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Original Research Article

To Examine the Prevalence of Metabolic Syndrome among Persons with a Diagnosis of type 2 Diabetes Mellitus

Shiv Shankar Prasad[1], Kaushal Kishore[2], Abhay Kumar Sinha[3]

[1]Senior Resident, Department of Medicine, Patna Medical College and Hospital, Patna, Bihar, India.

[2]Professor, Department of Medicine, Patna Medical College and Hospital, Patna, Bihar, India.

[3]Assistant Professor, Department of Geriatric, Patna Medical College and Hospital, Patna, Bihar, India.

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Corresponding Author: Dr. Shiv Shankar Prasad
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Abstract

Aim: To examine the prevalence of metabolic syndrome among persons with a diagnosis of type 2 diabetes mellitus.

Materials and Methods: This study was conducted in the Department of Medicine, PMCH, Patna, Bihar, India from June 2017 to May 2018. A total of 160 patients fulfilling the inclusion criteria were selected. Informed consent was obtained from patients after explaining the study's objective. All patients were interviewed and received a printed questionnaire. The sociodemographic variables include age, gender, residence, and marital status. Clinical variables included physical activity, adherence to diet, obesity, family history, duration of diabetes, medications, concomitant risk factors, and complications. In addition to fasting blood glucose tests, HDL-C and low-density lipoprotein-cholesterol (LDL-C) profiling was performed and analyzed.

Results: In T2DM patients with Metabolic syndrome, the prevalence was higher (65.6%) than in those without Metabolic syndrome. The average BMI for males was 26.70 ± 0.84 kg/m² whereas BMI for females was 29.38 ± 0.54 kg/m². Overweight and obesity actualization was 57 (35.6%) and 32 (20%), respectively. A greater WC was found in 110 (68.7%, n = 160) patients. Females exhibited a larger WC of 93.52 ± 1.58 cm, and 48 of 83 females reported diabetes microvascular complications. Whereas in males, the frequency of WC was 89.64 ± 1.79 cm, with 36 of 77 patients reporting diabetes microvascular complications. On comparing the diabetic population with the presence or absence of Metabolic syndrome, this study noted significant p-values for age, gender, high waist circumference, obesity, and BMI. Metabolic syndrome was diagnosed in the study population by combining the criteria summarized in operational definitions: a combination of three criteria in 43.4%, a combination of four criteria in 36.2%, and a combination of five criteria in 20.4%.

Conclusions: The prevalence of Metabolic syndrome observed among T2DM patients was high (65%), with married obese females in the 50-59-year age group being more likely to be affected than males. Hypertension, poor glycemic control, high triglycerides, low HDL-C, and greater WC and BMI are additional risk factors that tend to increase the Metabolic syndrome burden in T2DM. Diabetic retinopathy, nephropathy, and neuropathy are the most prevalent microvascular complications of diabetes, and immediate attention is needed to stop their detrimental effects.

Keywords: High-density lipoprotein-cholesterol (HDL-c), body mass index (BMI), diabetic retinopathy.

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Introduction

Metabolic syndrome (Metabolic syndrome) represents a cluster of interconnected metabolic abnormalities that significantly increase the risk of cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM). It is characterized by a combination of central obesity, insulin resistance, dyslipidemia, and hypertension. Individuals with Metabolic syndrome are at a heightened risk of developing T2DM due to the underlying pathophysiological mechanisms linking these conditions. Metabolic syndrome poses a substantial public health challenge globally, affecting millions of individuals and presenting a complex interplay of metabolic dysregulations. The prevalence of Metabolic syndrome varies widely across populations and is influenced by factors such as age, ethnicity, lifestyle, and genetic predisposition. [1,2] In individuals with T2DM, the prevalence of Metabolic syndrome is markedly elevated, compounding the already heightened risk of cardiovascular complications and other comorbidities associated with diabetes. The

pathophysiology of Metabolic syndrome involves intricate mechanisms that contribute to the development and progression of T2DM. Central obesity and insulin resistance play pivotal roles, with adipose tissue dysfunction leading to increased release of free fatty acids and adipokines, promoting inflammation and impairing insulin signaling. [3,4] Insulin resistance further exacerbates dyslipidemia, characterized by elevated triglycerides and reduced high-density lipoprotein (HDL) cholesterol levels, hallmark features of Metabolic syndrome that contribute to a proatherogenic lipid profile. Several factors contribute to the development of Metabolic syndrome among individuals with T2DM, including genetic predisposition, sedentary lifestyle, unhealthy dietary habits, and aging. Genetic studies have identified polymorphisms associated with components of Metabolic syndrome, highlighting the role of genetic susceptibility in its pathogenesis. Lifestyle factors such as physical inactivity and diets high in refined carbohydrates and saturated fats contribute to obesity and insulin resistance, further exacerbating the metabolic abnormalities seen in Metabolic syndrome. The presence of Metabolic syndrome in individuals with T2DM poses unique challenges for clinical management and preventive strategies. Effective management strategies should focus on comprehensive risk assessment, including monitoring blood pressure, lipid profiles, and glycemic control. Lifestyle interventions targeting weight reduction through diet and exercise are fundamental in improving insulin sensitivity and reducing cardiovascular risk. Pharmacological interventions may also be necessary, including lipid-lowering agents and antihypertensive medications, tailored to individual risk profiles and therapeutic goals. [5-8]

Materials and Methods

This study was conducted in the Department of Medicine, PMCH, Patna, Bihar, India from June 2017 to May 2018 . A total of 160 patients fulfilling the inclusion criteria were selected. Informed consent was obtained from patients after explaining the study's objective. All patients were interviewed and received a printed questionnaire. The sociodemographic variables include age, gender, residence, and marital status. Clinical variables included physical activity, adherence to diet, obesity, family history, duration of diabetes, medications, concomitant risk factors, and complications. WC was measured at the umbilicus level using labeled plastic tape. BMI was assessed by dividing the weight in kilograms by the square of height in meters (kg/m2). Blood pressure was monitored on the right arm using a standard mercury manometer in a sitting position. In addition to fasting blood glucose tests, HDL-C and low-density lipoprotein-cholesterol (LDL-C) profiling was performed and analyzed. The stages of diabetic retinopathy were identified using fundus examination (microaneurysm, dot and blot hemorrhages, hard exudates, cotton wool spots, macular lesions, and new vessel formation). For the assessment of diabetic neuropathy, clinical evaluations such as paresthesia, numbness, vibration, and tingling sensation were used. Similarly, the diagnosis of diabetic nephropathy was based on blood pressure assessment, kidney ultrasonography, urine tests, urinary complaints of urgency or frequency, and body swelling (hands, feet, or eyes).

Data Analysis

Statistical analysis from a printed questionnaire was performed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Frequencies were measured for qualitative variables. The mean values of age, gender, weight, height, BMI, WC, obesity, physical activity, dietary habits, glycemic control, diabetes duration, treatment types, FPG, blood pressure, and comorbidities (hypertension, dyslipidemia) were matched between Metabolic syndrome and no Metabolic syndrome groups along with the presence or absence of diabetes microvascular complications in these variable categories. Relative risk factors of associated microvascular complications were calculated with 95% confidence intervals (CIs). The p-value was calculated for diabetic patients with Metabolic syndrome, and a p-value <0.05 was considered significant.

Results

A total of 160 patients with T2DM participated in this study. In T2DM patients with Metabolic syndrome, the prevalence was higher (105, 65.6%, n = 160) than in those without Metabolic syndrome. The mean age was 52 years with a predominance of females 83 (51.8%, n = 160) in the 50-59-year age group (56.8%). The majority of people 156 (97.5%) were married, and 122 (76.3%) were urban dwellers. The average BMI for males was 26.70 ± 0.84 kg/m² whereas BMI for females was 29.38 ± 0.54 kg/m². Overweight and obesity actualization was 57 (35.6%) and 32 (20%), respectively. A greater WC was found in 110 (68.7%, n = 160) patients. Females exhibited a larger WC of 93.52 ± 1.58 cm, and 48 of 83 females reported diabetes microvascular complications. Whereas in males, the frequency of WC was 89.64 ± 1.79 cm, with 36 of 77 patients reporting diabetes microvascular complications. On comparing the diabetic population with the presence or absence of Metabolic syndrome, this study noted significant p-values for age, gender, high waist circumference, obesity, and BMI (Table 1). Metabolic syndrome was diagnosed in the study population by combining the criteria summarized in operational definitions: a combination of three criteria in 43.4%, a combination of four criteria in 36.2%, and a combination of five criteria in 20.4%.

Table 1-Sociodemographic and general characteristics of the studied type 2 diabetes mellitus participants (n = 160).

Variables	Categories	N (frequency, %)	Metabolic syndrome			Diabetes microvascular complications	
			Metabolic syndrome +	Metabolic syndrome -	P-value	No	Yes
Age (years)	20–39	15 (10.9)	04	11	0.03	12	3
	40–49	54 (33.7)	42	12	0.02	18	36
	50–59	91 (56.8)	59	32	0.01	46	45
Gender	Male	77 (48.1)	48	29	0.02	41	36
	Female	83 (51.9)	57	26	0.01	35	48
Residence	Urban	122 (76.2)	86	36	0.08	28	64
	Rural	38 (23.8)	19	19	0.09	18	20
Marital Status	Married	156 (97.5)	102	54	0.09	74	82
	Unmarried	4 (2.5)	02	02	0.08	2	2
Waist circumference (cm)	Male	89.64 ± 1.79 (22.5)	48	29	0.0002	41	36
	Female	93.52 ± 1.58 (30)	57	26	0.0003	35	48
Body mass index (BMI) (kg/m²)	Male	26.70 ± 0.84	48	29	0.02	41	36
	Female	29.38 ± 0.54	57	26	0.03	35	48
Obesity BMI (kg/m²)	BMI >30	32 (20)	32	00	0.03	00	32
Components of Metabolic syndrome	Three or more	105 (65.6)	105	55	0.02	76	84

Table 2-Clinical and laboratory characteristics of the studied type 2 diabetes mellitus participants (n = 160). Good: Performed at least 150 minutes/week (three days) of moderate-intensity exercise. Poor: Had not exercised at all or performed less than 150 minutes/week of moderate-intensity exercise.

Parameters	Categories	Number (percentage %)	Metabolic syndrome			Diabetes microvascular complications	
			Metabolic syndrome +	Metabolic syndrome -	P-value	No	Yes
Family history of diabetes	Yes	110 (68.7)	84	26	0.6	63	47
	No	50 (31.3)	21	29	0.8	32	18
Diabetes duration	≥5 years	126 (78.7)	97	29	0.02	43	83
	<5 years	34 (21.3)	08	26	0.06	12	22
Medications	Oral only	95 (59.4)	51	44	0.03	31	64
	Oral + insulin	35 (21.8)	31	04	0.04	19	16
	Insulin only	30 (18.8)	23	07	0.04	9	21
Physical activity	Good	58 (36.3)	16	42	0.06	40	18
	Poor	102 (63.7)	89	13	0.003	19	83
Adherence to diet	Yes	42 (26.3)	11	31	0.05	26	16
	No	118 (73.7)	94	24	0.02	17	101
Obesity	Yes	32 (20)	30	02	0.03	4	28
	No	128 (80)	75	53	0.04	61	67
Glycemic control	Good (fasting blood sugar <130 mg/dL)	27 (16.9)	09	18	0.05	19	8
	Poor (fasting blood sugar >130 mg/dL)	133 (83.1)	96	37	0.02	25	108
Hypertension	Yes	112 (70)	92	20	0.03	9	103
	No	48 (30)	13	35	0.05	32	16
High-density lipoprotein-cholesterol	Hypo	83 (51.9)	34	49	0.004	13	70
	Hyper	77 (48.1)	71	06	0.002	46	31
Triglycerides	Hypo	74 (46.2)	26	48	0.03	43	31
	Hyper	86 (53.8)	79	07	0.0001	13	73
Components of Metabolic syndrome	Three or more	105 (65.6)	105	55	0.02	76	84

Discussion

Various studies have found different prevalence rates of Metabolic syndrome. The IDF and AHA agree that three of the five risk factors are sufficient to establish a diagnosis of Metabolic syndrome. [7,8] Metabolic syndrome led to a threefold increased risk of CVDs, principally when diabetes is present in patients with Metabolic syndrome. [9-11]. This study aimed to estimate the prevalence, identify risk factors, and evaluate associated microvascular complications among Metabolic syndrome patients with T2DM. This study showed that Metabolic syndrome prevalence in this population was 65.6% according to the new IDF 2023 definition. This statistic accorded with those reported by Saeedi et al. at 66.8% [12] and Abagre et al. at 68.8% [13]. However, the prevalence was higher than that reported in Atlanta by Ford et al. [14], with the same coordination accord at 48.9%, and by Chen et al. at 51.4%. [15] Metabolic syndrome is highly prevalent in these patients, with a predominance of T2DM (78.4%), a rate comparable to that seen in the study reported by Vest et al. in 2018 at 79%. [16] Among type 1 diabetics with Metabolic syndrome, 27.3% were diagnosed. The study by Vest et al. in 2018 reported a rate of 22.2% , and a study by Udell et al. reported a rate of 25.5%. [17] It is possible to explain these variations in Metabolic syndrome prevalence by the time of the study, population, sociodemographic differences, and definitions of Metabolic syndrome. The mean age in this study was 52 years, with most participants in the 50-59-year age group (56.8%). More than half of the patients (83, 51.8%, n = 160) were females. The majority of participants (156, 97.5%) were married, and 122 (76.3%) were urban dwellers, as reported by Udell et al. [17] and Backholer et al. in the Australian population. [18] Regarding gender, the prevalence of Metabolic syndrome with associated diabetic microvascular complications in this study revealed a female predominance, with a frequency of 83 (51.9%) compared to T2DM with 77 males at 48.1% ($p = 0.01$). These findings are similar to those reported by Fawwad et al. in Balochistan, Pakistan [19], and by Adeleye et al. in Nigeria. [20] This distinction might be related to physical inactivity, obesity, large WC, and menopause in women. A large WC was found in 110 (68.7%, n = 160) participants. The frequency of WC in males was 89.64 ± 1.79 cm, and 36 of 77 patients reported diabetes microvascular complications. In females, the WC was 93.52 ± 1.58 cm, and 48 of 83 females reported diabetes microvascular complications. These results are in line with those reported by Dündar and Akıncı in 2022 from Turkey [21]. The average BMI for males was 26.70 ± 0.84 kg/m² whereas BMI for females was 29.38 ± 0.54 kg/m². Being overweight was noted in 57 (35.6%), and 32 (20%) participants were obese. In this study, the majority had a family history of diabetes (110, 68.7%, n = 160), and 126 (78.7%) has a disease duration of ≥5 years. The drug of choice for 95 (59.4%) T2DM participants was OHDs. Most of these (102, 63.7%) had poor physical activity as they had not exercised at all or performed less than 150 minutes/week of exercise. The majority of them (128, 80%) were non-obese, and (118, 73.7%) had no adherence to a balanced healthy sugar-free diet. Among these, 42 (26.3%) had adherence to diet, and 133 (83.1%) had poor glycemic control with FBS greater than 130 mg/dL. The omnipresent comorbid parameter in type 2 diabetics was high blood pressure (hypertension) found in 112 (70%). Matsubayashi et al. [22] and Alshammary et al. [23] in a meta-analysis of observational studies reported that it was the most determining factor for Metabolic syndrome prevalence, in contradiction to the study by Dündar and Akıncı[21] where visceral obesity was the most frequent criterion (68.3%). A significant p-value <0.05 concerning all components of Metabolic syndrome (hypertension, abdominal obesity, poor glycemic control, hypertriglyceridemia, and hypo-HDL) was observed. [24-25] Metabolic syndrome was diagnosed in this T2DM study population by combining the criteria summarized in operational definitions: a combination of three criteria in 43.4%, a combination of four criteria in 36.2%, and a combination of five criteria in 20.4%. These results are in line with those reported by Rossi et al.[24] and Thomas et al.[25]. The triad of diabetes, central obesity, and hypertension represented the most commonly reported correlation of Metabolic syndrome in a Taiwanese study by Hsu et al. on patients with T2DM. [26] There was a 36.9% prevalence of microvascular complications in this study (95% CI = 31.5%-42.3%). Specifically, diabetic retinopathy was the most common microvascular complication, with a prevalence of 24.9% (95% CI = 20.3%-29.6%) versus 19.6% of the T2DM without Metabolic syndrome ($p < 0.05$), which is higher than that reported by Hsu et al. in Taiwan at 37.9%.[26] Hypertension was reported in 82% of the Asian population in a study by Bhatti et al. in India. [27]

Diabetic kidney disease was found in 16.8% (95% CI = 12.8%-20.7%), which is similar to that reported by de Boer et al. at 15.85 [28] in contrast to the Thomas et al. study where nephropathy was observed at a prevalence of 40.8%[25]. Diabetic neuropathy was noted at a prevalence of 10.8% (95% CI = 7.4%-13.3%) among associated Metabolic syndrome patients, which is comparable to studies by Thomas et al. at 13% and Hsu et al. at 12.6%. [25,26] Ischemic heart disease was reported to be the most commonly observed macrovascular diabetes complication, with 58.3% compared to 24.7% for patients without Metabolic syndrome ($p < 0.05$) [27], and stroke was reported at 6.6%. [29,30] There are no specific treatment modalities for Metabolic syndrome in T2DM. Hence, it is

crucial to effectively correct each of the variables of Metabolic syndrome as soon as possible. The aim should be to modify sedentary to an active lifestyle with good adherence to a balanced diet and increased physical activity, educating on the intake of quality food (reducing excess calories), and losing excess weight, mainly abdominal girth. To reduce the impact of this disease on the microvascular system, it is important to correct these metabolic complications. [27-30] Excluding patients with type 1 diabetes mellitus, age less than 20 years, newly diagnosed diabetes, secondary diabetes, pregnant women, incomplete records, sample size, and other associated comorbidities was a limitation of this study. Nevertheless, this study was able to estimate multiple variables in a single study, which is its strong point.

Conclusions

The prevalence of Metabolic syndrome observed among T2DM patients was high (65%), with married obese females in the 50-59-year age group being more likely to be affected than males. Hypertension, poor glycemic control, high triglycerides, low HDL-C, and greater WC and BMI are additional risk factors that tend to increase the Metabolic syndrome burden in T2DM. Diabetic retinopathy, nephropathy, and neuropathy are the most prevalent microvascular complications of diabetes, and immediate attention is needed to stop their detrimental effects.

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