had WC in the range of 90-99, 17.5% had a WC of `100-109 and 7.9% had WC >109, while 32.1% in the control group had WC in the range of 80-89 whereas analysis of waist circumference in females revealed that 35.5% of the diabetics had WC in the range of 80-89, 38.7% had a WC of 90-99 and 14.5% had WC 100-109, while 21.7% in the control group had WC in the range of 80-89 and 39.1% are in the range of 70-79 which was statistically significant (Table 2).

Analysis of waist-hip ratio in males revealed that 30.2% of the diabetics had WHR in the range of 0.90-0.94, 36.5% had WHR of 0.95-0.99, 11.1% had WHR of 1.00-1.04 and 12.7% had WHR >1.05, while 30.4% in the control group had WHR in the range of 0.85-0.89, 1.8% had WHR of 0.80-0.84 and 10.7% had a WHR <0.80. Whereas analysis of waist-hip ratio in females showed that 32.3% had WHR of 0.85-0.89, 35.5% had WHR of 0.90-0.94, 11.3% had WHR of 0.95-0.99 and 8.1% had WHR of 1.00-1.04, while 10.1% in the control group had WHR of 0.80-0.84 and 17.4% had a WHR of <0.80 which was statistically significant. (Table 3)

Similarly, differences in the total cholesterol levels, HDL, LDL, VLDL, triglyceride levels are shown in Table (4, 5, 6, 7, 8).

| BMI(Kg/m2) | Male | | Female | |
|---|---|---|---|---|
| | Diabetics | Controls | Diabetics | Controls |
| <18.5 | 0 | 14(25.0%) | 0 | 11(15.9%) |
| 18.51-23 | 13(20.6%) | 23(41.1%) | 6(9.7%) | 23(33.3%) |
| 23.1-27.5 | 36(57.1%) | 19(33.9%) | 32(51.6%) | 31(44.9%) |
| >27.5 | 14(22.2%) | 0 | 24(38.7%) | 4(5.8%) |
| **Total** | **63(100%)** | **56(100%)** | **62(100%)** | **69(100%)** |

***Table 1: Body Mass Index in Males and Females***

Contingency coefficient: 0.481; p value: 0.000

| WC | Males | | Females | |
|---|---|---|---|---|
| | Diabetics | Controls | Diabetics | Controls |
| <70 | 0 | 0 | 0 | 4(5.8%) |
| 70-79 | 1(1.6%) | 16(28.6%) | 4(6.5%) | 27(39.1%) |
| 80-89 | 18(28.6%) | 18(32.1%) | 22(35.5%) | 15(21.7%) |
| 90-99 | 28(44.4%) | 11(19.6%) | 24(38.7%) | 17(24.6%) |
| 100-109 | 11(17.5%) | 4(7.1%) | 9(14.5%) | 4(2.9%) |
| >109 | 5(7.9%) | 7(12.5%) | 3(4.8%) | 4(5.8%) |
| **Total** | **63(100%)** | **56(100%)** | **62(100%)** | **69(100%)** |

***Table 2: Waist Circumference in Males and Females***

Contingency coefficient: 0.409, p value: 0.001

| WHR | Male | | Female | |
|---|---|---|---|---|
| | Diabetics | Controls | Diabetics | Controls |
| <0.8 | 0 | 6(10.7%) | 2(3.2%) | 12(17.4%) |
| 0.8-0.84 | 0 | 1(1.8%) | 3(4.8%) | 7(10.1%) |
| 0.85-0.89 | 6(9.5%) | 17(30.4%) | 20(32.3%) | 18(26.1%) |
| 0.9-0.94 | 19(30.2%) | 12(21.4%) | 22(35.5%) | 19(27.5%) |
| 0.95-0.99 | 23(36.5%) | 10(17.9%) | 7(11.3%) | 8(11.6%) |
| 1.00-1.04 | 7(11.1%) | 8(14.3%) | 5(8.1%) | 4(5.8%) |
| >1.05 | 8(12.7%) | 2(3.6%) | 3(4.8%) | 1(1.4%) |
| **Total** | **63(100%)** | **56(100%)** | **62(100%)** | **69(100%)** |

***Table 3: Waist-Hip Ratio in Males and Females***

Contingency coefficient: 0.397, p value: 0.01

| Total Cholesterol | Diabetics | Controls | Total |
|---|---|---|---|
| <200 | 67(53.6%) | 116(92.8%) | 183(73.2%) |
| 201-250 | 38(30.4%) | 8(6.4%) | 46(18.4%) |
| >251 | 20(16.0%) | 1(0.8%) | 21(8.4%) |
| **Total** | **125** | **125** | **250** |

***Table 4: Total Cholesterol Levels***

Contingency coefficient: 0.408; p value: 0.000

| HDL Level | Diabetics | Controls | Total |
|---|---|---|---|
| <30 | 50(40.0%) | 45(36.0%) | 95(38.0%) |
| 31-70 | 75(60.0%) | 78(62.4%) | 153(61.2%) |
| >71 | 0 | 2(1.6%) | 2(0.8%) |
| **Total** | **125** | **125** | **250** |

***Table 5: HDL Levels***

Contingency coefficient: 0.161; p value: 0.036

| LDL Levels | Diabetics | Controls | Total |
|---|---|---|---|
| <70 | 13(10.4%) | 28(22.4%) | 41(16.4%) |
| 71-100 | 25(20.0%) | 66(52.8%) | 91(36.4%) |
| 101-130 | 42(33.6%) | 22(17.6%) | 64(25.6%) |
| >131 | 45(36.0%) | 9(7.2%) | 54(21.6%) |
| **Total** | **125** | **125** | **250** |

***Table 6: LDL Levels***

| VLDL Levels | Diabetics | Controls | Total |
|---|---|---|---|
| <40 | 90(72.0%) | 114(91.2%) | 204(81.6%) |
| >40 | 35(28.0%) | 11(8.8%) | 46(18.4%) |
| **Total** | 125 | 125 | 250 |

***Table 7: VLDL levels***

Contingency coefficient: 0.240; p value: 0.000

| Triglyceride | Diabetics | Controls | Total |
|---|---|---|---|
| <70 | 0 | 14(11.2%) | 14(5.6%) |
| 71-130 | 14(11.2%) | 43(34.4%) | 57(22.8%) |
| 131-190 | 49(39.2%) | 62(49.6%) | 111(44.4%) |
| 191-250 | 29(23.2%) | 5(4.0%) | 34(13.6%) |
| >251 | 33(26.4%) | 1(0.8%) | 34(13.6%) |
| **Total** | **125** | **125** | **250** |

***Table 8: Triglycerides Levels***

Contingency coefficient: 0.486, p value: 0.000.

**DISCUSSION: Diabetes Mellitus:** More commonly referred to as "Diabetes"- a chronic disease associated with abnormally high levels of the sugar glucose in the blood. Diabetes is Due to One of Two mechanisms:

1. Inadequate production of insulin (which is made by the pancreas and lowers blood glucose), or
2. Inadequate sensitivity of cells to the action of insulin.

The two main types of diabetes correspond to these two mechanisms and are called insulin dependent (Type 1) and non-insulin-dependent (Type 2) diabetes. In type 1 diabetes, there is no insulin or not enough of it. In type 2 diabetes, there is generally enough insulin but the cells upon it should act are not normally sensitive to its action.[7] Obesity is one of the most important modifiable risk factors for type 2 diabetes mellitus. Most of the patients with diabetes is overweight or obese. It is well known that excess bodyweight induces or aggravates insulin resistance, which is a characteristic feature of type 2 diabetes. Thus, bodyweight plays a central role in the prevention and treatment of diabetes. Recent data suggest that lifestyle intervention in patients with impaired glucose tolerance results in an impressive reduction in the conversion to overt diabetes, which is greater than the effect of early intervention with drugs such as metformin or acarbose. The prevention of diabetes has been shown to be associated with the extent of weight loss. In patients with type 2 diabetes, weight loss by any means is followed by an improvement of metabolic control and associated risk factors.

The prevalence of Type 2 diabetes is showing a rapid progression worldwide, a phenomenon largely resulting from the epidemic proportions reached by obesity in various populations of the world.[8] Several cross-sectional epidemiological and prospective cohort studies suggest that obesity and particularly abdominal obesity is strongly linked to increased risk of diabetes.[9] Indeed, obesity is considered to be the link between insulin resistance and several metabolic abnormalities which include diabetes,

hypertension and dyslipidaemia, all of which are risk factors of coronary artery disease.[10]

Obesity, along with type 2 diabetes, has become a health problem of epidemic proportions, both in developed and developing countries in the past two decades. Correspondingly, both diabetes and obesity generate immense health care costs.[11] In the present study, 8.8% of the patients in the cases group had a history of smoking, which was comparable with the study done by Sargeant LA et al[12] in which 9.8% of the diabetics were smokers. In the present study, 12.8% of the patients in cases group had a history of alcohol consumption, whereas in the study done by Sargeant et al, they found that history of alcohol consumption was seen in 39.2% of the diabetics.[12] It was revealed that 57.1% of the males had a BMI in the overweight category and 22.2% were in the obese range. Most of the patients in the control group had a BMI in the normal range. Widlansky ME and associates in their study postulated that in the men with a body mass index higher than 28 were more likely to have diabetes.[13]

**CONCLUSION:** To conclude, there is an association of anthropometric parameters like body mass index, waist circumference, waist-hip ratio with type 2 Diabetes Mellitus.

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