



## Assessment of Diabetes Risk in Adults: Profiling Undiagnosed Prediabetics and Diabetic Individuals using IDRS and Glycated Hemoglobin in Uttarakhand, India.

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(Received: 07 October 2023

Revised: 12 November

Accepted: 06 December)

### KEYWORDS

MDRF IDRS,  
Diabetes,  
Prediabetes,  
HbA1c levels.

### ABSTRACT:

Background:

The incidence of prediabetes and type 2 diabetes mellitus (T2DM) is on the rise globally. In India, the prevalence of diabetes in adults has surged to 9.3%. However, only 45.8% of the population is aware of their diabetic status. Keeping this prospective in mind, a recent study was conducted to assess the risk of diabetes in undiagnosed prediabetic and diabetic individuals. The study employed the Indian Diabetes Risk Score (IDRS) as a screening tool and glycated hemoglobin (HbA1c) as a diagnostic marker for diabetes and prediabetes.

Material and methods:

A cross-sectional study was conducted after obtaining approval from the ethics committee of the institution. The study included participants from the five districts of Uttarakhand who met the following inclusion criteria: a) aged 18 years or older at the time of enrollment, b) not previously diagnosed with diabetes or prediabetes, and c) permanent residents of Uttarakhand for at least 10 years. Data were collected from 513 participants, between December 2020 and December 2023 to fulfill our study objectives.

Results:

Of the 513 participants, 303 (59.1%) were male and 210 (40.9%) were female. The mean age of the participants was 38.5 years (SD ±14.0 years). Among the participants, 261 (50.88%), 151 (29.43%), and 101 (19.69%) had moderate, high, and low diabetes risk scores, respectively. The HbA1c level was used as one of the diagnostic criteria given by the American Diabetes Association (ADA) to confirm the diagnosis of prediabetes and diabetes. Of the 513 participants, 61 (11.9%) and 30 (5.8%) were prediabetic and diabetic, respectively. A significant association (p value <0.05) was observed between subjects with higher risk scores and HbA1c levels.

Conclusion:

IDRS is a validated and non-invasive screening tool for diabetes mellitus and prediabetes. It can be used as a substitute for other more expensive and invasive testing tools in areas such as Uttarakhand, which is part of the sub-Himalayan region. Providing healthcare services to remote areas in Uttarakhand is a big challenge compared with metro cities. Our study supports the validity of IDRS as it can be used as a cost-effective tool for mass screening of diabetes and prediabetes.



## INTRODUCTION:

Elevated blood glucose levels due to inadequate insulin synthesis or poor insulin use characterize diabetes mellitus (DM), a chronic metabolic condition.<sup>1</sup> DM is a non-communicable disease that affects a significant proportion of the world population.<sup>2</sup> According to the National Non-Communicable Disease (NCD) Monitoring Survey conducted in March 2022, the prevalence of diabetes in adults in India has increased to 9.3%. However, only 45.8% of the population is aware of their diabetic status.<sup>3,4</sup>

Millions of people worldwide are affected by diabetes, according to the World Health Organization (WHO) and the International Diabetes Federation (IDF). According to the information provided by the World Health Organization (WHO), diabetes ranks as the seventh most prevalent cause of death globally.<sup>5,6</sup> The IDF Diabetes Atlas 2021 reports that the number of global diabetes cases has increased sharply from 151 million in 2000 to 537 million in 2021. If no intervention is taken, projections indicate that this number will increase to 783 million by 2045. Currently, over one in 10 adults worldwide live with diabetes, with some countries experiencing rates of one in five or more.<sup>6</sup>

According to the ICMR-INDIAB study, the prevalence of diabetes in India from 2008 to 2020 was 11.4%.<sup>7</sup> Recent data from sources such as the International Diabetes Federation indicate a rising trend in diabetes prevalence, emphasizing the urgent need for targeted health interventions to address this escalating

public health challenge in the diabetic capital of world.<sup>6</sup> Therefore, prompt identification and treatment are crucial for slowing down the advancement and complications of the illness, as well as averting the socioeconomic burden.<sup>8</sup> In the present era, the general populace tends to favor non-invasive risk scores over invasive procedures for screening, given their greater cost-effectiveness and practicality for widespread application.<sup>9</sup>

This scientific academic paper explores the efficacy of various diabetes risk assessment tools, including the widely employed Finnish Diabetes Risk Score (FINDRISC), American Diabetes Association (ADA) Risk Test, Indian Diabetes Risk Score (IDRS), and Canadian Diabetes Risk Questionnaire (CANRISK). FINDRISC, validated and extensively used, incorporates age, body mass index (BMI), waist circumference, physical activity, diet, and familial diabetes history.<sup>10,11,12</sup>

The Indian Diabetic Risk Score (IDRS) is a straightforward yet effective screening tool designed by Dr. Mohan V and his colleagues at the Madras Diabetes Research Foundation (MDRF), Chennai, for the early identification of individuals at risk of developing type T2DM in the Indian population. Using parameters such as age, family history of diabetes in parents, waist circumference, and physical activity, the IDRS categorizes subjects into low, moderate, and high-risk groups for diabetes. Numerous studies have demonstrated the tool's efficacy in identifying high-risk individuals within the community.<sup>13</sup>

Table 1: Madras Diabetes Research Foundation- Indian Diabetes Risk Score (MDRF IDRS)<sup>20,21</sup>

Parameter	Score
Age (Non modifiable factor)	Minimum score 0, Maximum score 30
>35 Years	0
35-49 Years	20
≥50 Years	30
Abdominal Obesity (Modifiable factor)	Minimum score 0, Maximum score 20
Waist circumference female <80 cm, male <90cm	0
Waist circumference female 80-89 cm, male 90-99cm	10
Waist circumference female ≥90 cm, Male ≥100cm	20
Physical Activity ((Modifiable factor)	Minimum score 0, Maximum score 30
Vigorous exercise or strenuous work	0
Mild exercise or strenuous work	20



No exercise and a sedentary lifestyle at home/work	30
<b>Family history (Non- modifiable factor)</b>	<b>Minimum score 0, Maximum score 20</b>
Both parents- non-diabetic	0
Either parent is diabetic	10
Both parents-diabetic	20
<b>Minimum IDRS</b>	<b>0</b>
<b>Maximum IDRS</b>	<b>100</b>
<b>Risk Category ( Final Score obtained out of 100 )</b>	
If IDRS score <30: Low risk of diabetes	
If IDRS score 30-50: Moderate risk of diabetes	
If IDRS score $\geq$ 60: High risk of diabetes	

HbA1c is a key marker for diabetes management that shows the average blood glucose levels over the past 2-3 months. This is a percentage that helps to evaluate how well the blood sugar is controlled and how effective the treatment is. It also helps to diagnose diabetes and prediabetes, with 6.5% or more indicating diabetes and 5.7%-6.4% indicating prediabetes.<sup>1</sup>

The current study was undertaken to investigate diabetes risk in undiagnosed prediabetic and diabetic individuals using the diabetes risk assessment tool (IDRS) and a biochemical indicator of long-term glycemic control (HbA1c) in the adult population of Uttarakhand.

**Table 2: American Diabetes Association (ADA) criteria for the diagnosis of prediabetes and diabetes<sup>14</sup>**

Parameter	Normal Range	Prediabetes Range	Diabetes Range
Glycated Hemoglobin* (HbA1c)	<5.7%	5.7-6.4%	$\geq$ 6.5

\*HbA1c test should be performed in a laboratory using a method that is National Glycohemoglobin Standardization Program (NGSP) certified and standardized to the Diabetes Control and Complication Trials (DCCT)<sup>14</sup>

### Material and Methods:

This scientific study conducted in Uttarakhand, India, aimed to evaluate the risk of type 2 diabetes mellitus (T2DM) in undiagnosed prediabetic and diabetic individuals in the adult population. This study was conducted using a facility-based cross-sectional design and included adults ( $\geq$ 18 years) who had not been previously diagnosed with diabetes mellitus and who provided their consent to participate. The study was conducted over a period of three years, from December 2020 to December 2023. The Indian Diabetic Risk Score (IDRS) and glycated hemoglobin were used to assess the risk of diabetes in the population.

Participants based on their Indian Diabetic Risk Score (IDRS) were divided into three categories: low-risk,

moderate-risk, and high-risk. The IDRS questionnaire comprised four factors: age, family history of diabetes, physical activity, and waist circumference. HbA1c estimation employs a technique (certified by NGSP and standardized to the DCCT),<sup>15,16</sup> known as latex agglutination inhibition. This method uses a synthetic polymer agglutinator with segments that are responsive to HbA1c<sup>17</sup>. The analysis was performed using the Rx Imola chemistry analyzer (United Kingdom), ensuring accuracy and adherence to standards.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 20. One-way analysis of variance (ANOVA) and chi-square tests were applied to compare continuous and categorical data, respectively.

This study had some limitations, such as the absence of blood sugar levels and other biochemical/hematological parameters. These limitations could have led to an underestimation of diabetes prevalence in the study area. In addition, the cross-sectional design of the study did not allow for causal inference. Therefore, the results may not be generalizable to other regions or

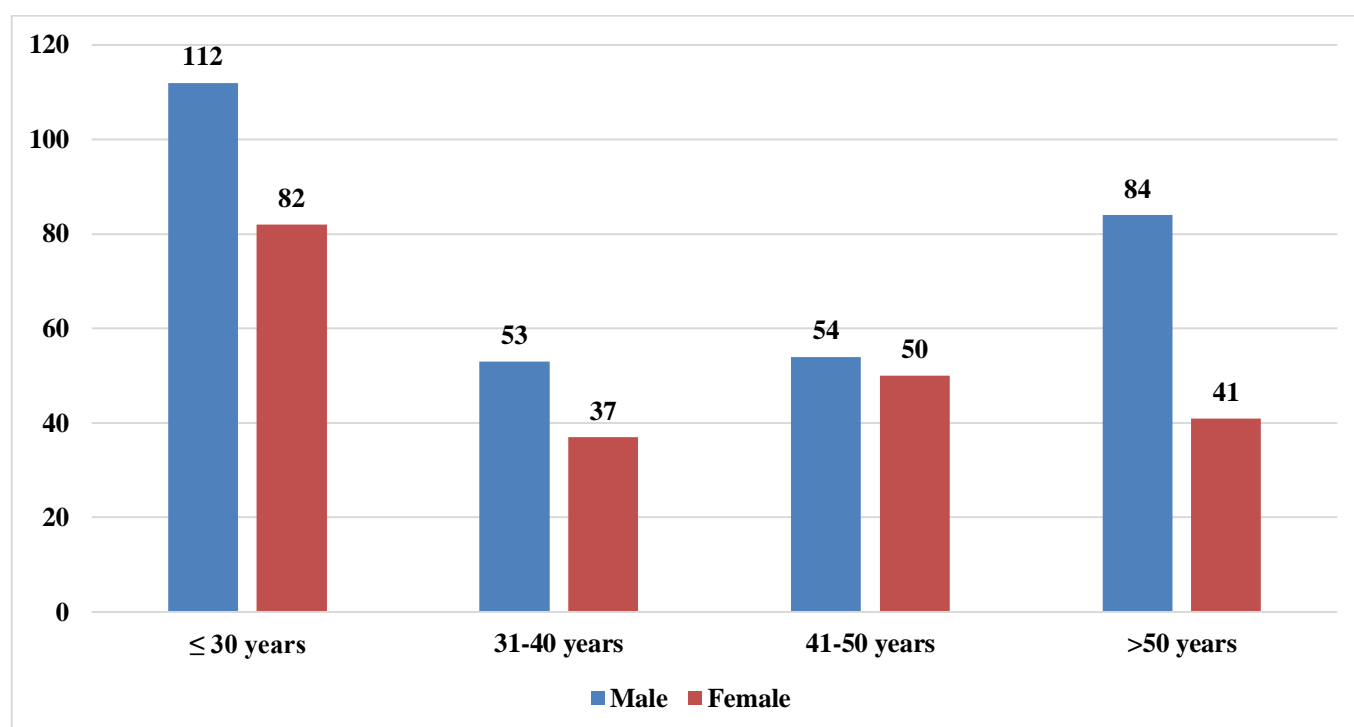


populations. Furthermore, the use of self-reported data could introduce recall bias. Despite its limitations, this study provided useful information on the potential risk factors associated with high HbA1c levels indicative of prediabetes or diabetes in the adult population of Uttarakhand, India.

### Results:

A total of 513 participants were enrolled in the study. The subjects were divided into four age groups, viz,  $\leq 30$ , 31-40, 41-50 and  $>50$  years.

**Fig. 1: Age- and gender- wise distribution of study participants (N=513)**



The age-wise distribution of the study participants showed that out of 513 participants, 303 (59.1%) and 210 (40.9%) were male and female, respectively. The mean age group of study participants was 38.5 years ( $SD \pm 14$  years). On the other hand, the maximum number of participants (194 participants, 37.8%) belonged to the

age group of  $\leq 30$  years, followed by age group  $>50$  years (125 participants, 24.4%), age group 41-50 years (104 participants, 20.3%), and least participants enrolled in the age group 31-40 years (90 participants, 17.5%).

**Table 3: Madras Diabetes Research Foundation- Indian Diabetes Risk Score Distribution (N=513)**

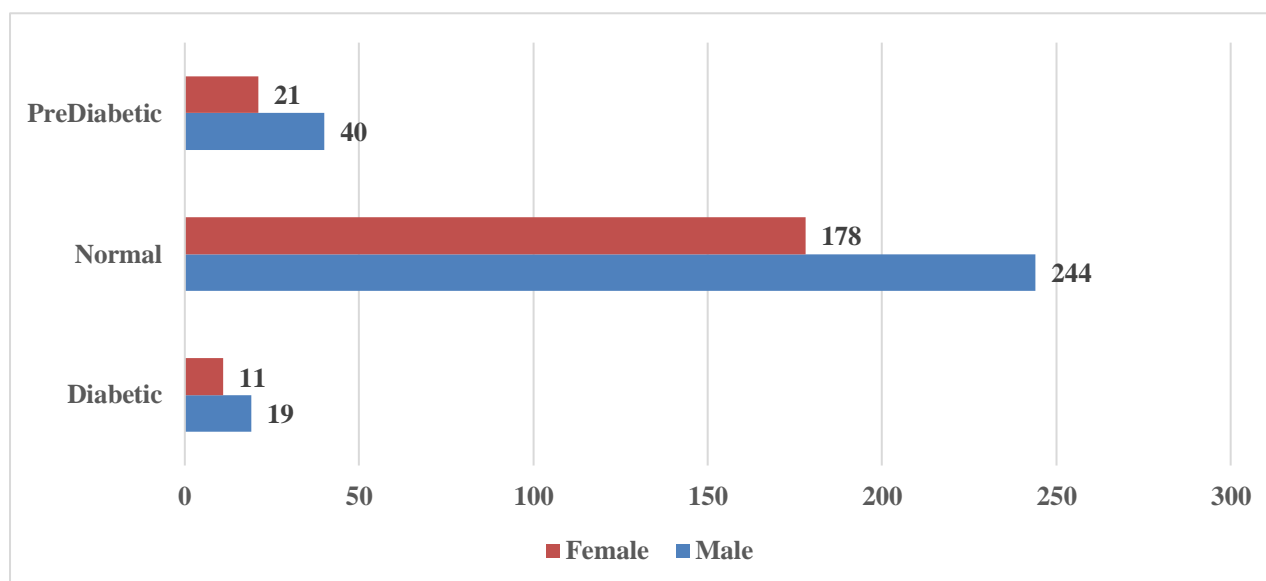
IDRS Risk Score category	Frequency (%)		Total
	Male	Female	
High risk (IDRS $\geq 60$ )	96 (63.58)	55 (36.42)	151 (29.43)
Moderate risk (IDRS 30-50)	148 (56.70)	113 (43.30)	261 (50.88)
Low risk (IDRS $>30$ )	59 (58.42)	42 (41.58)	101 (19.69)
Total	303 (59.10)	210 (40.90)	513 (100%)



In the present study, out of 513 participants, 261 (50.88%) came under moderate risk, 151 (29.43%) came under high risk, and 101 (19.69) came under low risk as per the IDRS risk score.

The study shows that a total 412 (80.3%) participants are at moderate to high risk of developing diabetes.

**Fig. 2: Comparison of normal, prediabetic, and diabetic participants based on glycated hemoglobin levels**



Glycated hemoglobin (HbA1C) was measured as one of the diagnostic parameters of the American Diabetes Association (ADA) for the confirmation diagnosis of prediabetes and diabetes. According to glycated hemoglobin (HbA1C), 61 (11.9%) of the 513 participants were diagnosed as prediabetics.

There was no significant difference in male and female participants within the study, 6.3% of the 303 male participants were categorized as diabetic, while 5.2% of the 210 female participants were categorized as diabetic. The overall prevalence of diabetic classification, considering both male and female participants, is calculated at 5.8%

**Table 4: Association of the Madras Diabetes Research Foundation- Indian Diabetes Risk Score with glycated hemoglobin**

Glycated Hemoglobin (HbA1c) Category	IDRS Risk Score category								
	Low risk		Moderate risk		High risk		Total		p- Value
	(N)	(P)	(N)	(P)	(N)	(P)	(N)	(P)	
Normal	95	18.5%	210	40.9%	117	22.8%	422	82.3%	0.04*
Prediabetics	02	0.4%	41	8.0%	18	3.5%	61	11.9%	
Diabetic	04	0.8%	10	1.9%	16	3.1%	30	5.8%	
Total	101	19.7%	261	50.8%	151	29.4%	513	100%	

Values are expressed as number N (%). \*P value  $\leq 0.05$  is considered statistically significant.



Of the 30 diabetic participants, 16 (53.3%) were at high risk, and of the 61 prediabetic participants, 18 (29.5%) were at high risk of developing diabetes as per the IDRS criteria. A significant association was found ( $P < 0.05$ ) between subjects with higher risk scores and HbA1c levels.

## Discussion:

In our study, 261 (50.88%) of the study participants were in the moderate risk of IDRS category, 151 (29.43%) were in the high risk score category, and 101 (19.69%) were in the low risk category. However, according to the IDRS Score, 412 (80%) participants combined were associated with the moderate to high risk category. Jeyaseeli V, A. et al<sup>18</sup> reported that IDRS categorization showed 12.6%, 73.7%, and 13.7% in the low-risk, moderate-risk, and high-risk groups, respectively. Anand K, Jain, et al<sup>19</sup> revealed that 250 (49.7%) subjects were in the moderate- risk IDRS category, 85 (16.9%) were in the low- risk category, and 168 (33.4%) were in the high- risk IDRS category. In their study, Singh, M. M, et al<sup>20</sup> concluded that out of 290 medical students with a mean age of 18.48 years ( $SD \pm 1.3$  years), 77% were classified as low-risk, 22% as moderate-risk, and 1% as high-risk individuals according to IDRS categorization. These differences may be due to different geographical areas, study settings, methodology, and other factors.

Of the 30 participants with diabetes, 16 (53.3%) were at high risk, indicating the presence of individuals with diagnosed diabetes or uncontrolled glycemic levels. among the 61 prediabetic participants, 18 (29.5%) were at high risk of developing diabetes as per IDRS. This suggests that a notable portion of the study population is at a higher risk of developing diabetes or experiencing impaired glucose regulation.

A significant association was found ( $P < 0.05$ ) between participants with higher risk scores and HbA1c levels. Higher IDRS categories, such as high risk and moderate risk, are associated with higher HbA1c levels. Elevated HbA1c levels indicate poorer glycemic control and are commonly used as a diagnostic criterion for diabetes.

This correlation has important implications for the risk assessment of diabetes mellitus and prediabetes. Similar findings were found in most of the studies

where the authors concluded that a significant association was found between study participants with higher risk score and HbA1c.<sup>21,22,23</sup>

## Conclusion:

The key findings of the study highlight the relationship between IDRS and HbA1c levels, emphasizing the importance of IDRS as a tool for identifying individuals at risk for diabetes based on their glycemic control. This correlation has important implications for the risk assessment of diabetes mellitus and prediabetes. By assessing individual IDRS scores, health care professionals can estimate their risk of developing diabetes and prediabetes soon. This correlation has important clinical implications. Individuals with higher IDRS scores and elevated HbA1c levels are at a greater risk of developing diabetes or experiencing impaired glucose regulation. Identifying individuals who not aware about their glycemic index early, allows for targeted intervention, lifestyle modifications, and preventive measures to prevent or delay the onset of diabetes. It also emphasizes the importance of regular monitoring of HbA1c levels in individuals with higher IDRS scores to assess their glycemic control and adjust interventions accordingly. It is worth nothing that while the correlation between IDRS and HbA1c levels is significant, it is important to consider other risk factors and clinical parameters in conjunction with IDRS and HbA1c for a comprehensive risk assessment. In conclusion, the data suggest a significant correlation between IDRS and HbA1c levels, indicating that higher IDRS categories are associated with higher HbA1c levels. This correlation supports the use of IDRS as a valuable tool in the risk assessment of diabetes mellitus and prediabetes, allowing for early identification and targeted interventions. However, it is important to consider other risk factors and clinical parameters in conjunction with IDRS and HbA1c for a comprehensive risk assessment.

**Acknowledgment:** We express our gratitude to all study participants and public representatives from various villages and Grampanchayats in Uttarakhand.

## Funding Statement:

This study was self- funded by the principal investigator



## Author contributions:

All authors contributed equally to the conceptualization, methodology, validation, writing, and supervision of this study, and they made a joint decision to publish the manuscript.

## Ethical approval:

Institutional Ethics Committee (IEC) of Veer Chandra Singh Garhwali Government Institute of Medical Science and Research Srinagar (Garhwal) Uttarakhand and the University Ethical Committee Hemwati Nandan Bahuguna Uttarakhand Medical Education University Dehradun Uttarakhand approved this study.

## Informed Consent Statement:

Before the final enrollment in the study, all participants were given an explanation of the study procedure and their role in it in their native language, and written informed consent was obtained from them.

## Conflict of Interest:

The authors declare that there are no conflicts of interest associated with this study.

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