Original Article

Pre-diabetes in offspring of patients with type 2 diabetes mellitus: A cross-sectional observational study

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Abstract

Background: More than 50% of patients with diabetes mellitus in India are unaware about their diabetic status. Pre-diabetes is a potential state for developing diabetes mellitus.

Methods: The present cross-sectional hospital based observational study aimed to screen apparently healthy offspring of patients known to have type 2 diabetes mellitus (T2DM) in Western Maharashtra region in India. The study was conducted in 187 offspring of T2DM patients between the age group of 18–50 years. Fasting blood glucose levels were tested in all of them.

Results: Among offspring of T2DM patients, pre-diabetes was documented in 20.9% (14.4% in males, 6.4% in females). In the age group of 41–50 years, pre-diabetes was evident in 27.8% which was high compared with other age groups. Prediabetes among offspring with father with T2DM, mother with T2DM and both parents with T2DM were 10.7%, 30.3% respectively 23.5%.

Conclusions: Our observations suggest that an association exists between positive family history of T2DM and pre-diabetes in Western Maharashtra. Screening offspring of patients with T2DM may be useful as a public health tool for early detection of T2DM.

Keywords: Fasting blood glucose, offspring, pre-diabetes, type 2 diabetes mellitus

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INTRODUCTION

Diabetes mellitus (DM) remains one of the most promising global epidemics of the 21st century.[1] It is recognised as one of the leading causes of death and disability worldwide.[2,3] Among people with DM, almost 90% the population suffer from type 2 DM (T2DM). DM is probably gaining epidemic proportions in India.[4] Currently, India is home to one-sixth of the world total population of people with DM.[5] The WHO has revised the diabetic population in India and predicted it to be as 80 million by the year 2030.[6] The incidence of DM is higher in developing countries as compared to developed countries.[5] The prevalence of diabetes worldwide was estimated to be 2.8% in 2000 and will reach 4.4% in 2030.[6] According to the report of the International Diabetes Federation,[7] 425 million people worldwide have been affected from DM in 2017 and with this trend will reach up to 629 million patients till 2045. India has a growth rate of 12.5% and 20% of the world's population with increased risk for DM lives in urban areas.[8] The prevalence of diabetes in India which was 8.8% in 2017 will reach up to11.4% by 2045.[9] In Asia,

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about 60% of persons with diabetes mellitus go undiagnosed in the South-east population.[7] Delayed diagnosis and inadequate management of glycaemia have led to severe microvascular and macrovascular complications in South Asians with T2DM.[10] Recently, it has been observed that there is an increase in the population with impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) in all parts of India.[11]

Pre-diabetes is a high-risk state for developing diabetes and associated complications.[12] Pre-diabetes is a high-risk state for diabetes mellitus that is defined by higher than normal glycaemic variables, but lower than diabetes thresholds.[13,14] Fasting blood glucose levels between 100 and 126 mg/dL or post-prandial blood glucose between 140–200 mg/dL is considered to be prediabetes.[15] The American Diabetes Association (ADA), pre-diabetes is set with a lower cut-off range for IFG that is between 100 and 125 mg/dL. Along with this ADA has also introduced glycosylated haemoglobin to diagnose pre-diabetes as levels ranging from 5.7% to 6.4% to avoid underestimation of the prevalence of diabetes and pre-diabetes.[15] For diagnostic purposes, capillary blood glucose estimation by glucometer is considered to be a an alternative to venous plasma glucose estimation.[16]

For patients with DM, family history information may act as a unique and useful tool in public health and preventive medicine as it gives an idea about genetic and environmental factors. Detailed family history can help to identify individuals at different levels of risk at an earlier stage and to promote health-modifying behaviours in them to halt the progression of the disease.[3] Currently, India is passing through nutritional transition with the rise in the prevalence of overweight and obesity. Rapid developmental urbanisation and changeovers in nutritional statuses due to busy lifestyles has in part led a high prevalence in DM.[10] For the success of the National Diabetes Control Programme initiated by the Government of India mass awareness and screening programmes will be definitely helpful. This will result in early detection of pre-diabetes which are prone to develop diabetes and also help to reduce the burden of diabetes in the country. Active screening efforts should be done for early detection to avoid further disease development and its complications.

Very few studies are available on the prevalence of pre-diabetes in the offsprings of known T2DM in Western Maharashtra. With the above-mentioned facts, the present study was designed to identify the burden of pre-diabetes in apparently healthy offspring of patients known to have T2DM in Western Maharashtra.

MATERIAL AND METHODS

A cross-sectional observational study based on a hospital data was conducted for 5 months to know the prevalence of pre-diabetes in offspring of patients with T2DM. The study was conducted in the Department of Physiology, Government Medical College, Miraj Maharashtra, after getting clearance from the Institutional Ethics Committee (GMCM/IEC-C/88/2021 Dt 20-9-2021). All the offsprings of both gender between the age group of 18 and 50 years of already diagnosed and registered type 2 diabetics in the out-patient department (OPD) of the hospital from the areas in and around Miraj and who were willing to participate in the study were considered as the study population. They were counselled and invited through personal meetings, e-mails, WhatsApp groups and phone calls to participate in the study. The newly diagnosed patients with diabetes mellitus attending the diabetes clinic in the hospital of the institute were also made aware about the primary prevention of diabetes and encouraged to send their family members to participate in this study. Thus, a total of 187 participants, one from each family, participated by the end of the study period as shown in Figure 1. Each participant was examined and inquired whether his/her either mother or father or both of them had diagnosed with T2DM by a physician. The family members with diabetic mother, diabetic father or diabetic parents were taken into account separately.

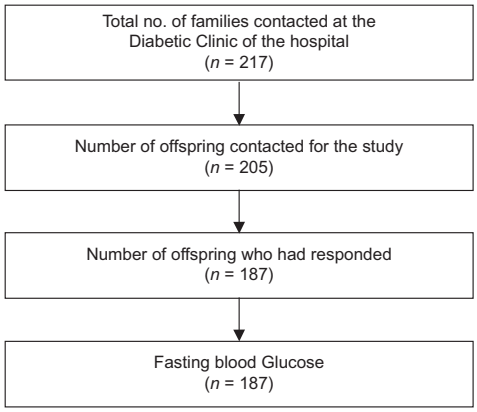

Figure 1: Study design

All the relevant information of participants regarding the demographic profile, dietary habits, detailed medical history, anthropometric measurements, physical examination and investigations were collected in the structured pro forma. The participants selected were counselled regarding the purpose and benefits of the study. A day before the study, the participants were advised to come in a fasting state for a minimum of 10 hours before blood sampling for blood sugar levels. After

obtaining consent from the participants, fasting blood glucose levels in finger-prick whole blood were measured using a Glucometer (Accu-Chek® Roche Diagnostics GmbH, D-68298 Mannheim, Germany). Participants were considered to have prediabetes if fasting plasma glucose (FPG) levels were between 100 mg/dL and 125 mg/dL.[15] Standing height was measured to the nearest 0.1 cm using a wall-mounted standard stadiometer. Body weight was measured to the nearest 0.1 Kg using standard automated balance. As obesity is a major risk factor for the development of T2DM to determine the percentage of pre-diabetics in the study population according to the body mass index (BMI) (Kg/m^2). Overweight was considered as BMI >23.0–27.5 Kg/m^2 and >27.5 Kg/m^2 for obese according to Asian Criteria for BMI.[17] Waist circumference was measured at the midpoint between the lowermost point of the costal margin and the highest point of the iliac crest with the subject standing erect, at the end of normal expiration.

Statistical analysis

Association between categorical variables was studied using Chi-square test. A $P < 0.05$ was considered statistically significant. Data were analysed using the Statistical Package for the Social Sciences (SPSS), Version 21 (SPSS, IBM, New York, USA) statistical software.

RESULTS

The study population participated in this study were 187 offspring of T2DM patients who were between 18 and 50 years of age (Figure 1). Out of 187 participants, 116 were male (62%). The maximum number of participants (50.3%) in the study belonged to the age group of 41–50 years. According to the family history, the participants having a family history of paternal DM were 56 (29.9%), participants with a history of maternal DM were 33 (17.6%) and participants with both parents having diabetes were 98 (52.4%). The prevalence of pre-diabetes among males and females was found to be 23.3% and 16.9% respectively. The prevalence of pre-diabetes was was significantly higher 27.8% in the age group 41–50 years among all the age groups [Table 1].

Pre-diabetes in offspring with either father, mother or both parents having DM was 10.71%, 30.30% and 23.46%, respectively [Table 2]. The prevalence was more among family members whose both parents had DM (23.5% Vs 18%; P=0.0323) [Table 2].

Table 2: Pre-diabetes according to parental history

Family history of diabetes	No. of subjects	Cases	%	*P*-value
Group A				
Only father	56	6	10.7	0.0882
Only mother	33	10	30.3	
Both parents	98	23	23.5	
Total	187	39	20.9	
Group B				
Both parents	98	23	23.5	0.0323
Single parent	89	16	18.0	
Total	187	39	20.0	

We found that 17.9% of participants were vegetarian and 82.1% participants had mixed dietary patterns, i.e., non-vegetarian. In the case of male participants, the waist–hip ratio (WHR) was ≥ 0.9 in 98 (84.5%). In females, WHR was ≥ 0.85 in 56 (78.9%). Sixty nine (37%) participants had a BMI ≥ 23 Kg/m^2, 118 (63.1%) ≥ a BMI of <23 Kg/m^2.

DISCUSSION

DM is one of the most preventable diseases among all non-communicable diseases. Preventive measures can be decided depending on the major risk factors for DM. Physical inactivity, obesity, overweight and the presence of family history are the major risk factors for diabetes.[18] We have focussed mainly on the presence of family history for pre-diabetes in the current study. Pre-diabetes was more among males as compared to females in the present study. Pre-diabetes was more in the age groups 31–40 (15.4%) and 41–50 years of age (27.8%). Hence, the people in the productive age group are facing these changing trends in the disease occurrence and reduction in their socio-economic efficiency.[3] Dysfunction of β-cells is the cause for progression from pre-diabetes to DM. In the present study, the prevalence of pre-diabetes was more among offsprings having both parents being diabetic (23.5%) compared with offsprings having a single parent with diabetes (18%). The prevalence of pre-diabetes varies in different states of India. According to recent statistics from Indian Council

Table 1: Pre-diabetes according to gender and age

Age (years)	Male	Pre-diabetes	Female	Pre-diabetes	Total subjects	Total pre-diabetes	Percentage	*P*-value
18–30	17	2	8	1	25	3	12	0.0053
31–40	47	7	18	3	65	10	15.4	
41–50	69	18	28	8	97	26	27.8	
Total	133	27	54	12	187	39	20.9	

of Medical Research–INdia DIABetes(ICMR-INDIAB), the overall prevalence of diabetes in 15 states of India was 7.3% (95% CI 7.0–7.5).[19]

In a study[10] in the Gwalior-Chambal region, 7608 participants in the age group of 20–79 years, the prevalence of pre-diabetes was found to be 5.7% and that was higher in the rural population. They found that the prevalence of DM was more in male participants (8.2% in rural; 5.1% in urban). The pre-diabetes cases were more in the participants living a sedentary lifestyle and in the aged population in their study. Another study[20] which was a 10-year prospective cohort study in central Kerala found the incidence rate of IFG as 45.01/1000 persons. The authors[21] mentioned age >45 years, family history of T2DM, BMI ≥ 25 Kg/m^2 and presence of central obesity as major risk factors for the development of T2DM.

Among all the risk factors associated with T2DM, obesity is the most modifiable risk factor.[20] We found the proportion of patients with obesity and overweight in persons with pre-diabetes to be 43.5%. In a study[21] carried out in Kerala on non-communicable risk factors found a high prevalence of overweight or obesity (25%). We found that 34 subjects (87.2%) subjects with pre-diabetes had a BMI ≥23 Kg/m^2. Among persons with pre-diabetes in our study, 29 (74.4%) of the participants had a WHR more than normal. A person with BMI ≥25 Kg/m^2 has nearly higher risk than those whose BMI is below 25 Kg/m^2.[20] Some studies which have reported overweight or obesity and central obesity as important risk factors for T2DM.[22-24] A diet containing higher amount of fat and meat and lower in carbohydrates and fibre, along with lesser physical activity leads to unwanted health effects.[14] Our observations are similar as 82.1% of participants consumed non-vegetarian diet. Obesity and physical activity are closely associated with adult-onset DM. The substances responsible for the development of insulin resistance such as non-esterified fatty acids, glycerol, hormones, cytokines and pro-inflammatory are increased in obese individuals.[25] We believe that reduction in obesity and overweight results reduction in the incidence of pre-diabetes and ultimately T2DM.

In a study[26] it was observed that the prevalence of pre-diabetes or diabetes was 12.3% and 8.4% among adolescent boys and girls in India, respectively. This study[27] reported that BMI and subscapular skinfold thickness as the two most important predictors of prediabetes or DM among adolescents. In another study[14] from south India found that the prevalence of diabetes and pre-diabetes was 37.3% and 8.7%. Pre-diabetes was more in males and in obese and overweight participants. An increasing age was a risk factor for pre-diabetes and mentioned the need to create awareness in the population about DM. In a cross-sectional study[27] carried out in 80 participants in the age group 30–70 years found the prevalence of diabetes to be 25%. Furthermore, they have observed that there were insignificant changes between persons with pre-diabetics and healthy controls in the mean BMI, mean body surface area, waist-to-height ratio.

There is a direct and strong relationship between family history and DM.[3] The presence of family history of DM in first-degree relatives, more are the chances of having DM. The risk is more when both the parents have DM. Detailed family history as a screening tool is very helpful in both clinical and community settings as it is inexpensive and easily applicable.[3] All these offspring can be targeted to reduce the risk of developing T2DM among them. By following healthy lifestyle with the inclusion of more physical activity, change in the work profile, balanced diet and reduction in weight has shown halting the progression towards the T2DM.[28]

Results observed in the current study suggest the need for early screening for pre-diabetes in offsprings of type 2 diabetics. More such studies can be conducted in the community for screening in apparently healthy individuals. Majority of the population in India is unaware of their diabetic status increasing the burden of DM. Health education programmes may be conducted to inculcate healthy dietary habits and physical activity in daily life. Thus, positive family history can be used as a screening tool to reduce the burden of T2DM in the society with more research.

This was an observational study; thus, the observed association cannot be interpreted as causal inferences. The method used for estimation of blood glucose in this study was by capillary blood glucose method. Further study needs to be carried out with larger sample size.

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Conflicts of interest
There are no conflicts of interest.

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