

Incidence of Nephropathy and Retinopathy in Newly Detected Type II Diabetes Mellitus Metabolic Syndrome Subjects Compared with Age Matched Diabetes Mellitus Without Metabolic Syndrome

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ABSTRACT

BACKGROUND

Metabolic syndrome is a cluster of metabolic abnormalities that often co-exist and would lead to a marked increase in the risk of cardiovascular disease and type 2 diabetes mellitus including obesity, hyperglycaemia, dyslipidaemia, nephropathy, retinopathy, neuropathy and hypertension. Early identification and effective prevention of metabolic syndrome will alter the life course of various chronic conditions reducing morbidity and hence mortality. This study was undertaken in a tertiary care hospital to detect incidence of nephropathy, retinopathy and neuropathy in newly detected type 2 Diabetes mellitus cases with metabolic syndrome.

METHODS

A case control study was undertaken in the OPD of Department of Internal Medicine and Endocrinology in a Tertiary Hospital among 50 cases of newly detected type 2 Diabetes Mellitus with metabolic syndrome and 50 cases of newly detected Diabetes Mellitus without metabolic syndrome. Clearance from the institutional ethics committee was obtained before the study was started. An informed consent was obtained from all the patients before they were included into the study. Final study sample included 50 cases of newly diagnosed case of Type 2 DM with metabolic syndrome and 50 newly diagnosed case of Type 2 DM without metabolic syndrome.

RESULTS

This difference in retinopathy, nephropathy, neuropathy was statistically significant among newly diagnosed cases of Type 2 DM with metabolic syndrome.

CONCLUSIONS

The age group of 51-60 years was commonly affected and males were involved more than the females. Diabetes with metabolic syndrome was known to result in many complications. This study is not without limitations. The sampling method was not followed in this study. Further research can bring out more facts about the metabolic syndrome with complications and its effective prevention.

KEYWORDS

Metabolic Syndrome, Type 2 Diabetes Mellitus, Hypertension, Nephropathy, Retinopathy, Neuropathy

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BACKGROUND

Metabolic syndrome is a cluster of metabolic abnormalities that often co-exist and would lead to a marked increase in the risk of cardiovascular disease characterised by type 2 diabetes mellitus, obesity, hyperglycaemia, dyslipidaemia and hypertension. The essence of the Metabolic syndrome lies in the clustering of these risk factors, whose presence has extensively been reported to point to an almost five-fold elevation in cardiovascular diseases risk.¹

World Health Organization defines metabolic syndrome as the presence of glucose intolerance or insulin resistance or diabetes mellitus with any two of the following components: obesity, high serum triglycerides, low serum high density lipoprotein cholesterol and hypertension.²

In 2005, the International Diabetes Federation (IDF) published new criteria for Metabolic syndrome. Although it includes the same general criteria as the other definitions; it requires obesity, but not necessarily insulin resistance, to be present. The obesity requirement is met by population-specific cut-points. This accounts for the fact that different populations, ethnicities and nationalities have different distributions of norms for body weight and waist circumference (WC). It also recognizes that the relationship between these values and the risk for cardiovascular disorders differs in different populations.³

Most patients with diabetes have diabetic syndrome with estimated prevalence of 69.9 per cent for white, 64.8 percent for blacks and 62.4 per cent for Mexican Americans.⁴ At least 65% of patients having type 2 diabetes mellitus with associated metabolic syndrome die of some form of heart disease or stroke. It is very important to investigate a newly detected case of type 2 diabetes mellitus for signs of the metabolic syndrome so that complications can be prevented.⁵ Syndrome is estimated to be prevalent in one fourth of the world's adults and is noticed in many ethnic groups. Amongst South Asians, evidence suggests that one third of the population is affected by metabolic syndrome and Asian Indians are particularly at high risk of diabetes and Cerebrovascular Disease with the numbers increasing at an alarming rate.⁶ Available literature suggests that the metabolic syndrome is highly prevalent in the patients with type 2 DM from an epidemiological point of view. It precedes to the onset of hyperglycaemia. The prevalence of the metabolic syndrome is 46.9% for males and 65.1% for females in Korea with type 2 diabetes mellitus.⁷ But, much controversy is existing regarding the importance of metabolic syndrome in diabetes as a separate biological entity over each of its components as a cardiovascular risk factor. The studies available have shown that irrespective of its definition the metabolic syndrome is the independent clinical indicator of macrovascular and microvascular complications in diabetes.⁸

Early identification and effective prevention of metabolic syndrome will alter the life course of various chronic conditions reducing morbidity and hence mortality. Hence this study was undertaken in a tertiary care hospital to

detect the burden of metabolic syndrome among the newly detected type 2 Diabetes mellitus cases.

We wanted to determine the incidence of retinopathy, nephropathy, neuropathy in a newly detected type 2 diabetes mellitus patients with metabolic syndrome.

METHODS

A study representing the Metabolic Syndrome were obtained according to modified WHO Criteria, including fasting blood glucose (FBG), 2 hrs. post prandial blood sugar(2 hr PPBS), Glycated Haemoglobin (HbA1c), waist circumference (WC), Hip circumference(HC), Height(H), Weight (W) high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), systolic blood pressure (SBP), and diastolic blood pressure (DBP), and body mass index (BMI), Serum Creatinine, At the baseline examination, blood samples were taken after minimum 6-hours overnight fasting. ophthalmological consultation sought for diagnosing retinopathy.

Inclusion Criteria

Patients presenting to the OPD with newly detected type 2 diabetes mellitus, in the age group 30 to 60 years.

Exclusion Criteria

Patients below the age group of 30 years of age, Palliative care patients. Age above 60 years, Patient with Type 1 Diabetes Mellitus and Gestational Diabetes Mellitus.

The study enrolled 1,986 (854 men and 1,132 women) patients with type 2 diabetes mellitus from outpatient clinics. A case control study was undertaken in the outpatient Department of Internal Medicine and Endocrinology from a private Hospital among 50 cases of metabolic syndrome in newly detected type 2 Diabetes Mellitus compared with 50 cases of Diabetes Mellitus for a period of two years (from January 2016 to Jan 2018). Clearance from institutional ethics committee was obtained before the study was started. An informed consent was obtained from all the patients before they were included in to the study. The sample size was calculated as follows- based on the previous literature, the prevalence of Metabolic Syndrome in newly diagnosed type 2 diabetes mellitus was 66.2%.¹⁹ So, after taking the prevalence as 66.2% and using formulae:

$$n = \frac{Z^2 PQ}{E^2}$$

n=sample size
 Z - Level of significance (5% table value is 1.96)
 P= probability (0.662)
 Q= 1-P (1-0.662=0.338)
 E= Allowable error (taken as 20% of P)
 $n = \frac{(1.96)^2 \times (0.662 \times 0.338)}{(0.132)^2}$
 n=49 ~ 50 (approx.)

So, the final sample size was 50 cases of newly diagnosed cases of Type 2 DM with metabolic syndrome and 50 type 2 diabetes mellitus without metabolic syndrome.

Methodology

A study representing the Metabolic Syndrome were obtained according to modified WHO Criteria, including fasting blood glucose (FBG), 2 hrs. post prandial blood sugar (2 hr PPBS), Glycated Haemoglobin (HBA1C), waist circumference (WC), Hip circumference (HC), Height (H), Weight (W) high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), systolic blood pressure (SBP), and diastolic blood pressure (DBP), and body mass index (BMI), Serum Creatinine, At the baseline examination, blood samples were taken after minimum 6-hours overnight fasting.

Measurements of Anthropometry

Body weight (in kg) was measured in light clothing and without shoes. The weight was recorded to the nearest kg. Height was measured without shoes with the subjects standing fully erect on a flat surface and taken to the nearest centimeter. Body mass index was calculated by the formula $\text{BMI} = \text{Weight in kg} / (\text{Height in meter})^2$. Waist circumference (in centimeter) was measured at midway between the costal margin & iliac crest. Waist circumference was measured at the end of normal expiration. Hip circumference (in centimeter) was taken as the largest circumference at the posterior extension of the buttocks (Trans trochanteric). Waist hip ratio is the waist circumference divided by the hip circumference.

Measuring of Blood Pressure

Study subjects' blood pressure was measured with a random zero mercury sphygmomanometer (Hawksley & Sons, Ltd.; Lancing, United Kingdom). The measurement protocol included; after a supine rest of 5 minutes, three measurements in the supine position, one in the standing position, and two in the sitting position at 5-minute intervals. The mean of all six measurements was used as the systolic and diastolic blood pressures. Blood pressure was measured on the right arm in the sitting position using a sphygmomanometer by the palpatory following auscultatory method.

Diagnosis of Type 2 Diabetes Mellitus

Laboratory Analysis Type 2 diabetes mellitus was diagnosed by history and biochemical tests. Subjects were asked to fast for 12 hours before blood sampling. Determination of routine biochemical parameters was performed with standard techniques by using an autoanalyzer. Glycated haemoglobin (HBA1C) as measured on EDTA blood by ion resin method. Serum Triglyceride was measured by GPO – PAP (Gowland 1988) method. Serum Total Cholesterol, HDL Cholesterol and LDL Cholesterol was measured by Precipitation & CHOD-PAP method (Gowland 1988). Urine microalbumin detected by dipstick method. Urine creatinine were analysed with modified kinetic Jaffe reaction on an architect Ci8200.^R The

estimated GFR is calculated by the Cockcroft and Gault Equation Creatinine Clearance = $((140 - \text{age}) * \text{Wt}) / (\text{serum creatinine} * 72)$ This value is multiplied by 0.85 to estimate GFR.

Statistical Methods

The data was collected using a predesigned proforma and entered in to an excel sheet. The data will be analysed by using Statistical Package for Social Service (vs 20). The categorical variables were presented as frequencies and percentages. The quantitative variables were presented as measure of central tendency and dispersion. Odds ratio between the cases and controls for risk factors and inter observer agreement by using Kappa statistic was calculated.

RESULTS

This study had shown that, 46% of the newly diagnosed type 2 DM with metabolic syndrome and 40% of the diabetic controls were aged between 51 – 60 years. This difference in age was not statistically significant thus ensuring the comparability between the cases and controls. About 50% of the cases and 50% of the controls were males and 50% of the cases and 50% of the controls were females. This difference in sex was not statistically significant between the two groups.

The distribution of the study group according to occupation had shown that, 54% of the cases and 64% of the controls were sedentary workers. This difference in occupation was not statistically significant between the cases and controls. About 74% of the cases and 12% of the controls were vegetarian by diet. About 26% of the cases and 88% of the controls were non vegetarians by diet. This difference in diet was not statistically significant between the cases and controls. Study had shown that, 18% of the newly diagnosed type 2 DM with metabolic syndrome and 10% of the diabetics were current smokers. About 74% of the cases and 80% of the controls were non-smokers. This difference in smoking was not statistically significant between the cases and controls.

About 12% of the cases and 6% of the controls were consuming alcohol. This difference in alcohol consumption was not statistically significant between the two groups. About 26% of the cases and none of the controls had retinopathy. About 22% of the cases and none of the controls had nephropathy. This difference in nephropathy was statistically significant between the cases and controls. About 26% of the cases and none of the controls had vasculopathy. This difference in vasculopathy was significant between the cases and controls. About 14% of the cases and none of the controls had neuropathy. This difference in neuropathy was statistically significant between the cases and controls. This study had shown that, about 84% of the cases and 2% of the controls were inactive. This difference in physical activity was statistically significant between the cases and controls.

Retinopathy	Newly Diagnosed type 2 DM with Metabolic Syndrome n (%)	Type 2 DM n (%)
Absent	37 (74.0)	50 (100.0)
Present	13 (26.0)	0
Total	50 (100)	50 (100)

Table 1. Distribution of the Study Group According to Retinopathy

Neuropathy	Newly Diagnosed Type 2 DM with Metabolic Syndrome n (%)	Type 2 DM n (%)
Absent	39 (78.0)	50 (100.0)
Present	11 (22.0)	0
Total	50 (100)	50 (100)

χ^2 Value= 12.36 df=1 p value, Sig=0.000, Sig

Table 2. Distribution of the Study Group According to Nephropathy

Vasculopathy	Newly Diagnosed Type 2 DM with Metabolic Syndrome n (%)	Type 2 DM n (%)
Absent	37 (74.0)	50 (100.0)
Present	13 (26.0)	0
Total	50 (100)	50 (100)

χ^2 Value= 14.943 df=1 p value, Sig=0.000, Sig

Table 3. Distribution of the Study Group According to Vasculopathy

Neuropathy	Newly Diagnosed Type 2 DM with Metabolic Syndrome n (%)	Type 2 DM n (%)
Absent	43 (86.0)	50 (100.0)
Present	7 (14.0)	0
Total	50 (100)	50 (100)

χ^2 Value= 7.527 df=1 p value, Sig=0.006, Sig

Table 4. Distribution of the Study Group According to Neuropathy

Physical Activity	Newly Diagnosed Type 2 DM with Metabolic Syndrome n (%)	Type 2 DM n (%)
Active	8 (16.0)	49 (98.0)
Inactive	42 (84.0)	1 (2.0)
Total	50 (100)	50 (100)

χ^2 Value= 68.584 df=1 p value, Sig=0.000, Sig

Table 5. Distribution of the Study Group According to Physical Activity

Sugar levels Mean \pm SD	Newly Diagnosed Type 2 DM with MS	Type 2 Diabetics	T Value	p, Sig
RBS	211.86 \pm 73.12	123.48 \pm 16.71	8.332	0.000, Sig
FBS	190.8 \pm 68.7	131.6 \pm 29.14	8.59	0.000, Sig
PPBS	249.66 \pm 85.07	160.4 \pm 29.14	10.164	0.000, Sig
HbA _{1c}	9.66 \pm 1.69	7.12 \pm 0.53	14.15	0.000, Sig

Table 6. Distribution of the Study Group According to Sugar Levels

The mean random blood sugar levels among the cases was 211.86 mg/dl and among the controls was 133.48 mg/dl. The mean FBS among the cases was 190.8 mg/dl and among controls was 131.6 mg/dl. The mean PPBS among the cases was 249.66 mg/dl and among controls was 190.4 mg/dl. The mean HbA_{1c} among the cases was 9.66 gms% and among the controls was 7.12 gms%. The mean difference in RBS, FBS, PPBS and HbA_{1c} were statistically significant between the cases and controls.

DISCUSSION

Definition^{11,12}

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycaemia, resulting from defects in

insulin secretion, insulin action or both. The metabolic dysregulation associated with diabetes mellitus causes secondary pathophysiological changes in multiple organ systems. With an increasing incidence worldwide, diabetes mellitus will be the leading cause of morbidity and mortality in the future.

Pathogenesis¹³

Chronic hyperglycaemia in Diabetes mellitus results both microvascular and macrovascular complications. The microvascular complications include retinopathy, nephropathy and neuropathy. The Macrovascular complications are manifested as coronary artery disease or cerebrovascular disease. The studies have revealed that microvascular complications are mainly because of hyperglycaemia, whereas insulin resistance is the major determinant in macrovascular disease. Atherosclerosis is the pathological entity in macrovascular disease.

Mechanism of Microvascular Complications

Increased flux through the polyol pathway. Intracellular production of advanced glycation end products (AGE)- It is harmful by three mechanisms. Protein kinase activation (PKC activation). Increased hexosamine pathway activity Hyperglycaemia increases superoxide production by the mitochondria and causes oxidative stress on the cells.

Macrovascular Pathogenesis

The increase in HbA_{1c} from 5.5% to 9.5% results in 10 fold increase in the in risk for microvascular disease end points. In contrast, over the same HbA_{1c} range, macrovascular risk increases only about twofold. Hence hyperglycaemia is not the major determinant of diabetic macrovascular disease. Insulin resistance is the main pathophysiologic abnormality found in these patients. Insulin resistance causes mitochondrial overproduction of ROS in macrovascular endothelial cells by increasing FFA flux and oxidation. And, as with hyperglycaemia, this FFA-induced increase in ROS activates the same damaging pathways: AGEs, PKC and hexosamine pathway.

Metabolic Syndrome

The metabolic syndrome is a set of important cardiovascular risk factors. IDF defines metabolic syndrome as increased waist circumference (ethnicity – specific values: ≥ 94 cm in male and ≥ 80 cm in female European Whites) is a main criteria that has to be fulfilled for the condition to be present. Any of the two of four factors including elevated triglycerides (≥ 1.7 mmol/ L), reduced HDL cholesterol (< 1.02 mmol/ L in males and < 1.29 mmol/L in females), elevated blood pressure (systolic ≥ 130 mm Hg, diastolic ≥ 85 mm of Hg, or antihypertensive treatment) and elevated fasting plasma glucose (≥ 5.6 mmol/ L or antidiabetic drug treatment) must also be present.¹⁴

Core Criteria for Diagnosing Metabolic Syndrome

The WHO definition¹⁵ of metabolic syndrome requires the presence of insulin resistance is identified by either type 2

diabetes, impaired fasting glucose or impaired glucose tolerance plus at least two of the following: BMI of > 30 kg /m² and / or waist hip ratio > 0.9 in men or > 0.85 in women. Serum triglycerides ≥ mg/dL (1.7 mmol/L) or HDL cholesterol < 35 mg/dL (0.9 mmol/L) in men and < 39 mg/dL (1.0 mmol/L) in women. Raised arterial blood pressure ≥ 140/90 mm Hg Urinary albumin excretion rate > 20 µg /min or albumin to creatinine ratio ≥ 30 mg/g.

International Diabetes Federation (2006) ¹⁵	US national Cholesterol Education program Adult Treatment Panel III (2001) ¹⁶
Central obesity – defined as waist circumference with ethnicity specific values plus any 2 of the following Raised triglycerides: ≥ 150 mg/dl (1.7 mmol/L), or specific treatment for this lipid abnormality Reduced HDL – C: < 40 mg/dl (1.033 mmol/L) in men, < 50 mg/dl (1.29 mmol/L) in women, or specific treatment for this lipid abnormality Systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg, or treatment of previously, diagnosed hypertension FPG ≥ 100 mg/dl (5.6 mmol/L), or previously diagnosed type 2 diabetes; glucose tolerance test strongly recommended (but not necessary for FPG > 5.6 mmol/L or 100 mg/dl.	At least 3 of the following: Central obesity: waist circumference > 102 cm or 40 in (men), > 88 cm or 35 in (women) Dyslipidemia: triglycerides ≥ 1.7 mmol/L (≥ 150 mg/dl) Dyslipidemia: HDL – C < 40 mg/dl (men), < 50 mg/dL (women) BP: ≥ 130/85 mm of Hg FPG: ≥ 110 mg/dl
<p align="center">Table 7. Core Criteria for Diagnosing Metabolic Syndrome</p>	

Epidemiology of Metabolic Syndrome¹⁷

The reports show that the current global metabolic syndrome is 16% in general population around the world. As per ATP criteria the unadjusted and age adjusted prevalence of metabolic syndrome was 21.8% and 23.7% respectively in United States. The prevalence was less (6.7%) among the participants among the patients aged between 20 – 29 years and 43.5% and 42% for participants aged between 60 – 69 years and more than 70 years. The age adjusted prevalence almost equal in men (24%) and women (23.4%). The African American and Mexican American women had quite higher prevalence than men. The age adjusted prevalence of metabolic syndrome Urban Indian population was 22.9% in men and 30.9% in women.¹⁷ CURES study done in Chennai had shown a prevalence of 23.2% in Urban south Indian population by WHO criteria, 18.3% by ATP III criteria and 25.8% by IDF criteria.

Aetiology of Metabolic Syndrome

The literature available shows that the aetiology of metabolic syndrome is not yet been completely established. Poor nutrition, inadequate physical activity and subsequent increase in body weight are thought to be root causes of metabolic syndrome in most of the patients. Insulin resistance mainly due to obesity and syndrome include cluster of metabolic disorders. A number of factor have been incriminated in the aetiology of Metabolic syndrome¹⁸ like resistance to insulin, waist to hip ratio and free fatty acids.

Components & Consequences of Metabolic Syndrome

Visceral obesity, hypertension, insulin resistance and type 2 DM, dyslipidaemia, atherosclerosis, prothrombotic state, endothelial dysfunction, microalbuminuria, polycystic ovary syndrome, non-alcoholic steato hepatitis, inflammatory markers, obstructive sleep apnoea

Review of Related Studies

In a cross sectional study by Abdul-Ghani M, et al. Isr Med Assoc J. The study group comprised 415 diabetic subjects attending a primary care clinic. Study concluded that in addition to hyperglycaemia and disease duration, the metabolic syndrome is a significant risk factor for the development of microvascular complications in diabetic subjects. In a cross sectional study by Ramachandran A, et al. J Assoc Physicians India. Peripheral neuropathy was present in 27.5%. Cerebrovascular accidents were reported in 26 cases (0.9%). Hypertension was present in 38% of the cases. Higher HbA1c increased the risk of retinopathy, neuropathy and nephropathy. Study conducted by Lee MY, et al. Am J Med Sci. 2018, Association between Metabolic Syndrome and Macrovascular Disease in Type 2 Diabetic Mellitus. The prevalence of metabolic syndrome (MetS) in patients with type 2 diabetes mellitus is high. The metabolic syndrome results in the marked increase in the risk of cardiovascular disease and type 2 diabetes mellitus including obesity, hyperglycaemia, dyslipidaemia and hypertension.¹

New criteria for metabolic syndrome have been suggested by International Diabetes federation (IDF) in the year 2005. Same general criteria have been involved as other definitions as it requires obesity, but not necessarily insulin resistance, to be present. The obesity requirement is met by population-specific cut-points. The literature available shows that this may account for different populations, ethnicities and nationalities have different distribution of norms for body weight and waist circumference (WC). The relationship with these values and the risk factors for cardiovascular disorders differs in difference populations.³

Some of form of heart disease or stroke with type 2 diabetes mellitus associated with metabolic syndrome may die in 65% of the population. It is very important to investigate a newly detected case of type 2 diabetes mellitus for signs of the metabolic syndrome so that complications can be prevented.⁵

The estimated prevalence of metabolic syndrome is one fourth of the world’s population in adults and noticed in many ethnic groups. One third of the South Asians and Asian Indians are affected with metabolic syndrome are at high risk of diabetes and cerebrovascular disease with numbers increasing at an alarming rate.⁶

Early identification and effective prevention of metabolic syndrome will alter the life course of various chronic conditions reducing morbidity and hence mortality. Hence this study was undertaken in a private hospital to detect the burden of metabolic syndrome among the newly detected type 2 Diabetes mellitus with metabolic syndrome cases.

A case control study was undertaken in the OPD of Internal Medicine and Endocrinology from a private Hospital among 50 cases of metabolic syndrome in newly detected type 2 Diabetes Mellitus compared with 50 cases of type 2 Diabetes Mellitus for a period of two years (from January 2016 to January 2018).

A study representing the Metabolic Syndrome were obtained according to modified WHO Criteria, including fasting blood glucose (FBG), 2 hr post prandial blood sugar (2 hr PPBS), Glycated Haemoglobin (HBA1C), waist circumference (WC), Hip circumference (HC), Height (H), Weight (W) high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), systolic blood pressure (SBP), and diastolic blood pressure (DBP), and body mass index (BMI), Serum Creatinine, At the baseline examination, blood samples were taken after minimum 6-hours overnight fasting.

Age Group

This study had shown that, 46% of the newly diagnosed type 2 DM metabolic syndrome and 40% of the diabetic controls were aged between 51-60 years. This difference in age was not statistically significant thus ensuring the comparability between the cases and controls. The mean age of patients with metabolic syndrome was 44.84 years and 48.89 years in without MS.²⁰ Thorat et al had observed that, most of the cases were aged between 30-49 years.²¹ Jacob et al had noted that, the mean age of the males was 49.13 years and females was 50.03 years.²² In a study by Yadav et al, the mean age of males was 55 years and females was 53 years.²³ A study by Osuji et al had shown that the mean age of the newly detected patients with type 2 diabetes mellitus was 55.27 years.²⁴

Sex

About 50% of the cases and 50% of the controls were males in this study which was not statistically significant. In a study by Nahar et al, about 58.5% were males and 41.5% were females.²⁰ In a study by Thorat et al, about 42% were males and 58% were females in contrary to the findings in this study.²¹ Jacob et al had observed that, about 59% of the study participants were males and 41% were females.²² In a study by Yadav et al, majority of the type 2 diabetic patients were males.²³

Occupation

The distribution of the study group according to occupation had shown that, 54% of the cases and 64% of the controls were sedentary worker which was not statistically significant. A study by Jacob et al had noted that, about 70.3% of the study subjects were sedentary by physical activity.²²

Diet

About 74% of the cases and 12% of the controls were vegetarian by diet. This difference in diet was not statistically significant between the cases and controls. A study by Jacob et al had shown that, about 60.1% of the cases with

metabolic syndrome were consuming the non-vegetarian diet.²²

Smoking Status

This study had shown that, 18% of the newly diagnosed type 2 DM and 10% of the diabetics were current smokers which was not statistically significant between the cases and controls. No similar studies were available to compare these results.

Alcohol

About 12% of the cases and 6% of the controls were consuming alcohol. This difference in alcohol consumption was not statistically significant between the two groups. A study by Jacob et al had noticed high prevalence of metabolic syndrome in non-alcoholic group.²²

Retinopathy

About 26% of the cases and none of the controls had retinopathy. This difference in retinopathy was statistically significant. Similar studies were not available to compare these results.

Nephropathy

About 22% of the cases and none of the controls had nephropathy which was statistically significant between cases and controls. No studies were available to compare these results.

Vasculopathy

About 26% of the cases and none of the controls had vasculopathy which was statistically significant between the two groups. The studies were not available to compare these results.

Neuropathy

About 14% of the cases and none of the controls had neuropathy which was statistically significant between the cases and controls. None of the similar study compared these results.

Physical activity

This study had shown that, about 84% of the cases and 2% of the controls were inactive which was statistically significant. A study by Jacob et al had noted that, about 70.3% of the study subjects were sedentary by physical activity.²²

Medications

Among the diabetes patients 18% were on insulin and 82% were on hypoglycaemics. No similar study was available to compare these results.

Family History of Diabetes

About 42% of the cases and 14% of the controls had family history of diabetes mellitus which was statistically significant between the cases and controls. The studies regarding comparison of family history were not available.

Anthropometric Measurements

The mean height of cases was 153.8 cms and controls was 153.98 cms which was not statistically significant. In a study by Yadav et al, the mean height among males was 165.3 mg/dl and females was 153.6 mg/dl. The mean weight of cases was 60.68 kgs and 59.82 kgs in controls. In a study by Nahar et al, among male patients, maximum 56.4% were normal weight, 36.8% were overweight, 3.4% were obese and 3.4% were overweight. In female patients, 49.4% were normal weight, 42.0% were overweight, 7.0% were obese and 2.0% were overweight. In a study by Yadav et al, the mean weight among males was 67.6 kgs and in females was 61 kgs.

The mean BMI among cases was 25.57 kg/m² and 25.24 kg/m² among the controls. Among female patients, the BMI was more than 25 in 61.4% of the patients and 40.2% of the male patients had BMI of more than 25. The mean BMI among the patients with MS was 25.48 and among patients without MS was 23.47. In a study by Thorat et al, the mean body mass index was 27.42. A study by Jacob et al had shown that, about 65.3% of the obese and 80% of the morbid obese cases were found to have metabolic syndrome. In a study by Yadav et al, the mean BMI among males was 24.7 and females was 25.9. Osuji et al had noted that the mean BMI was 30.3 among the patients with newly detected type 2 diabetes mellitus.

The mean waist circumference among the cases was 83.38 cms and among controls was 84.4 cms. Nahar et al had shown that, the mean waist circumference among patients with MS was 90.46 and 84.45 in patients without MS.²⁰ In a study by Thorat et al, the mean waist circumference was 94.67 cms. A study by Jacob et al had shown that, the waist circumference was 91.6 cms among the patients with metabolic syndrome.²² In a study by Osuji et al, about 3.86% of the men had waist circumference of more than 102 cms and 6.77% of the women had waist circumference of more than 88 cms. The mean hip circumference in cases was 87.66 cms and 90.9 cms among the controls. In a study by Thorat et al, the mean hip circumference was 91.24 cms. In a study by Jacob et al, the mean hip circumference among the patients with metabolic syndrome was 98.7 cms.

The mean W:H ratio among the cases was 0.95 and 0.92 among the controls. The mean W: H ratio among the patients with MS was 0.95 and 0.94 among patients without MS.

Duration of Diabetes Mellitus

The duration of diabetes in cases was 2.18 months in this study. Yadav et al had shown that, the duration of the disease among males was 6 years and 5.2 years among females.

Sugar and HbA1c Levels

The mean random blood sugar levels among the cases was 211.86 mg/dl and among the controls was 123.48 mg/dl was statistically significant. The mean FBS among the cases was

190.8 mg/dl and among controls was 101.6 mg/dl which was statistically significant. The mean fasting blood sugar level among patients with MS was 175.78 mg/dl and 150.81 mg/dl among the patients without MS. Study by Thorat et al had shown that, the mean fasting blood sugar among the patients was 186.13 mg/dl in newly detected diabetes. In a study by Yadav et al, the mean fasting blood sugar levels among males was 139.8 mg/dl and among females was 157.8 mg/dl. The mean PPBS among the cases was 249.66 mg/dl and among controls was 120.4 mg/dl. Yadav et al had reported that, the mean PPBS among the males was 207 mg/dl and among females was 219 mg/dl. The mean HbA_{1c} among the cases was 8.66 gms% and among the controls was 5.12 gms%.

Lipid Levels

The total cholesterol among the cases 187.12 mg/dl and among the controls was 159.1 mg/dl which was not statistically significant. In a study by Nahar et al, the mean total cholesterol was 184.87 mg/dl in patients with MS and 159.4 mg/dl in patients without MS. In a study by Yadav et al, the mean total cholesterol was 155.3 mg/dl among males and 169.3 mg/dl among females. Mean total cholesterol among newly detected patients with type 2 diabetes mellitus was 5.17 mmol/ L as noted by Osuji et al.

The mean triglyceride was 150.04 mg/dl among the cases and 159.1 among the controls which was not statistically significant. In a study by Nahar et al, the mean triglyceride levels in patients with MS was 224.96 mg/dl and 155.80 mg/dl among the patients without MS. In a study by Thorat et al, the mean triglyceride was 200.02 mg/dl among the newly detected diabetics. In a similar study by Jacob et al, the mean TG level was 151.3 mg/dl. In a study by Yadav et al, the mean Triglyceride among males was 134.5 mg/dl and among females was 138.8 mg/dl. In a study by Osuji et al, the mean triglyceride level was 1.75 mmol/L in newly detected type 2 diabetes mellitus cases.

The mean HDL was 36.86 mg/dl in cases and 36.48 mg/dl in controls was not statistically significant. In a study by Nahar et al, the mean HDL level was 36.8 mg/dl among the patients with MS and 41.43 among patients without MS. In a study by Yadav et al, mean HDL among males was 48.7 mg/dl and among females was 49.8 mg/dl. Osuji et al had noted that the mean HDL was 1.28 mmol/L among the newly detected type 2 diabetes mellitus cases.

The mean LDL in cases was 120.22 mg/dl and among controls was 118.72 mg/dl which was not statistically significant. Nahar et al had shown that, the mean LDL among patients with MS was 105.03 mg/dl and 89.49 mg/dl among patients without MS. In a study by Yadav et al, the mean LDL was 90 mg/dl among males and 98.7 mg/dl among females. In a study by Osuji et al, the mean LDL was 2.06 mmol/L in newly detected patients of diabetes mellitus. The mean VLDL among the cases was 30 mg/dl and among controls was 31.82 mg/dl which was not statistically significant. Yadav et al reported that, the mean VLDL among the males was 26.4 and among females was 27.7 mg/dl.

Other Biochemical Parameters

The mean microalbumin in cases was 102.86 mg/24 hours and 17.64 mg/24 hours in controls which was statistically significant between the cases and controls. The mean serum creatinine in cases was 1.11 mg/dl and controls was 1.17 mg/dl in controls. The mean BUN in cases was 21.04 U in cases and 18.92 U in controls. The Mean GFR in cases was 87.1 ml and 87.06 ml in controls. The studies were not available to compare these results.

CONCLUSIONS

The age group of 51-60 years was more commonly affected, and males were involved more than the females. Diabetes with metabolic syndrome was known to result in many complications. This study is not without limitations. The sampling method was not followed in this study. Further research can bring out more facts about the metabolic syndrome with complications and its effective prevention.

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