ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Risk factors associated with prediabetes and cardiovascular disease: A perceptive study

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Submission: 17-05-2022 Revision: 03-09-2022 Publication: 01-10-2022

ABSTRACT

Background: Diabetes mellitus is emerging as a major health problem due to its serious complications. It is important to assess the various factors contributing to the occurrence of the diseases so that by limiting these factors the progression of the disease in patients can be controlled. Prediabetes is a state characterized by impaired fasting glucose or impaired glucose tolerance. **Aims and Objective:** The present study was undertaken to determine the risk factors for Type 2 diabetes mellitus (T2DM) among adults, prediabetic subjects were identified from first degree relatives of T2DMpatients. **Materials and Methods:** The present observational study was carried out at Department of Physiology, S.P. Medical College and Hospital in collaboration with diabetic research center P.B.M. hospital Bikaner (Rajasthan). Prediabetic subjects were identified from first degree relatives of T2DMpatients, enrolled in diabetic research center P.B.M. hospital Bikaner. Prediabetics (impaired fasting glucose) subjects were identified on the basis of fasting blood glucose 100–125 mg/dL and HbA1C (5.7–6.4%) as per American Diabetic Association (ADA) 2011 guidelines. Consecutive sampling was conducted till sample size satisfied during the period of study. Subjects of age group 20–74 years having FPG between 100 and 125 mg/dL, HbA1C between 5.7% and 6.4%, and gave informed written consent were included in study. Pre-structured performa was used to collect general information, sociodemographic information, baseline physical characteristics, personal habits, biochemical analysis, and for blood parameters. **Results:** Age, occupation, body mass index (BMI), diet, smoking, alcohol, truncal obesity, and family history of DM were significantly associated with prevalence of T2DM/prediabetes whereas gender and literacy were not. **Conclusion:** In the present study, it was observed that advanced age, occupational changes, BMI, substance abuse such as alcohol and smoking, truncal obesity, and family history of diabetes were highly associated risk factors for T2DM whereas literacy, gender, and central obesity showed no association with risk of T2DM.

Key words: Impaired fasting glucose; Prediabetes; Cardiovascular disease; Risk factors

Access this article online

Website: http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v13i10.45148

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Diabetes mellitus is the single and most important metabolic disease recognized worldwide as one of the leading causes of death and disability.[1] The problem has reached pandemic proportions. Type 2 diabetes is the most common form of diabetes constituting almost 90% of diabetic population. The prevalence of diabetes in the adults worldwide was estimated to be 4.0% in 1995 and expected to be 5.4% by the year 2025. Its incidence is higher in developing countries than developed countries.[2]

Today, India leads in the world with its largest number of diabetic subjects as compared with any given country. It has been estimated that presently 19.4 million individuals are affected by diabetes and these numbers are expected to increase to 57.2 million by the year 2025 (one-sixth of the world total).[3]

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Diabetes mellitus is a chronic complex metabolic disorder characterized by elevated blood glucose level that might lead to micro and macrovascular complications. As the prevalence of diabetes increases, so does its complications. Poorly managed diabetes leads to serious complications that considerably increase mortality rate and impair the quality of life, even causing loss of productivity at a young age. It also presents a high burden on both individuals and society in terms of morbidity and socioeconomic costs.[4]

CVD is the leading cause of death among men and diabetes is a major risk factor for CVD in both men and women. The risk of developing CVD is greatly elevated in patients with Type 2 diabetes compared with the general population. Type 2 diabetes is the most common form of diabetes that most often occurs after the age of 40. The CVD that might accompany diabetes includes angina, myocardial infarction (heart attack), stroke, peripheral artery disease, and congestive heart failure.[5]

Understanding the pathogenesis of Type 2 diabetes is complicated by several factors.[6,7] Patients present with a combination of varying degrees of insulin resistance and relative insulin deficiency and it is likely that both contribute to T2DM.[8]

Furthermore, each of the clinical features can arise through genetic or environmental influences, making it difficult to determine the exact cause in an individual patient. Moreover, hyperglycemia itself can impair pancreatic ß-cell function and exacerbate insulin resistance, leading to a vicious cycle of hyperglycemia causing a worsening metabolic state.[6,9] Type 2 diabetes most likely represents a complex interaction among many genes and environmental factors. Monogenic causes of Type 2 diabetes represent only a small fraction of cases and commonly inherited polymorphisms individually contribute to only small degrees of risk for, or protection from, diabetes. The most of the genetic risks for Type 2 diabetes results from complex polygenic risk factors. First-degree relatives of patients with Type 2 diabetes frequently have impaired non-oxidative glucose metabolism (indicative of insulin resistance) long beforethey develop Type 2 diabetes.[9] In addition, they may have beta-cell dysfunction, as evidenced by decrease in insulin and amylin release in response to glucose stimulation.[7,10] Although many studies have been conducted in other countries, there is no study about relatives in P.B.M. hospital Bikaner population and there is no study that four different tests were done to the relatives in the literature. We designed the present study to observe the prevalence of prediabetes in the first degree relatives of Type 2 diabetic patients enrolled in diabetic research center P.B.M. hospital Bikaner population which will be helpful for clinicians to make the treatment line for this type of patients. Moreover,to assess various predisposing factors for diabetic and cardiovascular risk because it is a new work in this region and in prediabetic population.

Aims and objectives

To assess the effect of risk factors associated with prediabetes and cardiovascular disease.

MATERIALS AND METHODS

The present observational study was carried out at Department of Physiology, S.P. Medical College and Hospital in collaboration with diabetic research center P.B.M. hospital Bikaner (Rajasthan).Prediabetic subjects was identified from first degree relatives of Type 2 DM patients, enrolled in diabetic research center P.B.M. hospital Bikaner. Prediabetics (impaired fasting glucose)subjects were identified on the basis of fasting blood glucose 100–125 mg/dL and HbA1C (5.7% TO 6.4%) as per American Diabetic Association (ADA) 2011 guidelines.[11] We were taken sample size 142. Sample size calculated on the basis of prevalence of prediabetes in India[12] using appropriate sample size calculating formula.The present study data were collected in 8 months. The Institutional Ethical Committee at the Sardar Patel Medical College and Associated Group of P.B.M. Hospitals, Bikaner, Rajasthan, India, approved the study. The Developmental Research Committee at the Rajasthan University of Health Sciences, Jaipur, India, was also approved the study. Consecutive sampling was conducted till sample size satisfied during the period of study. Subjects of age group 20–74 years having FPG between 100 and 125 mg/dL, HbA1C between 5.7% and 6.4%, and gave informed written consent were included in study.

Tool of data collection

Pre-structured performa was used to collect general information, sociodemographic information, baseline physical characteristics, personal habits, biochemical analysis, and for blood parameters.

Socioeconomic status

The participants were interviewed with a pretested questionnaire regarding identification, demographic details, behavioral components, social, and biological variables. Education was classified based on International Standard Classification of Education. The occupation of study subjects was classified as workers and non-workers as per census of India 2001. Further workers were subdivided based on their occupation such as Skilled-I to Skilled –IV. Non-workers included house-wives and elderly persons who have stopped working.[13]

Family history of diabetes

Detailed family history of T2DM was taken. This was verified either by blood glucose measurement of the parents or in the person's absence, by other circumstantial evidences such as physician report, diet modifications, and consumption of drugs. Known cases of T2DM were included in the study. Duration of diabetes and medication details was noted. In the present study, if the response was "diabetes status of parents not known," it was assumed to be "No family history of DM."[14]

Smoking and alcohol

Smoking and alcohol were considered as risk factors. Smoking was measured in terms of frequency those who were smoking daily for 6 months and quantum tobacco chewing/beedies/cigarettes/cheroots/day. Based on tobacco content of Indian beedis, cigarettes, and cheroots, Indian cigarette equivalents of beedi and cheroot were calculated,the alcohol consumption pattern (amount, type, and frequency) of current drinkers and past drinkers (who have stopped before 12 months) was noted.[15]

Statistical analysis

Numerical variables were reported in terms of mean and standard deviation. Statistical analysis of results was done by normal distribution "Z" test. In this analysis, variables showing $P<0.05$ and 0.001 were considered to be statistically significant and highly significant, respectively. Correlation coefficient (r) was calculated for finding correlation between two biochemical parameters using Pearson two-tailed analysis.

RESULTS

The study sample according to as per criteria age-wise prediabetic subjectsis shown in Table 1. Age-wise distribution in prediabetic subjects was found 30–34 years in maximum 48; 33.80% with prediabetes, 35–39 years (29;20.42%) while 40–44 and 45–49 years (17;11.97%) and minimum only 55–59 years age group were found (1;0.70%) in prediabetic subjects out of 142 total subjects. Table 2 shows the gender-wise distribution in prediabetic subjects where the prediabetic subjects (91;64.08%) were male and (51;35.92%) were female out of both 142 in prediabetic subjects. Table 1 showsthat the socioeconomic status maximum number of prediabetic wasupper lower 140(38.99%), lower 105(29.24%), lower middle 56(15.59%), upper middle 37(10.3%), and minimum numberupper 21(5.84%) were found in prediabetes. Table 1 showsthat the literacy status maximum number of prediabetic wssecondary 65(45.77%), graduate and above 42(29.58%), primary 18(12.68%), and minimum no illiterate 17(11.97%) were found in prediabetes.

Table 2 shows the anthropometric measurements of the subjects with prediabetes. As expected, mean±SD levels of body mass index (BMI) (kg/m^2) (25.18±4.76), waist circumference (WC) (92.33±13.20), waist to hip ratio (Wc/Hc) (0.9195±0.09), systolic blood pressure (130.06±14.38), and diastolic blood pressure (82.26±7.09) showed marked difference and were statistically significantly in prediabetes in compare with diabetic. Biochemical parameters of the individuals studied in the present study are given in the (Table 2). Mean±SD levels of fasting glucose (fasting blood sugar) (116.92±6.14), triglycerides (3.50±0.81), total cholesterol (186.57±20.53), low-density lipoprotein-C (109.66±22.13), and very low-density lipoprotein-C (30.84±3.88) were significantly altered and high-density lipoprotein-C (3.50±0.81) to diabetic subject. Table 3 showsthat the hematologicalparameters in prediabetic subjectsmean±SD were also altered with compare to diabetic group. Comparison of baseline physical characteristics, biochemical and hematological parameters among normotensive, prehypertensive, and hypertensive prediabetic subjects. These all results were found significantly altered (Tables 4 and 5).

DISCUSSION

Epidemiological data from different parts of India showed a rise in prevalence of diabetes. In the present study, different finding was observed compared to other studies, despite adopting WHO standards which could be due to difference in methodologies for measuring blood glucose definition of diabetes, age group, and geographical situations. The present study showed high prevalence of T2DM (17.7%) in rural population of north Karnataka, while similar study reported lower prevalence (5.2%) in rural population in costal Karnataka.[16]

In present study, it is also observed that the increasing in age was significantly associated with higher risk of T2DM. Bhalerao (2013) and Howard (2004) had reported the similar results. This may be due to prolonged exposure to stress, obesity, genetic factor, and advancement of age. The high prevalence among young adults 30–39 years (4.9%), the most productive age group of the community is unacceptable and hence focus on prevention of diabetes among young is essential.[17,18]

The present study showed that BMI is a significant predictor of development of diabetes. Several studies reported BMI as an independent risk factor for development of diabetes (Snehalata, 2003 and Khan, 2006). The present study also supported the evidence among Indian, even at lower BMI, there was high odds of diabetes (adjusted OR=2.1). Hence, early identification of high BMI would be helpful

Table 1: Frequency and percentage distribution of the prediabetic patients according to their baseline socio-demographics characteristics of the study population

Parameter	Frequency of prediabetic (No. 142)	Percentage
Gender		
Male	91	64.08
Female	51	35.92
Age (years)		
30–34	48	33.80
35–39	29	20.42
40–44	17	11.97
45–49	17	11.97
50–54	18	12.68
55–59	1	0.70
60–64	5	3.52
65–69	5	3.52
≥70	2	1.41
Socioeconomic status		
Upper	21	5.84
Upper middle	37	10.3
Lower middle	56	15.59
Upper lower	140	38.99
Lower	105	29.24
Occupation		
Skilled –I	26	18.31
Skilled –II	48	33.80
Skilled –III	15	10.56
Skilled –IV	13	9.15
Non-worker	40	28.17
Literacy		
Illiterate	17	11.97
Primary	18	12.68
Secondary	65	45.77
Graduate andabove	42	29.58
BMI		
<18.5	10	7.04
18.5–24.9	83	58.45
25–29.9	28	19.72
30.0–34.9	14	9.86
35.0–39.9	6	4.23
≥40.0	1	0.70
Habits smoker		
Yes	54	38.03
No	88	61.97
Locality		
Rural	26	18.31
Urban	116	81.69
Exercise		
Vigorous exercise (regular)+strenuous activity on work/home	9	6.34
Regular moderate exercise moderate activity on work/home	19	13.38
Regular mild exercise mild activity on work/home	36	25.35
No exercise and sedentary work	78	54.93
BP category		
Normotensive	27	19.01
Prehypertensive	79	55.63
Hypertensive	36	25.35
Total	142	100.00

BMI: Body mass index, BP: Blood pressure

for primary prevention and early diagnosis of diabetes. Khan et al., reported that in obese individuals, adipose tissue releases increased amounts of non-esterified fatty acids, glycerol, hormones, proinflammatory cytokines, and other factors that are involved in the development of insulin resistance.[19,20]

The present study showed that there was a significant association of occupation with increasing prevalence of T2DM. Similar findings were reported by some other studies in India (Agardh, 2011). This association of diabetes with occupation could be due to combined effect of physical inactivity in employees, house wife,

Table 2: Baseline mean±SD of anthropometric physicalcharacteristics in prediabetic subjects

Parameters	Mean±SD	Median	Range
Age (years)	41.18±10.45	38	30–74
BMI (kg/m^2)	25.18±4.76	24.6	17.2–41.7
WC (cm)	92.33±13.20	91.44	60.96–139.7
W/H ratio	0.9195±0.09	0.899	0.697–1.652
SBP (mmHg)	130.06±14.38	130	86–164
DBP (mmHg)	82.26±7.09	80	70–100

SD: Standard deviation, BMI: Body mass index, WC: Waist circumference, W/H: Waist to hip ratio, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 3:Baseline mean±SD of anthropometric physicalcharacteristics in prediabetic subjects

Serum lipid profile	No. of patients	Percentage
Total cholesterol (mg/dL)		
<200	85	59.86
≥200	57	40.14
Mean±SD	186.57±20.53	-
Sr. TG (mg/dL)		
<150	63	44.37
≥150	79	55.63
Mean±SD	156.38±19.76	-
Sr. LDL (mg/dL)		
<100	51	35.92
≥100	91	64.08
Mean±SD	109.86±22.13	-
Sr. HDL (Males) (mg/dL)		
<40	32	35.16
≥40	59	64.84
Mean±SD	44.39±5.88	-
Sr. HDL (females) (mg/dL)		
<50	28	54.90
≥50	23	45.10
Mean±SD	48.64±6.61	-
Sr. VLDL (mg/dL)		
<38	119	83.80
≥38	23	16.20
Mean±SD	30.84±3.88	-
TG/HDL ratio (mg/dL)		
<3.5	80	56.34
≥3.5	62	43.66
Mean±SD	3.50±0.81	-
LDL/HDL ratio (mg/dL)		
<2.5	77	54.23
≥2.5	65	45.77
Mean±SD	2.48±0.78	-

Sr. Serum, SD: Standard deviation, TG: Triglycerides, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, VLDL: Very low-density lipoprotein

and work-related stress among those who work in agriculture field.[1]

There was no significant association with literacy. Similar results were reported from a cohort study among industrial workers (Chaturvedi, 1996). However, some Western studies had reported a decrease in prevalence with increase in educational status. Low educations may influence the lesser awareness and lesser opportunity for prevention and control. Higher educational status may influence the lifestyle factors.[21]

Table 4: Biochemical parameters in prediabetic subjects

Parameters	Mean±SD	Median	Range
Total cholesterol	186.57±20.53	190.5	152–218
TG	156.38±19.76	154	126–194
HDL	45.92±6.46	47	31–60
LDL	109.66±22.13	116.5	71–152
VLDL	30.84±3.88	30.5	25–38
TG/HDL	3.50±0.81	3.34	2.26–5.74
LDL/HDL	2.48±0.78	2.4	1.26–4.45
AIP ratio	0.170±0.09	0.153	0.003–0.399
HbA1C	6.03±0.27	6.1	5.4–6.4
FBS	116.92±6.14	118	100–125

SD: Standard deviation, TG: Triglycerides, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, VLDL: Very low-density lipoprotein, FBS: Fasting blood sugar

Table 5: Hematologicalparameters in prediabetic subjects

Parameters	Mean±SD	Median	Range
RBC	4.80±0.59	4.81	3.75–8.28
WBC	8.72±2.02	8.45	4.6–15.5
Lymphocyte %	40.99±7.93	41.1	23.6–57.4
Monocyte %	7.67±2.28	7.40	3.6–15.4
Granulocyte %	51.19±8.96	51.30	33–72.3
HB	13.19±1.68	13.6	8.4–16.2
HCT	40.61±4.90	41.5	25.29–51.3
MCV	84.04±11.90	86	55–108
MCH	27.66±3.59	27.75	14.3–39.1
MCHC	32.50±2.76	31.95	26.0–44.9
RDW-CV	14.63±1.30	14.40	12.7–21.7
Platelet	269.38±80.41	265	105–503
RDW-SD	44.74±4.05	44	33–65

SD: Standard deviation, RBC: Red blood cell, WBC: White blood cell

Dietary habits also demonstrated a significant association with incidence of T2DM in this study. Non vegetarian dietary habits were associated with 1.29 times odds for incident T2DM compared with those with good dietary habits (Chow, 2006).[22] The present study showed association between truncal obesity and prevalence of T2DM. But this association was of non significant type. Several studies reported that truncal obesity can be a risk factor for diabetes (Khan, 2006, Kahn, 2000 and Agardh, 2011).[1,20,23]

There were no significant gender differences in prevalence of diabetes. Similar findings were reported by multicentric studies in India (Khatib, 2008).[24] However, few studies have showed a higher prevalence in females and some other studies showed higher prevalence in males (Prabhakaran, 2005).[25] This is possibly due to coexisting risk factors in specific gender. Alternatively, gender may not be a risk factor in T2DM.The present study showed that the odds of diabetes among those with family history of T2DM (in terms of parental history) were 35.97 times as compared to those without a family history of T2DM.

The present study also reported the maternal history of T2DM to be stronger compared to paternal history of T2DM. Studies reported relatively higher risk with maternal history of diabetes compared to paternal(Meigs, 2000). When both parents were diabetic, the risk increases synergistically. However, in the present study, no such effect was observed, probably because there were only a few subjects with both parents diabetic. Family history of T2DM could act through environmental factors (diet, stress, physical activity, and socioeconomic status) as well as a genetic mechanism through gene expression. Family history of diabetes could be an important public health tool in predicting development of diabetes.[26]

The present study showed that smoking is associated with diabetes. Smoking habits were associated with 1.94 times odds for incident T2DM. This finding agrees with several other cohort studies(Nakanishi et al., 2000).[27] The present study showed a significant association between alcohol consumption and risk of diabetes. This is probably due to the development of insulin resistance, which is a key factor in the pathogenesis of T2DM among heavy alcohol drinkers and this has been shown by some studies to be mediated by increased obesity, especially abdominal obesity. The literature showed varied association of alcohol consumption and increased risk of diabetes (Wei et al., 2000 and Howard, 2004).[18,28] The present study is the first study conducted in the Bikaner region of Rajasthan state. Hence, it will be helpful for clinicians for making the treatment line in this region and to findout the causing factors of this type of non-communicable diseases.

Limitations of the study

We did'nt compare the prediabetes with the diabetes. And it must be a prospective study for better results.

CONCLUSION

In the present study, it was observed that advanced age, occupational changes, BMI, substance abuse such as alcohol and smoking, truncal obesity, and family history of diabetes were highly associated risk factors for T2DM whereas literacy, gender, and central obesity showed no association with risk of T2DM. This study created awareness of diabetes and its complication in rural population of this region. The baseline data of the present study regarding the prevalence of T2DM and its associated risk factors could be useful for implementation of the National Program for control of diabetes, cardiovascular diseases, and stroke (NPDCS). Therefore, the future research in this direction is a need of the time.

ACKNOWLEDGMENTS

Dr. B.K. Binawara, Professor, Guide is the study principal investigator. The authors are grateful to Professor for his helps in scientific discussion and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Source of Support: None, **Conflict of Interest:** None.