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Clinical and biochemical profile of Indians with type 2 diabetes mellitus: A problem lurking for India

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Abstract

Background: To define the profile of type 2 diabetes mellitus population from the Gwalior region of Madhya Pradesh, as the previous published data shows a pattern and profile variability of type 2 diabetes mellitus from India. **Materials and Methods:** A case control study was carried out in the Department of Medicine comprising 50 newly diagnosed type 2 diabetes mellitus patients and 50 healthy controls. **Results:** The body mass index (BMI) of the study subjects was – cases - 23.94 ± 1.83 kg/m^2, controls - 22.8 ± 1.38 kg/m^2 ($P < 0.001$). Prevalence of an abnormal value of waist-to-hip ratio (WHR) was found to be 46% in the cases. Of the cases, 58% had poor glycemic control. The dominating symptoms were polyuria 30% (15, $P < 0.05$) and tingling and numbness 26% (13, $P < 0.01$). The most prevailing complications were retinopathy 26% (13; $P < 0.01$) and neuropathy 26% (13; $P < 0.01$). Dyslipidemia was present in the 88% of the cases. **Discussion and Conclusion:** This study found that a vast proportion of the cases had poor glycemic control. Central obesity was present in the studied population, with generalized obesity, making the population prone to insulin resistance. Presence of the classical symptoms of diabetes on the back-foot in the studied subject suggests that the disease might be on track of changing its trend or the patients are reporting at a late stage due to health disparities. Dyslipidemia in retinopathic subjects suggests derangement of the lipid profile, which is a risk for retinopathy. The most prevalent form of dyslipidemia in diabetic males was low high density lipoprotein cholesterol (HDL-c), while in females it was high low density lipoprotein cholesterol (LDL-c), and high triglycerides (TG). The pattern of dyslipidemia differed from typical diabetic dyslipidemia.

Keywords: Body mass index, clinical profile, obesity, retinopathy, type 2 diabetes

Introduction

Type 2 diabetes mellitus (T2DM) has been defined as the most prevalent metabolic condition and most prevalent form of diabetes with a tagline as one of the major health problems worldwide.[1,2] The rising prevalence of the disease worldwide makes it a global public health threat with 180 million sufferers.[2,3] Its alarming increase, especially in south east Asia, indicates that more than 60% of the world's diabetic population will be in Asia, with India and China bearing the global diabetic load of more than 75% of the diabetic subjects by year 2025.[2,3]

India comprises a largest hub of diabetics, with 31.7 million cases of T2DM and a three-fold rise in disease prevalence in rural (2-6%) and urban (5-15%) areas.[4] We need to describe and understand the clinical and biochemical profile of diabetes population, to facilitate early diagnosis and suggest lifestyle modifications to curb the onward progression of the disease.[2] Owing to a delay in diagnosis by an average of three to five years leads to a significant proportion of people with type 2 diabetes presenting with complications (both macrovascular and microvascular), usually subclinical and asymptomatic. The pre-established micro- and macrovascular complications, which could be checked through early recognition makes diabetes mellitus a major public health concern.[2]

The published data over the past decades have shown variability in the socioclinical profile of type 2 diabetes mellitus in India, compared to the West.[5] The prognosis of the diabetic patients largely depends on the complications seen in the natural course of the illness, which is governed by the clinical and biochemical profile

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of the patients.[6] However, India being a highly diversified country, the type 2 diabetes mellitus population may have a varied profile. This diversity leads us to define the profile of the type 2 diabetes mellitus population from central India, from where no recent published data on the clinical or biochemical profile exists, to the best of our knowledge.

Materials and Methods

Study area

The present case-control study was carried out in the Department of Medicine; J.A. Group of Hospitals, Gwalior, a teaching hospital of the G.R. Medical College, from May 2009 to November 2010. Fifty newly diagnosed, type 2 diabetes mellitus patients and 50 healthy controls were studied.

Inclusion criteria

The American Diabetes Association criteria have been used for selecting the newly diagnosed type-2 diabetes mellitus patients.[7]

Exclusion criteria

Patients on drugs that altered the insulin sensitivity or on oral hypoglycemic agents (insulin, β agonist, prazosin, diuretics, steroids, oral contraceptive pills (OCPs)), having any condition associated with insulin resistance (polycystic ovary syndrome (PCOD), thyrotoxicosis, congestive cardiac failure, chronic renal failure, cirrhosis, pregnancy, or hypertension (JNC-7 stage I hypertension and stage II hypertension), were excluded.

The volunteer study subjects, who satisfied the inclusion and exclusion criteria, were educated regarding the study, its aims ad objectives. If they were willing to participate in the study, an informed consent was obtained and the subject was taken into the study.

Controls

Fifty healthy volunteers with no family or personal history of diabetes mellitus or hypertension, matched for age and sex, were recruited to serve as controls. Subjects with any history of diabetes mellitus, personal or family history of hypertension, any form of illness, and current use of any form of medication have been excluded from the study.

Collection of data

Consent

An informed consent was obtained from each of the patients prior to the interview. Clearance from the Institutional Ethical Committee was obtained prior to the advent of the study.

Anthropometric, clinical, and biochemical measurements

All patients and controls were subjected to a detailed history and physical examination and investigations. Information on age, sex, body weight, height, waist and hip circumference, and BMI (wt. (kg)/ht (mtr^2)) were obtained. The Ankle-Brachial Index (ABI) (was calculated using the mercury sphygmomanometer in both the cases and controls) measurements were obtained from all case and control subjects. The patients were subjected to a fundus examination, to detect any diabetic retinal abnormalities.

A biochemical profile was done for HbA1c, plasma glucose, renal function tests (RFT), and lipid profile. Fasting (overnight eight hours) and postprandial (two hours) venous plasma glucose were determined by the glucose oxidase method, using the glucose autoanalyzer. Concentrations of total cholesterol, triglycerides, high-density lipoprotein (HDL), and low-density lipoprotein (LDL) were determined by the enzymatic kinetic method using an autoanalyzer. A renal function test, namely, blood urea and serum creatinine, were done. Urine routine and microscopy and urine for microalbumin were also determined. The serum plasma was stored at 20°C until assayed. The corresponding specific insulin concentration was determined by a radioimmunoassay (RIA) using a human specific antibody RIA kit. An electrocardiogram (EKG) was done. The mean of two blood pressures taken five minutes apart had been considered as the actual blood pressure. The Joint National Committee-7 (JNC-VII) criteria was used for defining hypertension.[8]

The National Cholesterol Education Program guidelines were used for defining dyslipidemia.[9] The Asia-Pacific guidelines for defining the Waist circumference (WC) cut-offs were used.[9] The Indian Council of Medical Research recommendations for Indians-obese if BMI was ≥25 kg/m^2 and overweight when BMI was 23-24.9 kg/m^2-were used.[10] Good glycemic control, <7%; sub-optimal control, 7-8%; and inadequate control, 8-9% were used for defining the glycemic control.

Analysis of data

The SPSS 11.5 was used for analyzing the data. The mean and standard deviation was obtained for summarizing the Quantitative variables, while the categorical variables were tabulated using frequencies and percentages. A student's *t*-test was used for testing continuous variables and a Chi-square test for ordinal variables. A *P* value of less than 0.05 was considered significant.

Results

A sample of 50 recently diagnosed type 2 diabetes mellitus patients with 50 controls matched for age and

sex were enrolled. The mean age of the study subjects was 49.98 ± 8.3 years (female 48.87 ± 8.18 years, male 50.46 ± 8.46 years; $P = 0.53$). Seventy-six percent (38) of the subjects belonged to the age group of 41-60 years ($P < 0.01$). The study sample comprised 70% (35) males and 30% (15) females, which was statistically significant ($P < 0.05$).

The clinical and biochemical profiles of the cases and controls have been shown in Table 1. The type 2 diabetics were significantly short-statured with a mean height of 164.78 ± 5.45 cm, as compared to 167.78 ± 4.52 cm for the controls ($P < 0.01$) [Table 1]. According to the BMI, only 32% (16) of the cases had normal weight, with 44% (22) being overweight. The (BMI) body mass index of the cases was significantly higher (23.94 ± 1.83 kg/m^2; $P < 0.001$) as compared to the controls (22.8 ± 1.38 kg/m^2). The prevalence of abnormal WHR (Male > 0.95, Female > 0.8) was found to be 46% (23) in the cases and 38% (19) in the controls. The proportion of abnormal WHR was significantly high among the females in both cases (females - 14, 93.3%; male - 9, 25.7%; $P < 0.0001$) and controls (females - 13, 86.6%; male - 6, 17.4%; $P < 0.0001$).

Table 1: Clinical and biochemical profile of cases and controls

Variables	Mean±SD	
	Cases (50)	Controls (50)
Age	49.98±8.3	49.98±8.3
Systolic blood pressure (SBP, mm Hg)	122.68±7.54	120.52±6.58
Diastolic blood pressure (DBP, mm Hg)	77.24±4.68	77.72±4.37
Weight (kg)	65.3±5.52	64.48±5.99
Height (cm)	164.78±5.45**	167.78±4.52
Body mass index (BMI, kg/m^2)	23.94±1.83***	22.8±1.38
Waist circumference (WC, cm)	92.42±9.3**	87.34±6.57
ABI (Ankle-brachial index)	0.91±0.04**	0.93±0.03
WHR (Waist-hip ratio)	0.94±0.06***	0.9±0.05
Blood urea (mg/dL)	31.97±10.85	29.76±6.57
Serum creatinine (mg/dL)	0.89±0.18	0.88±0.11
Fasting plasma insulin (FPI ulU/ml)	10.54±9.43*	7.43±2.27
Fasting plasma glucose (FPG) (mg/dL)	164.1±54.43****	110.6±7.07
Postprandial glucose (PPG) (mg/dL)	249.46±79.5****	130.1±6.7
Hb (g%)	12.05±1.26****	13.08±0.76
Underweight (<18.5 kg/m^2)***	0	0
Normal range (18.5-22. 9 kg/m^2)	16 (32)	26 (52)
Overweight (23-24.99 kg/m^2)	22 (44)	24 (48)
Obese (≥25 kg/m^2)	12 (24)	0
Waist circumference female (15) >80 cm	14 (93.33)	11 (73.33)
Waist circumference male (35) >90 cm	17 (48.57)	11 (31.42)

Values are mean±SD numbers (percentage); *P** <0.05, ** <0.01, *** <0.001, **** <0.0001 compared to controls

The clinical parameters of the male and female newly diagnosed diabetic patients have been shown in Table 2. Diabetic females had a significantly low weight (female 62.53 ± 4.66 kg, male 66.49 ± 5.49 kg; $P < 0.05$) and height (female 159.73 ± 4.17 cm, male 166.94 ± 4.42 cm; $P < 0.0001$) as compared to their male counterparts, but had higher BMI (24.42 ± 2.15 kg/m^2) as compared to the males (23.73 ± 1.67 kg/m^2). There was a significant difference between males and females with respect to the mean cholesterol (male 194.87 ± 63.34 bmg/dl, female 162.57 ± 38.37 mg/dl; $P < 0.05$), HDL (male 45.33 ± 13.7 mg/dl, female 37.66 ± 7.31 mg/dl; $P < 0.05$), HbA1c (male 11.01 ± 3.12%, female 9.39 ± 1.73%; $P < 0.05$), and Hb (male 11.36 ± 1.17 gm%, female 12.35 ± 1.19 gm%; $P < 0.01$).

Very few study subjects (5, 10%) had good glycemic controls (≤7%). A majority of the subjects (29, 58%) had poor glycemic control (>9%). The odds of having poor glycemic control in females was twice more than in males (OR: 2.10; $P = 0.49$). A nearly significant inverse correlation was found between waist circumferences (WC) and HbA1c (r =−26.45; $P = 0.05$). An inverse correlation was obtained between the waist-to-hip ratio (W/H) and HbA1c (r =−0.24; $P = 0.08$), which was not statistically significant.

The symptoms present in these study subjects are shown in Table 3. Arrhythmia was seen in 4% (2; $P < 0.0001$) and coronary artery disease (CAD) in 10% (5; $P < 0.0001$) of the cases as EKG manifestations, as compared to the controls, who lacked in both manifestations. Twenty-six percent (13) of the study population was retinopathic. Diabetics with retinopathy had significantly high fasting plasma glucose (FPG) (191 ± 55.72 mg/dl; $P < 0.05$) as compared to cases with no retinopathy (154.65 ± 51.43 mg/dl) [Table 4].

Prevalence of low ABI was 12% (6; $P < 0.001$) in the study population. Prevalence of low ABI in male diabetics (14.28%, 5; $P < 0.001$) was significantly high, as compared to their control counterparts, 2.8% (1). A low ABI was seen in 6.6% (1; $P < 0.0001$) of the females, with none of the controls in this low group. Low ABI was found to be present six times more in male diabetics, as compared to their control counterparts. In all the subjects with type 2 diabetes, ABI was positively correlated with BMI (R = 0.15; $P = 0.28$) and systolic BP (R = 0.13; $P = 0.35$). ABI was significantly low in the cases, as compared to the controls (cases 0.91, controls 0.94; $P < 0.01$).

A significantly high proportion of diabetic males (cases 65.71%, 23; controls 37.14%, 13; $P < 0.05$) and females (cases 66.66%, 10; controls 26.66%, 4;

Table 2: Clinical parameters in males and females in the newly diagnosed type 2 diabetic subjects

Variables	Female (15)	Male (35)
Age (years)	48.87±8.18	50.46±8.46
SBP (mm Hg)	120.27±9.19	123±6.6
DBP (mm Hg)	75.73±4.95	77.89±4.47
ABI	0.92±0.03	0.9±0.05
Weight (kg)	62.53±4.66*	66.49±5.49
Height (cm)	159.73±4.17****	166.94±4.42
BMI (kg/m^2)	24.42±2.15	23.73±1.67
Waist circumference (cm)	93.87±9.48	91.8±9.29
WHR	0.92±0.07	0.94±0.05
Blood urea (mg/dl)	34.87±13.03	30.73±9.72
Serum creatinine (mg/dl)	0.85±0.17	0.91±0.18
Cholesterol (mg/dl)	194.87±63.34*	162.57±38.37
HDL (mg/dl)	45.33±13.72*	37.66±7.31
LDL (mg/dl)	126.87±49.01	108.11±30.98
TG (mg/dl)	168.07±53.62	159.97±63.51
HbA1c%	11.01±3.12*	9.39±1.73
FPI (ulU/ml)	13.71±12.57	9.18±7.53
FPG (mg/dl)	180.4±60.25	157.11±51.07
PPG (mg/dl)	260.6±94.53	244.69±73.16
Hbgm%	11.36±1.17**	12.35±1.19
IFG (cases, 100-125 mg/dl)	0	1 (2.85)
Underweight (<18.5 kg/m^2)	0	0
Normal range (18.5-22.9 kg/m^2)	5 (33.33)	11 (31.42)
Overweight (23-24.99 kg/m^2)	5 (33.33)	17 (48.57)
Obese (≥25-kg/m^2)	5 (33.33)	7 (20)

Numbers (percentage); *P** <0.05, ** <0.01, *** <0.001, **** <0.0001, SBP=Systolic blood pressure, DBP=Diastolic blood pressure, ABI=Ankle-brachial index, BMI=Body mass index, WHR=Waist-hip ratio, HDL=High density lipoprotein, LDL=Low density lipoprotein, TG=Triglycerides, FPI=Fasting plasma insulin, FPG=Fasting plasma glucose, IFG=Impaired fasting glucose

Table 3: Presenting symptoms of type 2 diabetic subjects from Gwalior, India

Presenting symptom	Proportion
Polyuria	15 (30)*
Polyphagia	12 (24)**
Polydipsia	09 (18)***
Tingling and numbness	13 (26)**
Weakness	11 (22)**
Nocturnal enuresis	09 (18)***
Decreased appetite	10 (20)**
Altered sleep	12 (24)**
Blurred vision	13 (26)**
Burning micturition	03 (6)****
Skin manifestation	02 (4)****
Chest pain	05 (10)****
Others	12 (24)**
Complications	
Retinopathy	13 (26)**
Nephropathy (Microalbuminuria: 30-300 mg/dl)	11 (22)**
Neuropathy	13 (26)**
CAD	05 (10)****
Arrhythmia	4% (2)****
Risk of PVD (ABI<0.9)	06 (12)****

Numbers (percentage); *P** <0.05, ** <0.01, *** <0.001, **** <0.0001. CAD=Coronary artery disease, PVD=Posterior vitreous detachment, ABI=Ankle-brachial index

P = 0.06) were anemic. The diabetics had significantly low hemoglobin as compared to the controls (cases 12.05 ± 1.26 mg%, controls 13.08 ± 0.76 gm%; *P* < 0.0001). The mean of hemoglobin (Hb) was significantly low in diabetic males (cases 11.7 ± 0.88 gm%, controls 12.45 ± 0.45 gm%; *P* = 0.007), but there was not much difference in the mean for Hb in females (cases 11.36 ± 1.17 gm%, controls 11.7 ± 0.12 gm%; *P* = 0.5). The odds of being anemic was three times in male diabetics as compared to non-diabetic males (OR = 3.2; *P* = 0.03) and for female diabetic as compared to non-diabetic female it was around six (OR = 5.5; *P* = 0.06). Diabetic males (cases 50.65 ± 7.6 years, controls 54.54 ± 7.97 years; *P* = 0.15) and females were younger as compared to their counterpart controls (cases 51.6 ± 7.32 years, controls 54.57 ± 4.11 years; *P* = 0.4).

The lipid profiles of the study subjects are shown in Table 5. In the lipid profile analysis, the HDL (cases 39.96 ± 10.17 mg/dl, controls 47.64 ± 9.83 mg/dl; *P* < 0.001) and triglyceride values (cases 162.4 ± 60.29 mg/dl, controls 120.6 ± 21.21 mg/dl; *P* < 0.0001) were significantly deranged in the cases as compared to the controls. Prevalence of dyslipidemia was significantly high (*P* = 0.009), 88% in the cases (male-30, 68.1%; female-14, 31.8%; *P* < 0.0001) as compared to 64% in the controls (male-21, 65.6%; female-11, 34.37%; *P* = 0.3). Twelve (92.3%) of the retinopathy cases had one or more types of dyslipidemia, while 7.6% (1) of the retinopathy cases was non-dyslipidemic. Microalbuminuric was found among 22% (11) of the subjects.

Discussion

The present study enrolled 50 recently diagnosed type 2 diabetic patients and 50 controls (35 males and 15 females in each group). The mean age of the patients was 49.98 ± 8.3 years. The mean age of the subjects is in accordance with other Indian studies, from 47-50 years,[6,11] however, less than that reported by others.[1,12]

Only 10% of the subjects had good glycemic control (HbA1c ≤ 7%) with poor glycemic control (HbA1c > 9%) reported in 58% of the cases (females-70% and males-52%). It was very low when compared with various studies reporting a good glycemic control proportion, varying from 31-38%.[13,14] This low proportion was in accordance with the studies reporting good glycemic control in only 7 to 17.6% of the study subjects.[2,15] The mean HbA1c of the subjects was 9.95 ± 2.3% (female-11.01 ± 3.12% and male -9.39 ± 1.73%), which was also reported in

other studies (7.9 ± 1.6 to 13.1 ± 3.1).[6,15] Females had a poorer control than there male counterparts, which is in contrast to studies reporting better control in females.[14] Non-adherence to the treatment could be a possible explanation for the uncontrolled glycemic status of these patients, as they are newly diagnosed T2DM subjects. Their prolonged disease state, as is evident from the significantly high proportion of complications, such as retinopathy (26%) and nephropathy (22%), also explains their deranged glycemic status. Deranged glycemic control in females could be explained by their sedentary life style leading to a higher BMI than the males, as also the gender inequality being faced by them in the society, deterring them from accessing medical care.

Table 4: Profile of type 2 diabetics with retinopathy and without retinopathy from Gwalior, India

Variables	Retinopathy	Without retinopathy
Age (years)	48.85 8.87	50.38 8.22
SBP (mm hg)	123.08±8.82	122.54±7.18
DBP (mm hg)	76.77±5.75	77.41±4.32
BMI (Kg/m^2)	24.05 2.08	23.9 1.77
ABI	0.92±0.02	0.9±0.05
Hb (mg/dl)	11.9±1.32	12.11±1.25
Male (Hb<13 mg/ld)	4 (17.3)	19 (82.6)
Female (Hb<12 mg/dl)	4 (40)	6 (60)
HbA1c%	10.68±2.56	9.57±2.25
FPI (ulU/ml)	12.97±11.77	9.57±8.5
FPG (mg/dl)	191±55.72*	154.65±51.43
PPG (mg/dl)	282.62±108.24	237.81±64.51
TC (mg/dl)	178.92±51.28	169.92±48.55
HDL (mg/dl)	40.08±8.16	39.92±1.89
LDL (mg/dl)	118.69±42.05	112±36.63
TG (mg/dl)	149.38±52.25	166.97±62.88

Values are mean±SD, HDL-C=High-density lipoprotein cholesterol, LDL-c=Low-density lipoprotein cholesterol, TC=Total cholesterol, TG=Triglycerides, Numbers (percentage), *P** <0.05. SBP=Systolic blood pressure, DBP=Diastolic blood pressure, ABI=Ankle-brachial index, BMI=Body mass index, HDL=High density lipoprotein, LDL=Low density lipoprotein, FPI=Fasting plasma insulin, FPG=Fasting plasma glucose, IFG=Impaired fasting glucose, PPG=Postprandial plasma glucose

A significant proportion of the cases were overweight and obese as compared to the controls, with none being underweight. The mean values and the prevalence of abnormal values of BMI, WC, and WHR were higher in the cases than in the controls.[16] The same held true for female cases and controls, as compared to their male counterparts.[15,17,18] Diabetic females overpower males in the proportion of being obese. High mean of BMI in females despite being significantly low weight and short statured when compared to the males could be explained from the bread-winning responsibility of male, with the male being the gatekeeper for the outside activity of females, confines them to a sedentary lifestyle – the main culprit for being overweight and obese, with decreased insulin sensitivity.[15,19,20] The high mean of WHR in both the sexes was suggestive of central obesity in this population.[17] A significantly high proportion of abnormal WHR in females was a marker of central obesity and a sedentary lifestyle, a plausible cause of a high mean of BMI in the female subjects forecasts a toll of insulin resistance diabetic female cases in the near future owing to decreased insulin sensitivity.[20] High fasting plasma glucose (FPG), postprandial plasma glucose (PPG), and fasting plasma insulin (FPI) in females, supports the notion of high BMI in the studied females, as even a unit change in BMI significantly increases the risk of developing glucose intolerance.

Predominance of a classic symptom in newly diagnosed young diabetics has been reported in previous studies.

Table 5: Lipid profile with type 2 diabetes subjects from Gwalior, India

Characteristics	Cases (50)		Controls (50)		Total	
	Male (35)	Female (15)	Male (35)	Female (15)	Cases (50)	Controls (50)
TC>200 (mg/dl)	4 (11.4)	6 (40)*	2 (5.7)	1 (6.6)	10 (20)	3 (6)
LDL>100 (mg/dl)	20 (57.1)	12 (80)	20 (57.4)	10 (66.6)	32 (64)***	30 (60)
HDL<40 (mg/dl)	24 (68.5)	6 (40)	7 (20)	3 (20)	30 (60)****	10 (20)
TG>150 (mg/dl)	19 (54.2)	8 (53.3)	1 (2.8)	2 (13.3)	27 (54)****	3 (6)
Pattern of dyslipidemia						
High LDL-c	0	0	14 (40)	6 (40)	0****	20 (40)
Low HDL-c	5 (14.2)	2 (13.2)	1 (2.8)	0	7 (14)	1 (2)
High TG	2 (5.7)	0	0	1 (6.6)	2 (4)	1 (2)
High LDL-c+High TG	3 (8.5)	3 (20)	0	1 (6.6)	6 (12)	1 (2)
High LDL-c+Low HDL-c	4 (11.4)	1 (6.6)	5 (14.2)	2 (13.2)	5 (10)	7 (14)
High TG+Low HDL-c	4 (11.4)	0	1 (2.8)	0	4 (8)	1 (2)
High TC+High LDL-c+Low HDL-c+High TG	2 (5.7)	0	0	0	2 (4)	0
TC (mg/dl)					172.26±48.9	170.74±17.82
HDL-c (mg/dl)					39.96±10.17***	47.64±9.83
LDL-c (mg/dl)					113.74±37.78	104.58±18.87
TG (mg/dl)					162.4±60.29****	120.6±21.21

Values are mean±SD HDL-C=High-density lipoprotein cholesterol, LDL-c=Low-density lipoprotein cholesterol, TC=Total cholesterol, TG=Triglycerides, Numbers (percentage), *P** <0.05, ** <0.01, *** <0.001, **** <0.0001

The presence of classical symptoms of diabetes on back-foot in the studied subject suggests that the disease might be on a track of changing its trend. The second explanation could be late presentation to clinics due to treatment disparities. This study reported a high prevalence of microvascular complications dominated by retinopathy (26%) and peripheral neuropathy (26%) over nephropathy (22%), and followed by others, also reported previously.[11,21] The prevalence of peripheral vascular disease was similar to other studies.[22] A high prevalence of retinopathy in the present study was in accordance with the other studies from India.[23] A male preponderance was reported in the prevalence of retinopathy (male-53.84%, female-46.15%), with an unclear reason, requiring further investigation.[23] The diabetics with retinopathy were young, having poor glycemic control, a significantly high FPG, with less prevalence of anemia, and high ABI, as compared to those without retinopathy; 92.3% of the retinopathic cases were dyslipidemic, as compared to the non-retinopathy cases, suggesting that derangement of the lipid profile was a risk for retinopathy. The mean of the fasting plasma glucose was significantly higher in those with retinopathy than in those without retinopathy, but there was no such difference for blood pressure. The significance of the findings lies in the fact that presently India comprises of more than 31.7 million diabetics, which would translate to a figure of around 8.3 million with diabetic retinopathy (DR) in the light of present DR frequency of 26%, as found in the study.

The prevalence of nephropathy was too high when compared with the existing studies, but was in accordance with the findings of Singh *et al*.[11,23] The prevalence of nephropathy was close to retinopathy and neuropathy, in contrast to the previous studies, which reported very less prevalence of the other two in similar age group subjects.[24] The possible explanation for this unusual finding could be that the rate of progression of nephropathy was high, or these patients could have had an early onset of disease or could be presenting late to the clinic. This close prevalence of nephropathy to retinopathy might be used in the prediction of a high-risk of concomitant diabetic neuropathy (DN) in patients with DR.

The parallel progression of DR and DN is evident from the existing evidences, which suggest that one could be a predictor of the other.[25] Therefore, all patients with DR must be considered as having a high-risk of development and progression to DN, with close monitoring for DN. No association has been found among dyslipidemia and nephropathy in the present study, which is consistent with the previous reports, but not consistent with two large prospective studies.[26,27]

The prevalence of low ABI (<0.90) was found to be significantly high in our study population. A significant difference in the mean of ABI in the cases and controls suggested a high risk of posterior vitreous detachment (PVD) in the studied population.[28] A positive association of ABI with BMI was seen, which was in accordance with the other reports.[29] Our study reported a negative association of ABI with systolic blood pressure (SBP), which was contrary to the findings published.[29] A high prevalence of ABI and its low mean in male cases and controls, as compared to females, suggested that the males were more vulnerable to the development of PVD.[30] Hence, a low ABI should be considered seriously, as it could act as a perfect screening tool for the prediction of cardiovascular disease and PVD in these patients, prior to their development.[28,31]

A significantly high proportion of diabetic males (cases 65.71%, 23; controls 37.14%, 13; $P < 0.05$) and females (cases 66.66%, 10; controls 26.66%, 4; $P = 0.06$) were anemic. Studies suggested that anemia, a common complication, was more prevalent in persons with diabetes.[32] The mean of the hemoglobin (Hb) was significantly low in diabetic males, but there was not much difference in the mean for the Hb in females. Diabetic males were three times more prone to be anemic then non-diabetic males and it was six times for the diabetic females. Anemic diabetic males and females were younger than their non-diabetic counterparts, suggesting an earlier onset of kidney disease leading them to anemia. Anemia can lead to falsely low HbA1c levels, which may result in the undertreatment of hyperglycemia, which in turn will contribute to the progression of both microvascular and macrovascular diabetic complications.[33] Therefore, an investigation for the presence of anemia should be done in such cases.

The lipid profile was significantly deranged in the studied population.[11,14] Dyslipidemia was present in 88% of the cases, as compared to 66% of the controls. The proportion of individual dyslipidemia reported in our study was higher than in other studies.[17] Overall the most prevalent form of dyslipidemia was high LDL-c, with low HDL-c among cases and high LDL-c among controls, in contrast to other reports, with certain supportive clues suggesting high LDL-c in diabetics.[15,34-37] The males were significantly more dyslipidemic than females in both cases and controls. The most prevalent form of dyslipidemia in diabetic males was low HDL-c, while in females it was high LDL-c and high TG. In the control group, for both the genders, high LDL-c was the prevailing condition. In the control group, both the males and females had an equal proportion of derangement for the lipid profile.

The pattern of dyslipidemia in our study differs from the typical diabetic dylipidemia (namely, high TG and low HDL with no difference in the level of TC and LDL) as reported in many studies.[38] More than 60% of the patients had low HDL-c with a female predominance for it.[15,17] A high cardiovascular risk (CV) risk is suggested in this population, as HDL-c is a powerful predictor in diabetes.[39] A high mean of TC, TG, LDL-c, and HDL-c in diabetic females is supported by other studies for LDL-c and TG, but it is different for HDL-c. Reports from Kuwait and Malaysia suggest a worldwide variability in the lipid profile of diabetics.[18]

Conclusion

The present study comprised of 50 recently diagnosed type 2 diabetes mellitus patients, with 50 controls matched for age and sex. Only 10% of the subjects had good glycemic control as compared to other studies reporting the proportion varying from 31-38%. Females had a poorer control than their male counterparts. Diabetic females were greater in number than the males in proportion of being obese. The presence of classical symptoms of diabetes on the back-foot in the studied subject suggests that the disease might be on the track of changing its trend or could be due to the late presentation to clinics due to treatment disparities. A study reported a high prevalence of microvascular complications, dominated by retinopathy (26%) and peripheral neuropathy (26%) over nephropathy (22%), followed by others. The significance of the findings lies in the fact that presently India comprises of more than 31.7 million diabetics, which would translate to a figure of around 8.3 million with DR, in light of the present DR frequency of 26%, as found in this study. The pattern of dyslipidemia in our study differs from typical diabetic dyslipidemia (namely high TG and low HDL, with no difference in the level of TC and LDL), as reported in many studies. Diabetic males are three times more prone to be anemic than non-diabetic males and it is six times for diabetic females. Anemia can lead to falsely low HbA1c levels, which may result in the undertreatment of hyperglycemia, which in turn will contribute to the progression of both microvascular and macrovascular diabetic complications. Therefore, an investigation for the presence of anemia should be done in such cases.

Strength and limitations of the study

The strength of the study is that it has age-and sex-matched controls for each case. Unavailability of local data from the study area is another strength of the study, as there is no recent published data from the area to the best of our knowledge. Being a hospital-based study; the prevalence of the certain findings may be high, due to reporting of the population at a late stage, therefore, the study may not reflect the whole picture of the problem in the community.

Any conflicts of interest relevant to this manuscript are nil.

Ajay Pal Singh, contributed to the study concept and design, and wrote the manuscript. Sandeep Singh, Manish Kishore Multani and Ashish Purohit contributed to the study concept and design, analysis, interpretation of the data, and drafting of the manuscript.

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