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ASSESSMENT OF IMPAIRED GLUCOSE METABOLISM IN FIRST DEGREE FAMILY MEMBERS OF DIABETES MELLITUS

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ABSTRACT
Background and Objectives This study aimed to determine the prevalence of impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) in first-degree relatives (FDRs) of individuals diagnosed with Type 2 diabetes mellitus (T2DM), as these conditions are associated with an increased risk of developing diabetes.
Materials & methods: A total of 278 participants (195 males and 83 females) who were FDRs of individuals diagnosed with T2DM and aged 18 years and above were selected for this Study. Fasting blood sugar (FBS) and 2-hour postglucose blood sugar (PG2BS) levels were assessed using a fully automated analyzer that utilized enzymatic colorimetric methods.
Results: The findings of the study demonstrated that the prevalence of IFG among FDRs of individuals diagnosed with T2DM was approximately 17.11%. Moreover, 11% of the participants were newly identified as having diabetes based on their FBS levels. Interestingly, only 11% of the subjects displayed impaired PG2BS levels, and the prevalence of diabetes determined through this method closely corresponded to that determined by the FBS method.
Conclusion: The prevalence of diabetes is experiencing a rapid surge, even within rural regions of India. This alarming trend necessitates immediate attention and the implementation of preventive measures and interventions aimed at mitigating the escalating rates and fostering improved health outcomes in these communities.

Key words: Diabetes Mellitus, Fasting, Glucose Intolerance, Prediabetic State.

INTRODUCTION

Diabetes mellitus (DM) encompasses a complex and heterogeneous collection of chronic metabolic disorders that stem from insufficient insulin production, be it relatively or absolutely, due to impaired insulin action and/or inadequate insulin secretion [1]. Historically, diabetes was predominantly linked to Western countries; however, shifting trends and lifestyle patterns have contributed to a substantial increase in its prevalence within Asian nations, notably India and China [2]. Notably, individuals of Asian descent exhibit a proclivity for developing diabetes at younger ages, lower levels of obesity, and higher disease rates compared to other populations, even when weight gain is comparable [3].

Regrettably, diabetes often manifests without noticeable symptoms, resulting in a considerable duration of undiagnosed cases. Research indicates that individuals with newly diagnosed Type 2 diabetes mellitus (T2DM) frequently harbor the condition for 4-7 years before it is identified, thereby increasing the risk of complications [4]. To address this issue, the implementation of screening programs during the asymptomatic phase, commonly referred to as prediabetes, is of paramount importance for early detection and intervention. Prediabetes, as defined by the American Diabetic Association [5], denotes a condition in which blood glucose levels are elevated but have not yet reached the threshold for a diabetes diagnosis. Prediabetes encompasses two primary parameters: impaired fasting glucose (IFG), which signifies elevated glucose levels following a fasting period, and impaired glucose tolerance (IGT), which indicates difficulty in maintaining normal blood glucose levels after the consumption of a glucose-rich solution.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 07, 2023

The escalating prevalence of diabetes is impacted by various factors, one of which is genetics. Individuals who have first-degree relatives (FDRs) with diabetes face an elevated risk of developing the disease themselves. The risk is approximately 40% if one parent is affected and rises to 70% if both parents are affected. To address this heightened risk, screening FDRs for prediabetes and implementing lifestyle modifications can play a crucial role in delaying or preventing the progression to diabetes. Such interventions offer the opportunity to mitigate the impact of the disease and promote better health outcomes.

Contrary to commonly held assumptions, Type 2 diabetes mellitus (T2DM) is not confined solely to urban areas but also affects individuals hailing from rural backgrounds, primarily due to its genetic basis. Nevertheless, the evaluation of prediabetes prevalence in rural regions of India faces challenges arising from limited awareness, inadequate healthcare infrastructure, financial constraints, and various other factors. Consequently, only a few studies have been conducted in rural India [7-12]. Therefore, the objective of this study was to contribute to the existing body of knowledge by assessing the prevalence of prediabetic individuals among the first-degree relatives (FDRs) of T2DM patients in the rural region of western India.

MATERIAL & METHODS

The study was conducted at a rural hospital in western India, following the principles outlined in the Declaration of Helsinki [13]. The sample size for the study was determined to be 250 subjects, with a 95% confidence level, utilizing the Open Epi, version 3.1, open-source calculator. The participants included individuals aged 18 years and above who were identified as FDRs of patients diagnosed with T2DM.

The study established specific inclusion and exclusion criteria. Inclusion criteria encompassed individuals aged 18 years and above who were identified as first-degree relatives (FDRs) of patients diagnosed with Type 2 diabetes mellitus (T2DM). Conversely, certain individuals were excluded from participation, including those 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.

The diagnostic criteria for new cases of DM, IFG, and IGT were determined in accordance with the guidelines provided by the American Diabetic Association and World Health Organization. A diagnosis of DM was made if a patient presented with symptoms of diabetes in addition to meeting one of the following criteria: a random plasma glucose concentration exceeding 200 mg/dl, fasting blood sugar (FBS) levels above 126 mg/dl, or a 2-hour postglucose blood sugar (PG2BS) level surpassing 200 mg/dl. Prediabetes, classified as IFG, was defined as a fasting venous plasma glucose level ranging from ≥100 mg/dl to <126 mg/dl, irrespective of the PG2BS values. IGT was identified when the PG2BS level fell between ≥140 mg/dl and <200 mg/dl following the ingestion of a 75g glucose load.

The investigations conducted in the study involved the measurement of FBS and PG2BS levels. FBS measurements were obtained by collecting venous blood samples from participants after a 12-hour overnight fasting period. Laboratory analysis was conducted to determine the FBS levels. To assess PG2BS, participants were administered 75g of anhydrous glucose dissolved in 200ml of water. After a 2-hour interval, venous blood samples were collected to measure the blood sugar levels at that specific time point. The collected blood samples were promptly transported to the biochemistry lab for analysis of glucose levels. A fully automated analyzer was employed for the analysis, utilizing an enzymatic colorimetric method to measure glucose levels in the samples.

The collected data was entered and processed using Microsoft Excel 2016 for subsequent statistical analysis. To perform the statistical analyses, OpenEpi version 3.01, an open-source calculator, was utilized.

RESULTS

Among the total study population of 278 individuals, the male participants constituted the majority, comprising 70% of the total sample. In terms of age distribution, the largest proportion was observed in the 41-50 years category, accounting for 28.42% of the population. The 31-40 years category closely followed, representing 23.02% of the participants. For further details regarding the distribution of age and gender, please refer to Table 1.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 07, 2023

Table 1: Age and Gender variation in study participants

Age group (in years)	Male		Female		Total	
	N	%	N	%	N	%
18-30	28	10.07	12	4.32	40	14.39
31-40	47	16.91	17	6.12	64	23.02
41-50	54	19.42	25	8.99	79	28.42
51-60	35	12.59	22	7.91	57	20.50
61-70	15	5.40	3	1.08	18	6.47
71-80	14	5.04	4	1.44	18	6.47
> 80	2	0.72	0	0.00	2	0.72
Total	**195**	**70.14**	**83**	**29.86**	**278**	**100.00**

The study population, including women, predominantly consisted of individuals engaged in agricultural work, comprising 55% of the participants. Approximately 20% were involved in local shops or were self-employed. Housewives represented a smaller percentage, accounting for only 4% of the female population. Regarding educational background, around 39% of the participants had no formal education, while 21% had completed high school, and a mere 10% had attended college. The majority of the subjects (85%) adhered to a vegetarian diet. Additionally, a significant portion (81%) of the population identified as early risers, waking up around 5 am, and most individuals preferred to have their dinner before 7 pm.

Table 2 reveals that among the total study population, 37 individuals (13.31%) were identified as having prediabetes based on thei FBS levels alone, with approximately4.32% being women and 8.9% being men. Furthermore, newly detected cases of diabetes mellitus were observed in 23 individuals (8.27%) within the overall study population, indicating a highly significant finding.

Table 2: Gender distribution of FBS values

FBS (in mg/dl)	Male		Female		Total	
	N	%	N	%	N	%
<100 (normal)	152	54.68	63	22.66	215	77.34
≥100<126 (IFG)	25	8.993	12	4.317	37	13.31
≥126 (diabetes)	18	6.475	8	2.878	26	9.353
Total	**195**	**70.14**	**83**	**29.86**	**278**	**100**

Table 3 indicates that out of the total study population, 32 individuals (11.51%) exhibited IGT, with approximately 6% being women and 5% being men. It is noteworthy that IGT was significantly more prevalent among women compared to men. Additionally, only 12 individuals (4.32%) were newly identified with diabetes mellitus using the IGT method, further emphasizing the significance of this finding.

Table 3: Gender distribution of PG2BS values

FBS (in mg/dl)	Male		Female		Total	
	N	%	N	%	N	%
<140 (normal)	168	60.43	61	21.94	229	82.37
≥140<200 (IGT)	18	6.475	14	5.036	32	11.51
≥200 (diabetes)	9	3.237	8	2.878	17	6.115
Total	**195**	**70.14**	**83**	**29.86**	**278**	100

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

Table 4: Age wise distribution of IFG

Age group (in years)	Male	Female	Total
18-30	2	3	5
31-40	8	5	13
41-50	5	7	12
51-60	3	1	4
61-70	1	0	1
71-80	1	0	1

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> 80	1	0	1
Total	**21**	**16**	**37**

Table 5: Age wise distribution of IGT

Age group (in years)	Male	Female	Total
18-30		2	4
31-40	7	5	12
41-50	5	5	10
51-60	2	1	3
61-70	1	0	1
71-80	1	0	1
> 80	1	0	1
Total	**19**	**13**	**32**

DISCUSSION

T2DM represents a significant global health concern and has reached epidemic proportions in India. However, there is a scarcity of research focusing specifically on prediabetes among FDRs of individuals with DM in rural western India. Therefore, the primary objective of our study was to assess the prevalence of prediabetes in FDRs of DM patients residing in a village located in western India.

Previous research conducted in rural communities has indicated a growing prevalence of DM among FDRs. According to the International Diabetes Federation, India has an estimated diabetes prevalence of 8% among individuals aged 20-79 years [14]. A community study conducted by the Indian Council of Medical Research revealed varying proportions of diabetes cases across different states, with Maharashtra and Tamil Nadu exhibiting higher numbers compared to states in Northern India [15]. Notably, a national urban diabetes survey conducted in 2001 focused primarily on major cities and did not provide data on rural areas, emphasizing the need for research in this particular population [16]. Consequently, we undertook this study to address this knowledge gap and shed light on the prevalence of prediabetes among FDRs of DM patients in rural areas.

Our study findings align with previous research conducted in Andhra Pradesh, which reported a comparable overall prevalence of prediabetes identified through IFG [10]. However, it is important to note that our study focused specifically on a vulnerable population. Similarly, another study conducted in a rural community in South India revealed a similar prevalence of prediabetes among individuals with a positive family history of T2DM [18]. Furthermore, our results are consistent with the observed pattern of association between IFG or IGT in the FDRs of T2DM patients, as observed in urban areas, and are in line with findings from other rural communities [19].

The limited research conducted on T2DM and prediabetes in both rural and urban areas of India underscores the significance of this study. By shedding light on the genetic epidemiology of T2DM and providing valuable insights into its prevalence, this study contributes to the existing knowledge base. It is particularly noteworthy as a substantial portion of the country's population resides in rural areas, making it an essential reference point for future researchers [10, 15].

Numerous trials have demonstrated that lifestyle modifications and drug interventions can effectively decrease the risk of developing diabetes in individuals with prediabetes. Diabetes is often referred to as a "silent disease" because it typically remains asymptomatic until significant organ damage has occurred. Despite advancements in medical care in India, rural areas in India still encounter challenges associated with limited knowledge and resources, making the detection of prediabetes a difficult task [20, 21].

CONCLUSION

The primary objective of our study was to ascertain the prevalence of prediabetes within a vulnerable group residing in rural India. Our findings revealed an escalating number of undetected prediabetic individuals, challenging the perception of a healthy rural lifestyle. Although our study's outcomes may not be fully representative of all rural areas in India, they do underscore the increasing prevalence of undiagnosed prediabetes. These findings emphasize the critical need to improve healthcare facilities and enhance awareness within rural communities to address this pressing issue.

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ISSN: 0975-3583,0976-2833 VOL14, ISSUE 07, 2023

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