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Original Research Article

Prevalence of Impaired Fasting Glucose and Impaired Glucose Tolerance in the First-Degree Relatives of Patients with Type 2 Diabetes Mellitus

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Abstract

Background and Objectives: Prediabetes is characterized by impaired fasting glucose (IFG) and impaired glucose tolerance (IGT). It poses a higher risk of progressing to diabetes, particularly in first-degree relatives (FDRs) of individuals with Type 2 diabetes. This study aimed to assess the prevalence of IFG and IGT in FDRs of individuals diagnosed with Type 2 diabetes mellitus (T2DM).

Materials & Methods: 300 participants (201 males and 99 females) who were FDRs of patients with T2DM, aged 18 years and above, were selected from rural area of central Madhya Pradesh. Fasting blood sugar (FBS) and 2-hour postglucose blood sugar (PG2BS) levels were measured using a fully automated analyzer employing the enzymatic colorimetric.

Results: The study revealed that prevalence of IFG among FDRs of individuals with T2DM was approximately 15.1%. Additionally, 12% of the participants were newly diagnosed with diabetes based on their FBS levels. Notably, only 14% of the subjects exhibited impaired PG2BS levels, and the prevalence of diabetes determined by this method closely aligned with the FBS method.

Conclusion: The prevalence of diabetes is rapidly increasing, even in rural India. There is urgent need for preventive measures and interventions to curb the escalating rates and promote better health outcomes in these communities.

Keywords: Prediabetic State, Glucose Intolerance, Diabetes Mellitus, Prevalence, Fasting.

Introduction

Diabetes mellitus (DM) is a complex and diverse group of chronic metabolic disorders characterized by a deficiency in insulin, either relative or absolute, resulting from impaired insulin action and/or inadequate insulin secretion [1]. While diabetes was traditionally associated with the Western world, the changing trends and lifestyle patterns have led to a significant rise in its occurrence in Asian countries,

particularly in India and China [2]. It is noteworthy that individuals of Asian descent have a tendency to develop diabetes at younger ages, lower levels of obesity, and experience higher rates of the disease compared to other populations, even with comparable weight gain [3].

Diabetes, unfortunately, is a condition where many patients remain asymptomatic, leading to undiagnosed cases for a significant duration. Studies have shown that individuals with newly diagnosed T2DM often have the condition for 4-7 years before it is detected [4], which increases the risk of complications. To address this, it is crucial to implement screening programs during the asymptomatic phase known as prediabetes to facilitate early detection and intervention. Prediabetes, as defined by the American Diabetic Association [5], refers to a state where blood glucose levels are elevated but not yet at the threshold for a diabetes diagnosis. It encompasses two main parameters: IFG, indicating elevated glucose levels after a period of fasting, and IGT, which reflects difficulty in maintaining normal blood glucose levels after consuming a glucose-rich solution.

The increasing prevalence of diabetes is influenced by multiple factors, including genetics. First-degree relatives of diabetic patients have a higher risk of developing the disease, with a 40% risk if one parent is affected and a 70% risk if both parents are affected. Screening the FDRs for prediabetes and implementing lifestyle changes can help delay or prevent the progression to diabetes.

Contrary to popular belief, T2DM is not limited to urban areas but also affects individuals from rural backgrounds due to its genetic nature. However, limited awareness, inadequate healthcare infrastructure, financial constraints, and other factors hinder the assessment of prediabetes prevalence in rural regions of India. Few studies have been conducted in rural India [7-12]. Therefore, this study aimed to contribute to the assessment of prediabetic individuals among the FDRs of T2DM patients in the rural region central India.

Material & Methods

Ethical aspects: The study was done in a rural hospital in Madhya Pradesh, central India adhering to the principles outlined in the Declaration of Helsinki [13]. The study had a sample size of 300 subjects, determined at a 95% confidence level using the Open Epi, version 3.1, open-source calculator. The participants included individuals aged over 18 years who were FDRs of patients with T2DM. Prior to commencing the survey, informed consent was obtained from all participants. Upon obtaining consent, basic vital information such as age, gender, education, and occupation was collected.

Inclusion & Exclusion criteria: The inclusion criteria for the study consisted of individuals aged over 18 years who were FDRs of patients with T2DM. Patients with known diabetes, chronic renal failure, liver cell diseases, endocrine disorders such as insulinoma, post-pancreatectomy, individuals taking specific medications (e.g., somatostatin, beta blockers, diazoxide, thiazide diuretics, phenytoin, alloxan, and steroids), pregnant women, post-menopausal women, individuals with fever, edema, osteoporosis with very low bone density, bodybuilders or professional athletes, patients on dialysis, and individuals with pacemakers were excluded.

Case definitions: The criteria for diagnosing new cases of diabetes mellitus (DM), IFG, and IGT were based on the guidelines provided by the American Diabetic Association and World Health Organization. DM was diagnosed if a patient exhibited symptoms of diabetes along with a random plasma glucose concentration >200 mg/dl, FBS >126 mg/dl, or PG2BS >200 mg/dl. Prediabetes was defined as IFG, which included a fasting venous plasma glucose level ≥100 mg/dl and <126 mg/dl, regardless of the PG2BS values. IGT was identified when

the PG2BS was ≥140 mg/dl and <200 mg/dl after a 75g glucose load.

Investigations: The investigations conducted in the study included the measurement of FBS and PG2BS. For FBS, venous blood samples were collected from participants after an overnight fasting period of 12 hours. The FBS levels were then determined through laboratory analysis. To assess the PG2BS, participants were given 75g of anhydrous glucose dissolved in 200ml of water. After a 2-hour interval, venous blood samples were collected again to measure the blood sugar levels at this time point. The blood samples collected were promptly transported to the biochemistry lab for analysis of glucose levels. The analysis was performed using a fully automated analyzer (MERCK Microlab 300 LX, manufactured by Vital Scientific N.V in the Netherlands). The glucose levels in the samples were measured using an enzymatic colorimetric method.

Statistical Analysis: The collected data was entered and processed using Microsoft Excel 2016. For statistical analyses, OpenEpi version 3.01, an open-source calculator, was employed.

Results

Out of the total study population of 300 individuals, the majority were males, accounting for 67% of the participants. Among the age groups, the largest proportion was found in the 41-50 years' category, comprising 29% of the population, followed closely by the 31-40 years category, which accounted for 23%. Additional information regarding the age and gender distribution can be found in Table 1.

Table 1: Age and Gender distribution of study participants

Age group (in years)	Male		Female		Total	
	N	%	N	%	N	%
18-30	29	10	14	5	42	14
31-40	48	16	20	7	68	23
41-50	57	19	30	10	87	29
51-60	38	13	26	9	63	21
61-70	12	4	5	2	17	6
71-80	15	5	6	2	21	7
> 80	3	1	0	0	3	1
Total	**201**	**67**	**99**	**33**	**300**	**100**

The majority of the study population, including women, were engaged in agricultural work, comprising 53% of the participants. A significant proportion, 22%, were involved in local shops or were self-employed. Housewives represented a small percentage, accounting for only 3% of the female population. In terms of education, approximately 37% of the participants had no formal education, while 23% had completed high school and only 13% had attended college. The majority of the subjects (88%) followed a vegetarian diet. Additionally, 83% of the population were early risers, waking up around 5 am, and most individuals had their dinner before 7 pm. In Table 2, it can be observed that out of the total study population, 44 individuals (15%) had prediabetes based on their fasting blood sugar (FBS) levels alone, with approximately 6% being women and 9% being men. Additionally, newly detected diabetes mellitus was present in 33 individuals (11%) across the entire study population, which was found to be highly significant ($P < 0.01$).

Table 2: Gender distribution of FBS values

FBS (in mg/dl)	Male		Female		Total	
	N	%	N	%	N	%
<100 (normal)	155	52	72	24	227	76
≥100<126 (IFG)	26	9	18	6	44	15
≥126 (diabetes)	21	7	9	3	30	10
Total	**201**	**67**	**99**	**33**	**300**	**100**

In Table 3, it is evident that 39 individuals (13%) of the entire study population had impaired glucose tolerance (IGT), with approximately 18% being women and 10% being men (Table 3). Notably, IGT was significantly more prevalent among women compared to men ($P < 0.01$). Furthermore, only 18 individuals (10%) were newly detected with diabetes mellitus using the IGT method, which again showed a high level of significance ($P < 0.01$).

Table 3: Gender distribution of PG2BS values

FBS (in mg/dl)	Male		Female		Total	
	N	%	N	%	N	%
<140 (normal)	170	57	68	23	237	79
≥140<200 (IGT)	21	7	18	6	39	13
≥200 (diabetes)	11	4	14	5	24	8
Total	**201**	**67**	**99**	**33**	**300**	**100**

Tables 4 & 5 show age distributions of IFG & IGT, respectively.

Table 4: Age wise distribution of IFG

Age group (in years)	Male	Female	Total
18-30	2	3	5
31-40	5	8	13
41-50	8	5	13
51-60	4	1	5
61-70	1	0	1
71-80	1	0	1
> 80	1	0	1
Total	**22**	**17**	**39**

Table 5: Age wise distribution of IGT

Age group (in years)	Male	Female	Total
18-30	0	0	0
31-40	5	6	11
41-50	11	4	15
51-60	3	4	7
61-70	3	3	6
71-80	0	1	1
> 80	0	0	0
Total	**22**	**18**	**40**

Discussion

T2DM is a global concern and an epidemic in India, but research on prediabetes in FDRs of DM patients in rural central India is limited. Our study aimed to determine the prevalence of prediabetes in FDRs of DM in a village in central India.

Previous studies conducted in rural communities have shown a rising

prevalence of diabetes mellitus (DM) among first-degree relatives (FDRs). The International Diabetes Federation reported an estimated diabetes prevalence of 8% in India among individuals aged 20-79 years [14]. The Indian Council of Medical Research conducted a community study which revealed varying proportions of diabetes cases across different states, with Maharashtra and Tamil Nadu having higher numbers compared to states in Northern India [15]. A national urban diabetes survey conducted in 2001 focused on major cities and did not provide data on rural areas, highlighting the need for research in this population [16]. Thus, we conducted this study to address this knowledge gap.

A study conducted in Andhra Pradesh reported a comparable overall prevalence of prediabetes by IFG to our study findings. However, our study specifically focused on a vulnerable population. Another study conducted in a rural community of South India showed a similar prevalence of prediabetes among individuals with a positive family history of T2DM. Our results are also consistent with the urban pattern of association between IFG or IGT in the FDRs of T2DM patients and align with findings from other rural communities. [10, 18, 19]

Given the limited research conducted on T2DM and prediabetes in both rural and urban areas of Madhya Pradesh, this study sheds light on the genetic epidemiology of T2DM and provides valuable insights into the prevalence of the condition. The findings of this study are particularly significant as a large proportion of the country's population resides in rural areas, making it a crucial reference point for future researchers. [10, 15]

Multiple trials have shown that lifestyle modifications and drug interventions can effectively reduce the risk of diabetes in individuals with prediabetes. Diabetes is often referred to as a "silent disease" as it typically presents no symptoms until significant organ damage occurs. Despite improvements in medical care in India, rural areas in Madhya Pradesh continue to face challenges due to limited knowledge and resources, making the detection of prediabetes difficult [20, 21].

Conclusions

Our study aimed to detect the prevalence of prediabetes in a vulnerable group in rural India and revealed an increasing number of undetected prediabetics, contradicting the notion of a healthy rural lifestyle. While our findings may not be representative of all rural areas in India, they highlight the growing prevalence of undetected prediabetes. In light of this, it is crucial to enhance healthcare facilities and raise awareness within our rural communities.

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