Validation of Indian Diabetes Risk Score for Screening Prediabetes in West Tripura District of India

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Abstract

Background: Viswanathan Mohan and his team have developed "Indian Diabetes Risk Score" (IDRS) for identifying the Indians at risk for developing diabetes and prediabetes. Due to heterogeneity of Indian population, this risk score needs further validation in different parts across the country. **Objectives:** The objective is to estimate the sensitivity, specificity, positive, and negative predictive values of IDRS for screening prediabetes in West Tripura District. **Methodology:** It was a community-based cross-sectional study conducted in West Tripura district during January 1, 2018–December 31, 2019 among 325 self-declared nondiabetic individuals, selected by multistage sampling. Fasting blood sugar value was used as the gold standard to validate IDRS. Data were collected using a validated and pretested interview schedule. Data entry and analysis were performed in computer using SPSS-24. Receiver operating characteristic (ROC) curve was constructed to validate IDRS. **Results:** Among the study individuals, 19% and 6.5% were identified as prediabetic and diabetics, respectively. Optimum sensitivity of 83.13% and specificity of 82.64%, with positive and negative predictive values 62.16% and 93.45%, respectively, were observed at an IDRS score of ≥60 for identifying prediabetes and diabetes in this study population. IDRS showed good accuracy with an area under ROC curve of 0.832 (95% confidence interval: 0.77–0.88). **Conclusion:** IDRS is found to be a valid tool for screening prediabetes at community level in West Tripura district of India.

Keywords: Indian Diabetes Risk Score, prediabetes, West Tripura

INTRODUCTION

Diabetes mellitus is a group of metabolic disorders characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both.[1] Prediabetes is a condition that comes before diabetes and is characterized by blood glucose levels higher than normal but not high enough to be called diabetes.[2] There are no clear symptoms of prediabetes. The global prevalence of diabetes has nearly doubled since 1980, rising from 4.7% to 8.5% in the adult population.[3]

In India, the prevalence of diabetes among adults has also increased from 5.5% in 1990 to 7.7% in 2016.[4] The Indian Council of Medical Research (ICMR) has reported an inter-state variation in the prevalence of diabetes across India ranging from 4.3% in Bihar to 10% in Punjab.[5] According to the ICMR-INDIAB study, Tripura, has the highest prevalence of diabetes (9.4%) and prediabetes (14.7%) among all the north-eastern states.[5] Evidence from various studies suggests that people with prediabetes may have concomitant end organs damages that are traditionally considered to be the

complications of diabetes.[6-9] However, these complications can be prevented by early identification and intervention to control hyperglycemia.[10-12]

Any program aimed at the early identification of type 2 diabetes through screening will also identify individuals with impaired glucose tolerance and/or Impaired Fasting Glycaemia (IFG).[13] Nowadays, the use of noninvasive risk scores is gaining popularity in screening diabetes due to higher community acceptance, cost-effectiveness, and feasibility for large-scale application than the invasive procedures.[14] Mohan *et al.* developed a simple screening tool from the Chennai Urban Rural Epidemiological Study (CURES) named: Indian

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Diabetes Risk Score (IDRS) [Table 1], to screen population for diabetes.[15] The score ranges from 0 to 100, based on four simple parameters namely age, family history of diabetes, physical activity, and waist circumference.[15]

However, Indian population being heterogeneous in composition, this risk score needs further validation in different parts across the country. Data regarding application of this scoring system on the population of Tripura are lacking. In this context, this study was designed with an aim to test the validity of IDRS for screening prediabetes among population of West Tripura district of India.

METHODOLOGY

This community-based cross-sectional study was conducted during January 01, 2018–December 31, 2019 in West Tripura district of India among 325 individuals aged 18 years or more chosen by multistage sampling technique. The minimum sample size requirement for this study was determined to be 320 individuals, using the formula for calculating sample size in sensitivity studies i.e., $N = \dfrac{[z_\alpha^2 \times \bar{p} \times (1 - \bar{p})]}{d^2}$.[16] Where: N is the sample size. Z_α is standard normal deviate and its value is $1.96 \approx 2$ at 5% level of significance with 95% confidence interval (CI). $\hat{P} = 72.5\%$, which was the predetermined value of sensitivity ascertained from a previously published study.[15] $d = 5\%$, which is the absolute error considered for this study.

West Tripura district consisted of two urban and nine rural areas. Urban areas were the Agartala Municipal Corporation (AMC) area and the Ranirbazar Municipal area. Rural areas were the nine administrative Blocks under this district. This district had approximately 40% urban and 60% rural population,[17] so to ensure proportionate representation in the study sample, 128 participants from urban and 192 participants from the rural areas were recruited. AMC had four zones and 49 wards. Ranirbazar Municipal area had only 13 wards. The municipal wards and villages had family registers maintained by the ward secretaries and the panchayet secretaries, respectively.

At the 1st stage, one municipal ward from each of the four zones of AMC area, one ward from Ranirbazar Municipal area and one Village (Gram Panchayet) from each of the nine administrative Blocks of West Tripura district was chosen by simple random sampling (SRS). Ranirbazar Municipal area, being a small town, contributed only 3% of the total urban population of West Tripura district, so only 4 participants were selected from that area [Figure 1].

At the 2nd stage, families were selected from the identified urban wards and villages by SRS without replacement using their respective family registers as the sampling frames. Presuming roughly equal population in each of the municipal wards and villages, 31 families from each of the selected municipal wards and 22 families from each of the selected villages were chosen. At the final stage, only one eligible adult member from each of the identified family was chosen by SRS.

A validated and pretested interview schedule, containing questions related to socio-demographic information, dietary habit, anthropometric parameters, and components of IDRS were used for collecting data. Data were collected by paying home visits to the selected houses and informed written consent for participation in this study was obtained from the respondents. On the first visit, after conducting the interview, measurement of blood pressure and anthropometry were performed and the study participants were asked to remain fasting for at least 10 h till the second visit on next morning, when fasting blood glucose values were measured using a glucometer (Accu-Check active blood glucose monitor, Roche diagnostics, Germany). The World Health Organization criterion was used to define diabetes and prediabetes. Patients having fasting blood sugar (FBS) value of ≥126 mg/dl were considered as diabetic. FBS value of 110 mg/dl to 125 mg/dl was considered as impaired fasting glucose or prediabetics.[18]

Data entry and analysis were performed with computer using SPSS version24 (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.) for windows. Data were presented with the help of text, tables, charts, etc., Qualitative data were expressed in terms of percentages and continuous data were expressed in terms of mean and standard deviation. Validity (sensitivity, specificity, positive predictive values [PPV], and negative predictive values [NPV]) was tested at different cut off points of IDRS. ROC curve was constructed and area under the curve (AUC) was used to find out the accuracy of this scoring system. Chi-square test for testing the significance of difference between two or more proportions and Student's t-test for testing the significance of difference between two means were used. $P < 0.05$ was considered statistically significant.

RESULTS

Initially, 352 individuals were selected by the sampling procedure considering the issue of nonresponse. Out of them 12 subjects reported to be diabetic and on medication, four subjects refused to give blood samples, two women were pregnant, five were lactating women, one was suffering from severe hearing impairment, two were suffering from hemiplegia, and one was suffering from schizophrenia. Thus, 27 participants met exclusion criteria and were excluded from this study. Finally, 325 subjects got enrolled in this study and data collected from all of them were included for analysis.

Majority (51.40%) of the study participants were aged either 50 year or above followed by 35.7% aged between 35 and 49 year and 12.9% were aged <35 year. Out of total, 57.80% were female, 85.50% were Hindu by religion, 11.10% were Muslim, and 3.40% were Christian. Among the study population, 43.10% were from general community, 26.80% were scheduled caste, 13.80% were scheduled tribe and 16.30% belonged to other backward communities. Regarding type of family, 66.76% belonged to nuclear families and the rest to the joint families.
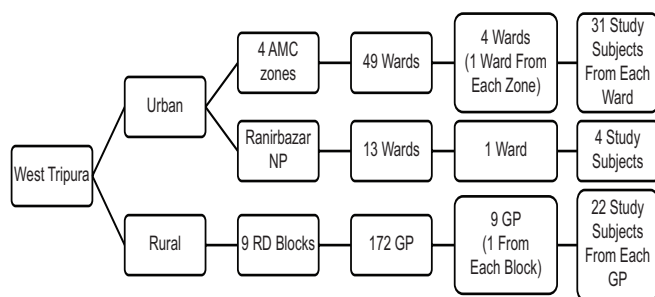
Figure 1: Sampling algorithm. AMC = Agartala Municipal Corporation area (Urban); NP = Nagar-panchayet (urban area); GP = Gram panchayet (rural area)
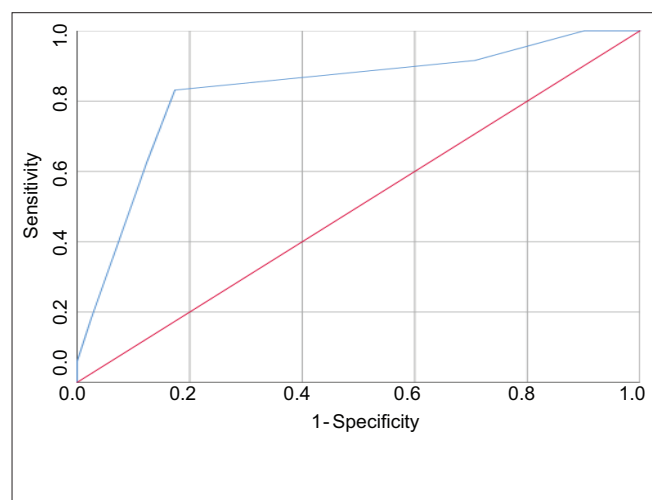

Figure 2: Receiver operating characteristic curve showing the performance of Indian diabetes risk score in predicting prediabetes

Among all, 86.50% of the study participants were married, 1.50% was unmarried and 12.00% were either widow/widower or divorced. Majority (40.90%) of the study participants were primary educated, followed by 35.40% secondary educated, 12.30% illiterate, and remaining 11.40% were either graduates or higher educated. Regarding occupation, 43.50% were homemakers, 13.50% were service holders, 12.90% had own business, 9.80% were skilled workers, and 6.80% were unskilled workers. According to B G Prasad's socioeconomic classification, 34.80% of the study participants belonged to lower middle class, followed by 25.50% to middle class, 22.20% to upper middle class, 14.80% to upper class, and 2.80% belonged to lower socioeconomic class. 89.23% of the study participants were nonvegetarians and the rest were vegetarians.

Majority of the study participants, i.e., 77.20% were tobacco users and out of the users, 47.70% were using smokeless forms of tobacco such as khaini, jarda, and guthka. Majority of the participants (77.60%) never consumed alcohol. Among the ever consumers, 8.00% were quitters, 13.20% were occasional consumers and only 1.20% used to consume alcohol regularly.

Among the study participants, 8.00% had family history of diabetes and in 2.50% of the instances both parents were diabetic.

Table 1: Computation of Indian Diabetes Risk Score

Particulars	Score
Age (years)	
<35 (reference)	0
35-49	20
≥50	30
Abdominal obesity	
Waist <80 cm (female), <90 (male) (reference)	0
Waist ≥80-89 cm (female), ≥90-99 cm (male)	10
Waist ≥90 cm (female), ≥100 cm (male)	20
Physical activity	
Exercise (regular) + strenuous work (reference)	0
Exercise (regular) or strenuous work	20
No exercise and sedentary work	30
Family history of diabetes	
No family history (reference)	0
Either parent	10
Both parents	20

Minimum score=0; Maximum possible score=100. IDRS is computed using age, family history of Diabetes, waist circumference and physical activity level of a subject. Score ≥60 denotes high risk, 30–60 denotes moderate and score <30 in a subject denotes low risk of developing Diabetes in future. IDRS: Indian Diabetes Risk Score

Out of total, 30.47% of the study participants were found to be hypertensive, 60.60% had normal body mass index, 34.50% were overweight, 2.50% were obese, and 2.40% were underweight. Among the study participants 19.10% and 6.40% were identified as prediabetic and diabetics, respectively. The prevalence of newly diagnosed diabetes and prediabetes among urban subjects was 12.20% and 20.60%, respectively; whereas, the same was 2.60% and 18% respectively among the rural participants. Based on IDRS, 34.20% of the study participants had high, 63.70% had moderate, and 2.10% had low risk of developing diabetes in near future. Associations of FBS with anthropometric parameters and different components of IDRS are shown in table 2 and 3.

The optimal sensitivity and specificity for predicting prediabetes in this study was found at an IDRS score of ≥60 which was 83.13% and 82.64%, respectively. At the same cut off score, the PPV and NPV were found to be 62.16% and 93.45%, respectively [Table 4]. Receiver operating characteristic (ROC) curve, constructed to validate IDRS in detecting prediabetes by comparing against FBS level shows an area of 0.832 (95% CI: 0.77–0.88) under the curve (AUC) with a *P* value of <0.001 which signified high level of accuracy of the IDRS score [Figure 2].

DISCUSSION

Using IDRS, the present study found that 34% of the study participants had high and 63% had moderate risk of developing diabetes in future. Similarly, Nagalingam *et al.* have also reported the moderate and high risk of developing diabetes as 45% and 37%, respectively.[19] Gupta *et al.* in their study observed that 31% and 50.32% of study participants were at high and moderate risk respectively of developing type-2 diabetes.[20] However, different observation was reported by

Arun *et al.*, where 15% of the participants were found to have high risk of developing diabetes.[21]

In the present study, IDRS had shown optimum sensitivity of 83.13% and optimum specificity of 82.64% at a score ≥60, for identifying prediabetes and undiagnosed diabetes with a PPV and NPV of 62.16% and 93.45%, respectively. In the landmark CURES study, Mohan *et al.* observed a sensitivity of 72.5% and specificity of 60.1% with a PPV and NPV of 17% and 95.1% respectively, at a score of ≥60 and recommended that score as cut off value for identifying undiagnosed diabetes.[15] In another 8-year follow-up study, Mohan *et al.* observed that 38.40% of the participants who got converted to either diabetes or prediabetes had IDRS ≥60 at baseline, which reflected that IDRS can also be used to detect people at risk of prediabetes.[22] Adhikari *et al.* conducted a study among different set of Indian population and reported an optimum sensitivity and specificity of 62% and 73% respectively at cut off score of ≥60 for identifying undiagnosed diabetes.[23] Some other studies also reported higher sensitivity than the present one at the same cut off score.[24-26] However, Bhadoria *et al.* reported optimum sensitivity and optimum specificity at a score of ≥40, which differs from the result of the present study.[27] A study conducted in Shimla, reported optimum sensitivity and optimum specificity as 61.33% and 56.14%, respectively, for detecting undiagnosed type-2 diabetes at a score of ≥70.[28]

The present study reported an AUC of 0.83 (95% CI: 0.77–0.88), which reflects a good accuracy of IDRS to detect prediabetes and undiagnosed diabetes. This finding was higher from the findings of CURES study, where an AUC of 0.69 (95% CI: 0.66–0.73) was observed.[15] This difference may be due to the fact that only newly diagnosed diabetes cases were included in that study, whereas, the present study included both newly diagnosed diabetes and prediabetes.

Table 2: Fasting blood sugar levels by anthropometric parameters of the study participants

Variables	Mean (SD)		P
	FBS ≥110 mg % (n=83)	FBS <110 mg% (n=242)	
Height (meter)	1.51 (0.08)	1.51 (0.07)	0.843
Weight (kg)	58.44 (7.46)	53.89 (9.24)	0.000
Waist circumference (cm)			
Male	90.17 (6.59)	85.01 (7.25)	0.001
Female	88.43 (8.01)	82.59 (9.26)	0.000

That subjects with higher body weight and greater waist circumference had significantly higher FBS levels (≥110 mg/dl) than those with lower body weight and lesser waist circumference (*P*<0.05). SD: Standard deviation, FBS: Fasting blood sugar

Table 3: Fasting blood sugar level by age, physical activity, and family history of diabetes of the study subjects

Variables	Sub groups	FBS level (mg/dl)		P
		≥110 mg%, n (%)	<110 mg%, n (%)	
Age (years)	≥40	78 (31.10)	173 (68.90)	0.000
	<40	5 (6.80)	69 (93.20)	
Physical activity	Heavy	0	7 (100)	0.000
	Moderate	23 (13)	153 (87)	
	Sedentary	60 (42.30)	82 (57.70)	
Family history of diabetes	Present	20 (76.90)	6 (23.10)	0.000
	Absent	63 (21)	236 (79)	

That subjects aged 40 years or above, those having family history of diabetes and lesser physical activity had significantly higher fasting blood sugar levels (*P*<0.05). FBS: Fasting blood sugar

Table 4: Sensitivity, specificity, positive predictive value and negative predictive value at different cut offs of Indian Diabetes Risk Score detected by this study

IDRS	95% CI			
	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
≥30	100 (95.65-100)	2.89 (1.17-5.86)	26 (20.88-30.64)	100
≥40	100 (95.65-100)	9.91 (6.45-14.39)	27.57 (26.74-28.41)	100
≥50	91.56 (83.39-86.54)	29.33 (23.68-35.51)	30.76 (28.59-33.03)	91.02 (82.84-95.48)
≥60	83.13 (73.32-90.46)	82.64 (77.27-87.19)	62.16 (55.10-68.73)	93.45 (89.82-95.85)
≥70	62.65 (51.34-73.02)	87.60 (82.77-91.47)	63.41 (54.39-71.58)	87.24 (83.75-90.07)
≥80	21.68 (13.38-32.09)	97.52 (94.68-99.08)	75.00 (55.20-87.95)	78.40 (76.39-80.29)
≥90	6.02 (1.98-13.50)	100 (98.48-100)	100	75.60 (74.60-76.61)

The sensitivity, specificity, positive and negative predictive values of IDRS for predicting prediabetes at different cut-offs. IDRS of ≥60 showed the optimal sensitivity and specificity of 83.13% and 82.64% respectively for predicting prediabetes in this study. At the same cut off score, the PPV and NPV were found to be 62.16% and 93.45% respectively. Higher IDRS showed higher specificity of predicting prediabetes, but with lowered sensitivity. Similarly lower IDRS had high sensitivity of predicting prediabetes, but with lowered specificity. IDRS: Indian Diabetes Risk Score, NPV: Negative predictive values, PPV: Positive predictive values, CI: Confidence interval

The present study had certain limitations like only one measurement of FBS was performed and testing of venous plasma glucose and oral glucose tolerance test was precluded to determine prediabetes due to resource constraints.

CONCLUSION

This community-based cross-sectional study showed that, if the IDRS with a cut off score of ≥ 60 is applied upon the population of West Tripura district, it will be able to identify 83% of the undiagnosed diabetic and prediabetic patients and will also be able to identify correctly 82% of the individulas who are free from either diabetes or prediabetes. Thus, IDRS can be used as an efficient screening tool in West Tripura district also for the identification of people at risk for developing prediabetes or diabetes in future to apply early preventive measures.

Conflicts of interest
There are no conflicts of interest.

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