

Metabolic syndrome in type 2 diabetes, an anthropometric and biochemical evaluation - A cross-sectional study from Central India

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ABSTRACT

Background: Diabetes represents a spectrum of metabolic disorder which has become a major health challenge, worldwide. Diabetes caused 1.5 million deaths in 2012, and 80% of all new cases of diabetes expected to appear in the developing countries by 2025. In India, diabetes is expected to increase from 40.6 million in 2006 to 79.4 million by 2030. 75% of patients with type 2 diabetes or impaired glucose tolerance have the metabolic syndrome (MS). Clinical evidence indicates a stronger association of diabetes with central obesity than general obesity. **Objectives:** The objectives of this study is to compare the association of different anthropometric measurements and biochemical findings in type 2 diabetes patients with or without MS and evaluate the practicability and usefulness of these measurements in clinical practice and public health. **Materials and Methods:** A total of 60 proven cases of type 2 diabetes mellitus were studied from January 1, 2015, to June 30, 2015, in the Department of Physiology, GRMC, Gwalior (MP). The biochemical investigations were done in the Department of Biochemistry of the Institution. After obtaining consent, the patients were selected for the study and a detailed history was taken as per predesigned questionnaires; then, they were subjected for biochemical analysis of fasting blood glucose, and lipid profile. **Results:** Of 60 patients, 40% were diabetic for 7–10 years (62% men and 38% women), we included 30 patients from 40–45 years age group (mean age 42.5 ± 1.5 years) and 30 patients from 45–50 (mean age 48.2 ± 1.42 years). Body mass index was normal in 50% and 50% overweight, and abdominal obesity was in 82% (waist circumference = 94.28 ± 6.17 cm). Mean waist-hip ratio of 65% was 0.96 ± 0.08 , 51% of men (0.98 ± 0.04) and 49% of women (0.94 ± 0.10). 55% (33) of patients had MS (64% of female and 50% of male). The mean values of anthropometric measurements were statically significantly higher in MS group. Biochemical parameters were higher in women, and all the biochemical parameters measured except high-density lipoprotein cholesterol were significantly higher ($P < 0.001$) in MS group. **Conclusion:** The presence of MS in diabetic patients is associated with higher prevalence of coronary vascular disease. Anthropometric findings of obesity and biochemical abnormalities were significantly associated with MS in type 2 diabetes patients.

KEY WORDS: Type 2 Diabetes Mellitus; Obesity; Body Mass Index; Waist Circumference; Waist-hip Ratio; Metabolic Syndrome

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INTRODUCTION

Diabetes is a metabolic disease defined by hyperglycemia due to defects in insulin secretion, insulin action, or both.^[1] As per the WHO reports, 422 million adults (or 8.5% of the population) had diabetes in 2014, compared with 108 million (4.7%) in 1980. Diabetes was reported to be a causative factor

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in 1.5 million deaths in 2012, while abnormal blood glucose levels triggered an additional 2.2 million deaths, by increasing the risks of cardiovascular and other diseases. Many of these deaths (43%) occur prematurely, before the age of 70 years.^[2] It is projected that diabetes will be the 7th leading cause of death in 2030.^[3] The prevalence of diabetes has increased worldwide in both genders equally, in men from 43% in 1980–90% in 2014 and in women from 50% to 79%.^[4] India is the second largest contributor to regional mortality, with 1 million deaths attributable to diabetes. India had 69.2 million diabetes and 36.5 million impaired glucose tolerance (IGT) people (20–79 years) in 2015 and is projected to increase to 123.5 million and 63.6 million by 2040, respectively. Diabetes prevalence is more in urban compared with rural India (14.2% vs. 8.3%), and pre-diabetes prevalence was almost the same (urban 14.5% and rural 14.7%).^[5] The emergence of type 2 diabetes mellitus (T2DM) in India, coinciding with the country's rapid financial growth in the past several decades, is often considered as a modern epidemic resulting from westernization.^[6]

The metabolic syndrome (MS) is a constellation of metabolic abnormalities that confer an increased risk of cardiovascular diseases and T2DM. The major features of this syndrome are insulin resistance, central obesity, hypertension, and dyslipidemia.^[7] Patients with concomitant T2DM and MS are predisposed to a higher risk of cardiovascular diseases, stroke, and premature death compared to both non-diabetic individuals and diabetic individuals without MS. The presence of MS in T2DM has been shown to decrease the survival rate at least by 10 years.^[8]

Obesity is a major risk factor for T2DM. Clinical evidence indicates a stronger association of diabetes with central obesity than general obesity.^[9] Despite low prevalence of obesity as per body mass index (BMI) cut points, South Asians tend to have larger waist measurements and waist-to-hip ratios (WHR), indicating a greater degree of central body obesity. This is linked with a distinctive metabolic profile with higher insulin levels, a greater degree of insulin resistance, and a higher prevalence of diabetes.^[10] Simple anthropometric measurements have been used as surrogate measurements of obesity and have more applied value both clinically and for epidemiological studies. An increased volume of visceral fat in obese subjects is associated with dyslipidemia, characterized by increased TG and low plasma high-density lipoprotein (HDL) concentrations.^[11] The present study is aimed to compare the association of different anthropometric measurements and biochemical findings in type 2 diabetes patients with or without MS and evaluate the practicability and usefulness of these measurements in clinical practice and public health.

MATERIALS AND METHODS

The present study was conducted in the Department of Physiology, GRMC, Gwalior; the biochemical investigations

were conducted in the Department of Biochemistry of the Institution.

Study Duration

The study duration was from January 1, 2015, to June 30, 2015.

A total of 60 type 2 diabetes patients were studied, and all patients were examined clinically and confirmed by the investigations.

It was a cross-sectional study, in which 33 cases of T2DM suffering from MS were studied and compared with age and sex-matched 27 type-II diabetic subjects not suffering from MS, and the study comprised of T2DM patients aged 40–50 years attending medical outpatient department. Approval has been taken from the Ethical Committee of the Institute.

All the cases were proved cases of T2DM as per the American Diabetes Association criteria.^[1]

Inclusion Criteria

- All the patients with diabetes type-2 proved by recent blood glucose studies were included in the study.

Exclusion Criteria

The following criteria were excluded from the study:

- Type 2 diabetic patient with a history of cerebrovascular accidents.
- Patients with evidence of orthopedic impairment.
- Patient with abnormal finding in resting ECG as well as clinical examination.
- Chronic alcoholics.

Patients were grouped into two categories based on the criteria of MS according to the International Diabetic Federation (2006):^[12]

1. MS group (33).
2. Non MS group (27).

All the patients selected for study were subjected to a detailed history which was taken as per predesigned questionnaires. History of present and past illness was taken and family history, especially of non-communicable disease, congestive heart failure was recorded. All patients were subjected for biochemical analysis of fasting blood glucose as well as serum lipid profile. All the data collected and appropriate statistical tests were applied. $P < 0.05$ was considered as statistically significant.

RESULTS

In our study, a total of 60 type 2 diabetes patients were studied, based on the International Diabetic Federation (2005).^[5] 55%

(33) of patients were found to have MS. Remaining 45% (27) of diabetic patients were not having evidence of MS. Based on the duration of disease, it was found that majority of the patients (40%) were suffering from the disease from 7–10 years including 62% of men and 38% of women [Figure 1].

In the age range 40–45 years, 70% of men (42.66 ± 1.15 years) and 30% of women (42.11 ± 1.45 years) were studied, and 57% of men (48.23 ± 1.52 years and 48.15 ± 1.34 years) were in the age range >45–50 years.

Taking BMI as a gold standard, the study population was classified into normal weight (BMI 18.5–24.9 kg/m²) category; 50% of the study (23.4 ± 1.05 kg/m²) population were fell into this group including 77% of men (23.5 ± 1.09 kg/m²) and 23% of women (22.80 ± 0.80 kg/m²). Remaining 50% were classified as overweight/obese (BMI >25 kg/m²) category (28.29 ± 2.18 kg/m²) including 50% of men (28.24 ± 2.01 kg/m²) and 50% of women (28.22 ± 2.41 kg/m²). 82% of study population had abdominal obesity (waist circumference [WC] 94.28 ± 6.17 cm) including 59% of men (93.31 ± 4.49 cm) and 41% of women (WC 95.7 ± 7.9 cm). Mean WHR of 65% of study population was 0.96 ± 0.08 including 51% of men (0.98 ± 0.04) and 49% of women (0.94 ± 0.10).

64% of female diabetic patients were having MS while it was existing in 50% of male patients. Table 1 illustrates mean values of anthropometric parameters in patients with or without MS. It shows no gender difference in both the groups. The mean values of anthropometric measurements were higher in MS group as compared to non-MS group. Table 2 compares the anthropometric parameters in patients with or without MS. It was observed that all the measured anthropometric parameters were significantly ($P \leq 0.001$) higher in MS group.

It is evident from Figure 2 that the mean values that measured biochemical parameters were on higher in women as compared to men. Dyslipidemia was not observed in non-MS group. Table 3 reveals that all the biochemical parameters measured except HDL cholesterol were significantly higher ($P < 0.001$) in MS group. HDL cholesterol was significantly low ($P < 0.001$) in this group.

DISCUSSION

The main aim of the present work was to study the anthropometric and biochemical characteristic of type 2 diabetes with or without MS. The study comprised of 60 type 2 diabetes patients, aged 40–50 years. 30 patients fell in the

Table 1: Mean values of anthropometric parameter in type 2 diabetic patients

Variables	MS groups		Non-MS groups	
	Men (n=19)	Women (n=14)	Men (n=19)	Women (n=8)
Age (years)	45.9±2.86	45.9±3.71	44.4±3.44	45.3±2.71
BMI (kg/m ²)	27.15±2.8	27.72±3.07	26.66±1.06	24.43±2.48
WC (cm)	94.26±4.88	98.28±7.12	87.47±5.02	86±8.84
WHR	0.98±0.04	0.96±0.10	0.856±0.04	0.847±0.07

WHR: Waist-hip ratio, MS: Metabolic syndrome, BMI: Body mass index, WC: Waist circumference

Table 2: Comparison of anthropometric parameter in type 2 diabetic patients (student *t*-test)

Variables	Metabolic syndrome overall (n=38)	Non-MS overall (n=22)	<i>t</i> -value	<i>P</i> -value
Age (years)	45.9±3.19	44.6±3.21	1.5	NS
BMI (kg/m ²)	27.39±3.91	23.89±1.6	5.5	<0.001
WC (cm)	95.97±6.1	87.03±6.25	5.49	<0.001
WHR	0.97±0.08	0.85±0.05	7.17	<0.001

WHR: Waist-hip ratio, NS: Not significant, BMI: Body mass index, WC: Waist circumference

Table 3: Comparison of biochemical parameters in type-2 diabetic patients (student *t*-test)

Variables	MS overall (n=38)	Non-MS overall (n=22)	<i>t</i> -value	<i>P</i> -value
Fasting serum glucose (mg/dl)	162.67±22.54	136.70±11.22	5.3	<0.001
Total cholesterol (mg/dl)	271.87±49.65	192.7±12.7	7.92	<0.001
Serum triglyceride (mg/dl)	186.85±27.85	131.85±11.5	9.49	<0.001
LDL cholesterol (mg/dl)	198.9±46.27	118.8±12.52	8.5	<0.001
VLDL cholesterol (mg/dl)	35.3±5.18	26.32±2.35	8.4	<0.001
HDL cholesterol (mg/dl)	35.75±3.27	47.51±5.28	10.37	<0.001

LDL: Low-density lipoprotein, VLDL: Very low-density lipoprotein, HDL: High-density lipoprotein, MS: Metabolic syndrome

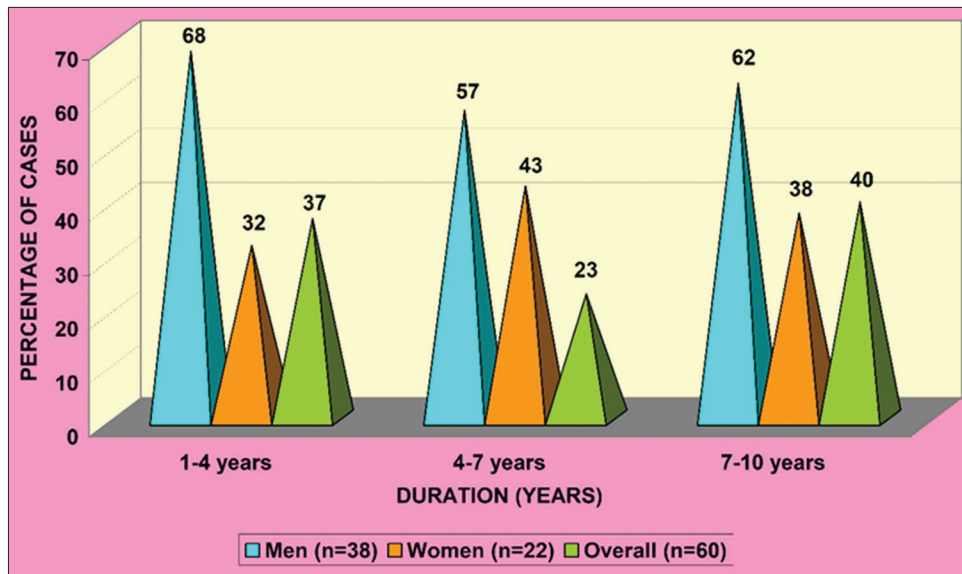


Figure 1: Distribution of type 2 diabetic patients based on the duration of disease ($n = 60$)

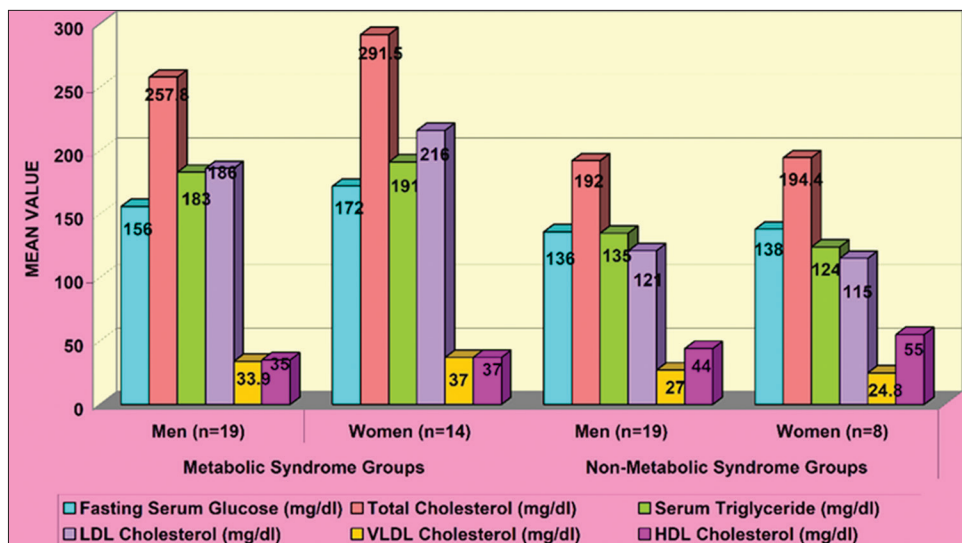


Figure 2: Mean values of biochemical parameters in type 2 diabetic patients

age range of 40–45 years with mean age ($42-5 \pm 1.5$ years) and remaining 30 patients were in the age group $>45-50$ years (48.2 ± 1.42 years). 50% of the study population was categorized as obese based on BMI (28.29 ± 2.18 kg/m²). 82% have abdominal obesity based on WC measurements (94.28 ± 6.17 cm). According to the International Diabetes Federation (2005), 55% of study population categorized as having MS. The mean BMI and WC of the patients having MS (27.39 ± 3.91 kg/m² and 95.97 ± 6.1 cm) were significantly ($P < 0.001$) higher than patients not having MS (23.89 ± 1.6 kg/m² and 87.03 ± 6.25 cm). The study demonstrated that patients with MS showed the existence of both generalized and abdominal obesity. The duration of disease in 60% of the subjects was <7 years and in remaining 40% was more than 7 years.

Ahmed *et al.* found the prevalence of Met S (according to IDF Criteria) to be 66.5%. This frequency was significantly

higher in women (84.7%) than men (44.3%). The main reason seems to be a very high rate of obesity in females, average WC being 97.36 cm, and BMI 29.79 Kg/min² in women having MS. They reported 56% of patients with obesity in type 2 diabetic patients aged above 40 years.^[13] According to Sharmila *et al.*, the overall prevalence of MS to be above three-fourth (77.44%) of the diabetic sample in an urban southern district of India. The prevalence of MS was higher among women (84.67%) as compared to men (72.40%).^[14] In a study done by Zafer *et al.*, 77.3% of the diabetic patients were found to be suffering from MS, and the prevalence of MS was significantly higher among obese and overweight individuals than those with a normal BMI.^[7] Meshram *et al.* reported that diabetic subjects had higher BMI ($P < 0.006$).^[15] Rachaiah and Malleshappa^[11] found that the mean BMI of male diabetic hypertensives is 25.80 and female diabetic hypertensives is 26.36, suggesting that they are overweight and the mean WC was significantly higher in male and

female diabetic hypertensives than controls. Awasthi *et al.* stated that, in their study, diabetic for <10 years' duration had significant higher values of BMI and WC than non-diabetic control.^[16] In the present study, the estimation of biochemical parameters revealed significantly higher values of all biochemical parameters measured in patients with MS compared to patients not having MS. Arat *et al.*^[17] conducted their study in patients with normal coronary angiography, in two groups according to presence (32) or absence (29) MS. The patients with MS exhibited hypertension (44%), increase blood glucose (37%), hypertriglyceridemia (31%), and a low HDL cholesterol level (30%). The prevalence of these risk factors was low in patients without MS. Many studies have confirmed the existence of correlation of central obesity with insulin resistance, dyslipidemia, hypertension, and cardiovascular disorders.^[14,18]

Strength and Limitation

The present study was an effort to categorize the discriminatory power of various anthropometric measures and its association with MS in type 2 diabetes cases. Despite the small sample size, undisputedly WC may be recommended as the single most convenient, feasible measure that could be used across communities for its significant association with T2DM. Generalizability of the results is a limitation of the study because of the smaller sample size and due to disparities in various cutoffs used to define obesity in the available literature. A cohort study with a larger sample size is recommended to determine the optimal cutoff points for the various anthropometric measurements specific for the Indian population.

CONCLUSION

DM is a unique endocrinal disorder, the poor control of which leads to complications involving nearly all the system of human body. It is estimated that large majority of patients with T2DM or IGT test have the MS. The presence of MS in these population is associated with higher prevalence of coronary vascular disease than found in patients without MS. Among the various anthropometric measurements, BMI was found to have the best discriminatory power. WC and WHR were also found to be sensitive markers. Hence, WC as a single measure could be advocated due to the simplicity of measurement and usage either in hospital or community settings. All the biochemical parameters measured except HDL cholesterol were significantly higher ($P < 0.001$) in MS group.

The diagnosis of MS and its association with cardiovascular risk factors may point to right direction for effective prevention of cardiovascular complications.

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