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Original Research Article

Clinical-Demographic Profile of Metabolic Syndrome in Individuals Diagnosed with type 2 Diabetes Mellitus

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Abstract

Aim: To investigate the frequency of metabolic syndrome in individuals diagnosed with type 2 diabetes mellitus.

Materials and Methods: The research was carried out in the Cardiology department of IGIMS in Patna, Bihar, India from January 2019 to December 2019. The inclusion criteria were met by 160 patients. After describing the study's goal, subjects gave informed permission. Every patient was questioned and given a printed questionnaire. The sociodemographic factors include age, gender, residence, and marriage. Fitness, nutrition, obesity, family history, diabetes duration, medicines, concurrent risk factors, and complications were clinical variables. Besides fasting blood glucose testing, HDL-C and LDL-C profiling was done and analysed.

Results: In T2DM patients with MetSy, the prevalence was 65.6% greater than without. Males had an average BMI of 26.70 ± 0.84 kg/m², whereas females had 29.38 ± 0.54 kg/m². In reality, 57 (35.6%) were overweight and 32 (20%) obese. WC was higher in 110 (68.7%, n = 160) individuals. Females had a higher WC (93.52 ± 1.58 cm) and 48 of 83 reported microvascular problems from diabetes. Male patients had a frequency of WC of 89.64 ± 1.79 cm, with 36 of 77 patients experiencing diabetes-related comorbidities. This research found significant p-values for age, gender, high waist circumference, obesity, and BMI in diabetics with or without MetSy. Three criteria were used to diagnose MetSy in 43.4% of the study population, four in 36.2%, and five in 20.4%.

Conclusions: T2DM patients had 65% MetSy, with married obese females aged 50–59 being more prevalent than men. Hypertension, poor glycemic control, high triglycerides, low HDL-C, and higher WC and BMI enhance T2DM MetSy burden. Diabetic retinopathy, nephropathy, and neuropathy are the most common microvascular consequences of diabetes and need rapid treatment.

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

Introduction

Metabolic syndrome (MetS) is a collection of metabolic disorders that greatly increase the likelihood of developing cardiovascular illnesses and type 2 diabetes mellitus (T2DM). The main components of MetS consist of central obesity, insulin resistance, dyslipidemia, and hypertension. The rising occurrence of Metabolic Syndrome (MetS), especially among patients with Type 2 Diabetes Mellitus (T2DM), is a significant public health problem owing to the accompanying risks of illness and death. Gaining a comprehensive understanding of the complex connection between Metabolic Syndrome (MetS) and Type 2 Diabetes Mellitus (T2DM) is essential in order to create successful methods for preventing and managing both conditions. The incidence of Metabolic Syndrome (MetS) in patients with Type 2 Diabetes Mellitus (T2DM) is significantly elevated, with research suggesting rates that vary between 50% and 85% depending on the specific diagnostic criteria used and the demographic under investigation. MetS is typically defined by criteria set by organisations like the National Cholesterol Education Programme Adult Treatment Panel III (NCEP ATP III) and the International Diabetes Federation (IDF). These criteria focus on central obesity, high blood sugar, elevated blood pressure, and abnormal lipid levels as the main components. [1-4]

The development of MetS in individuals with T2DM includes an intricate interaction between genetic, environmental, and behavioural variables. Insulin resistance is a key factor in the development and progression of Metabolic Syndrome (MetS), and it may both contribute to and result from MetS. Insulin resistance hinders the ability of tissues to take in glucose, resulting in high blood sugar levels and an

increase in insulin production as a compensatory response. Over time, there is a gradual deterioration of β-cell activity, which worsens high blood sugar levels and makes the development of type 2 diabetes mellitus more likely. Adipose tissue, namely visceral fat, has a crucial impact on the development of insulin resistance and Metabolic Syndrome (MetS). Visceral obesity is linked to higher production of pro-inflammatory cytokines such tumour necrosis factor-α (TNF-α) and interleukin-6 (IL-6), which lead to widespread inflammation and insulin resistance. [5,6] In addition, adipocytes secrete free fatty acids (FFAs) into the bloodstream, which stimulates the production of glucose in the liver and the buildup of fats, worsening metabolic imbalances. Individuals diagnosed with Type 2 Diabetes Mellitus (T2DM) and Metabolic Syndrome (MetS) have a considerably elevated likelihood of acquiring cardiovascular diseases (CVD), which continue to be the primary cause of illness and death in this particular group. Dyslipidemia, which is defined by increased triglycerides and decreased high-density lipoprotein (HDL) cholesterol levels, together with hypertension, significantly amplifies the likelihood of atherosclerosis and subsequent cardiovascular events. Non-alcoholic fatty liver disease (NAFLD) is a significant coexisting condition linked to both Metabolic Syndrome (MetS) and Type 2 Diabetes Mellitus (T2DM). NAFLD includes a range of liver disorders, starting from simple accumulation of fat in the liver (steatosis) to non-alcoholic steatohepatitis (NASH), which may advance to cirrhosis and hepatocellular cancer. Insulin resistance and high levels of insulin in the blood encourage the buildup of fat and inflammation in the liver, which is the underlying cause of non-alcoholic fatty liver disease (NAFLD) in people with type 2 diabetes mellitus (T2DM). [7,8]

To effectively treat Metabolic Syndrome (MetS) in patients with Type 2 Diabetes Mellitus (T2DM), it is necessary to use a comprehensive strategy that addresses each aspect of the syndrome. Implementing lifestyle alterations, such as altering one's diet and engaging in more physical exercise, is essential for effectively controlling Metabolic Syndrome (MetS). Studies have shown that losing weight may enhance the body's ability to respond to insulin, lower blood pressure, and improve abnormal levels of lipids in the blood, therefore reducing the likelihood of developing cardiovascular issues. Pharmacological therapies are often necessary to attain adequate metabolic regulation. Metformin, a primary medication used to treat diabetes, enhances the body's response to insulin and has beneficial impacts on body weight and cholesterol levels. In addition, more recent antidiabetic drugs such as sodium-glucose cotransporter-2 (SGLT2) inhibitors and glucagon-like peptide-1 (GLP-1) receptor agonists have cardiovascular advantages that go beyond controlling blood sugar levels. This makes them beneficial in the treatment of metabolic syndrome in patients with type 2 diabetes mellitus (T2DM). Antihypertensive medications, such as ACE inhibitors and ARBs, are advised for controlling high blood pressure in this group of people because of their ability to protect the kidneys and heart. Statins are the primary treatment for dyslipidemia, successfully lowering levels of low-density lipoprotein (LDL) cholesterol and decreasing the risk of cardiovascular disease. [9,10]

Materials and Methods

The research was carried out in the Cardiology department of IGIMS in Patna, Bihar, India from January 2019 to December 2019. 160 patients who met the inclusion criteria were chosen. Prior to the trial, patients were provided with a clear explanation of the study's goal and their permission was gained based on their understanding of the information provided.

Methodology

Every patient was questioned and given a printed questionnaire. The sociodemographic factors include age, gender, place of residence, and marital status. The clinical variables included physical activity, diet adherence, obesity, family history, diabetes duration, medicines, concurrent risk factors, and complications. Waist circumference (WC) was measured at the level of the umbilicus using labelled plastic tape.

BMI was calculated by dividing the weight in kilogrammes by the square of the height in metres (kg/m2). Blood pressure was measured in the right arm while the person was seated, using a conventional mercury manometer. Aside from doing fasting blood glucose testing, we also conducted and analysed HDL-C and low-density lipoprotein-cholesterol (LDL-C) profiling. The phases of diabetic retinopathy were determined using fundus examination, which included identifying specific indicators such as microaneurysms, dot and blot haemorrhages, hard exudates, cotton wool spots, macular lesions, and the creation of new blood vessels. Clinical tests, including paresthesia, numbness, vibration, and tingling sensation, were used to evaluate diabetic neuropathy. Diabetic nephropathy was diagnosed by evaluating blood pressure, doing renal ultrasonography, performing urine tests, assessing urinary complaints of urgency or frequency, and seeing body edoema in the hands, feet, or eyes.

Data Analysis

Statistical analysis from a printed questionnaire was performed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). The p-value was calculated for

diabetic patients with MetSy, and a p-value <0.05 was considered significant.

Results

This research included a cohort of 160 people diagnosed with type 2 diabetes mellitus (T2DM). The prevalence of Metabolic Syndrome (MetSy) was greater in patients with Type 2 Diabetes Mellitus (T2DM) (105, 65.6%, n = 160) compared to those without MetSy. The average age was 52 years, with a majority of females (51.8%, n = 160) in the 50-59-year age group (56.8%). Out of the whole population, 156 individuals (97.5%) were married, and 122 individuals (76.3%) lived in urban areas. The mean BMI for men was 26.70 ± 0.84 kg/m², whereas the mean BMI for females was 29.38 ± 0.54 kg/m². The prevalence of overweight was 57 individuals, accounting for 35.6% of the population, whereas the prevalence of obesity was 32 individuals, accounting for 20% of the population. A higher waist circumference (WC) was seen in 110 individuals, which accounts for 68.7% of the total sample size (n = 160). Female individuals had a greater waist circumference (WC) of 93.52 ± 1.58 cm. Out of the 83 females, 48 reported experiencing diabetic microvascular complications. In men, the average waist circumference (WC) was 89.64 ± 1.79 cm, and 36 out of 77 patients reported having diabetic microvascular complications. When comparing the diabetic population with the presence or absence of MetSy, this research observed significant p-values for age, gender, high waist circumference, obesity, and BMI (Table 1). The research group was diagnosed with Metabolic Syndrome (MetSy) by using operational definitions that included a combination of criteria. Specifically, 43.4% of the sample met three criteria, 36.2% met four criteria, and 20.4% met five criteria.

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

Variables	Categories	N (frequency, %)	Metabolic syndrome (MetSy)			Diabetes microvascular complications	
			MetSy +	MetSy -	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 MetSy	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 (MetSy)			Diabetes microvascular complications	
			MetSy +	MetSy -	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 MetSy	Three or more	105 (65.6)	105	55	0.02	76	84

Discussion

Diverse studies have shown varying incidence rates of Metabolic Syndrome (MetSy). Both the IDF and AHA concur that a diagnosis of MetSy [7,8] may be established with three out of the five risk factors. Metabolic syndrome (MetSy) is associated with a threefold higher risk of cardiovascular diseases (CVDs), particularly in persons with both MetSy and diabetes. The objective of this research was to determine the prevalence, identify the variables that increase the risk, and assess the microvascular consequences associated with MetSy individuals who had type 2 diabetes mellitus (T2DM). The prevalence of Metabolic Syndrome (MetSy) in this population was found to be 65.6% based on the updated definition provided by the International Diabetes Federation (IDF) in 2023. The figure aligns with the findings published by Saeedi et al. at 66.8% and Abagre et al. at 68.8%. [12,13] Nevertheless, the prevalence exceeded the rates reported in Atlanta by Ford et al. [14], who found a coordination accord of 48.9%, and by Chen et al., who reported a rate of 51.4%. [15] The prevalence of Metabolic Syndrome (MetSy) is significant in these individuals, with a preponderance of Type 2 Diabetes Mellitus (T2DM) at a rate of 78.4%. This percentage is similar to the one published by Vest et al. in 2018, which was 79%16. Of the individuals with Metabolic Syndrome (MetSy) who have type 1 diabetes, 27.3% have received a diagnosis. In 2018, Vest et al. found a prevalence rate of 22.2% [16], while Udell et al. reported a rate of 25.5%. [17] The variations in the prevalence of Metabolic Syndrome (MetSy) may be attributed to factors such as the research period, characteristics of the population, sociodemographic disparities, and variations in the definitions of MetSy. The average age in this research was 52 years, with the majority of participants falling between the 50-59-year age range (56.8%). A majority of the patients, namely 51.8% (n = 160), were females. According to Udell et al. and Backholer et al., the study found that the vast majority of participants (156, 97.5%) were married, and 122 (76.3%) lived in metropolitan areas. In terms of gender, this research found that there was a higher occurrence of MetSy with diabetic microvascular complications in females compared to men. Specifically, 83 females (51.9%) had this condition, whereas 77 males (48.1%) had it. This difference was statistically significant with a p-value of 0.01. The findings presented here are consistent with the results reported by Fawwad et al. in Balochistan, Pakistan [19], and Adeleye et al. in Nigeria. [20] This differentiation may be associated with sedentary behaviour, obesity, increased waist circumference, and the onset of menopause in women. A significant proportion of subjects (68.7%, n = 160) were found to have a big WC. The incidence of waist circumference (WC) in men was measured to be 89.64 ± 1.79 cm. Out of the 77 patients, 36 reported experiencing diabetic microvascular complications. The waist circumference (WC) of females was measured to be 93.52 ± 1.58 cm. Out of the 83 females, 48 reported having diabetic microvascular problems. These findings align with the data presented by Dündar and Akıncı in 2022 from Turkey. [21] The mean BMI for men was 26.70 ± 0.84 kg/m², whereas the mean BMI for females was 29.38 ± 0.54 kg/m². 57 individuals, accounting for 35.6% of the total, were identified as overweight. Additionally, 32 participants, or 20% of the total, were classified as obese. The research found that a large proportion of participants (110, 68.7%, n = 160) had a familial predisposition to diabetes, and 126 individuals (78.7%) had been living with the condition for at least 5 years. Out of the 95 individuals with Type 2 Diabetes Mellitus (T2DM), 59.4% preferred Oral Hypoglycemic Drugs (OHDs) as their medication. The majority of these individuals (102, 63.7%) exhibited low levels of physical activity, either by not engaging in any exercise or by participating in fewer than 150 minutes of exercise each week. Out of the total number of individuals, a significant proportion of

them (128, 80%) were not obese, and a majority of them (118, 73.7%) did not follow a balanced healthy diet that excludes sugar. Out of them, 42 individuals (26.3%) followed the prescribed diet, whereas 133 individuals (83.1%) had inadequate glycemic control with fasting blood sugar levels over 130 mg/dL. In type 2 diabetics, the most common comorbid parameter was hypertension, which was present in 112 individuals (70%). In a meta-analysis of observational studies, Matsubayashi et al. [22] and Alshammary et al. [23] found that MetSy prevalence was mostly determined by a specific factor, which contradicted the findings of Dündar and Akıncı[21] who identified visceral obesity as the most common criteria (68.3%). An observed p-value <0.05 was shown to be significant for all components of MetSy, including hypertension, abdominal obesity, poor glycemic control, hypertriglyceridemia, and hypo-HDL.In this research group of individuals with type 2 diabetes mellitus (T2DM), the diagnosis of metabolic syndrome (MetSy) was determined by using certain criteria. Specifically, 43.4% of the sample met three criteria, 36.2% met four criteria, and 20.4% met five criteria. These findings are consistent with the results published by Rossi et al. [24] and Thomas et al. [25] In research conducted by Hsu et al. on patients with type 2 diabetes mellitus (T2DM) in Taiwan, the most often seen connection of metabolic syndrome (MetSy) was found to be the combination of diabetes, central obesity, and hypertension. [26] The research found that microvascular problems had a prevalence of 36.9% (95% CI = 31.5%-42.3%). Diabetic retinopathy was the prevailing microvascular consequence, with a frequency of 24.9% (95% CI = 20.3%-29.6%) compared to 19.6% in individuals with T2DM without MetSy ($p < 0.05$). This prevalence is greater than the 37.9% reported by Hsu et al. in Taiwan.The number is 26. Bhatti et al. conducted research in India and found that 82% of the Asian population had hypertension. [27]

The prevalence of diabetic kidney disease was determined to be 16.8% (95% CI = 12.8%-20.7%), which is comparable to the findings published by de Boer et al. at 15.8528%. In contrast, the research conducted by Thomas et al. identified a higher incidence of nephropathy at 40.8%. [25] The prevalence of diabetic neuropathy among patients with concomitant Metabolic Syndrome (MetSy) was seen to be 10.8% (95% CI = 7.4%-13.3%), which is similar to the findings of Thomas et al. (13%) and Hsu et al. (12.6%). [25,26] The prevalence of ischemic heart disease was shown to be significantly higher in individuals with Metabolic Syndrome (MetSy) compared to those without MetSy, with a percentage of 58.3% vs 24.7% respectively ($p < 0.05$).The incidence of stroke was observed to be 6.6% among those aged 27. [29,30] There are no particular therapeutic methods for metabolic syndrome in type 2 diabetes mellitus. Therefore, it is essential to promptly rectify each of the factors of MetSy. The objective should be to transition from a sedentary lifestyle to an active one by adhering to a well-balanced diet and engaging in more physical exercise. This includes educating oneself on consuming nutritious food (while lowering calorie consumption) and aiming to lose extra weight, particularly around the abdomen. In order to mitigate the effects of this illness on the microvascular system, it is crucial to address these metabolic problems. [27-30] A limitation of this research was the exclusion of patients with type 1 diabetes mellitus, those under the age of 20, those with newly diagnosed diabetes, secondary diabetes, pregnant women, incomplete records, small sample size, and other related comorbidities. However, this research excels in its ability to estimate numerous variables inside a single study, which is its main strength.

Conclusions

The incidence of Metabolic Syndrome (MetSy) among patients with Type 2 Diabetes Mellitus (T2DM) was found to be significant, with a prevalence rate of 65%. Among individuals in the age category of 50-59 years, married females who were obese were more susceptible to being impacted by MetSy compared to men. Hypertension, inadequate glycemic control, elevated triglyceride levels, low levels of HDL cholesterol, and higher waist circumference and body mass index are additional risk factors that likely to exacerbate the burden of metabolic syndrome in individuals with type 2 diabetes mellitus. Diabetic retinopathy, nephropathy, and neuropathy are the most common small blood vessel problems of diabetes, and urgent intervention is required to prevent their harmful consequences.

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