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Indian Journal of Medical Sciences

Original Article

Risk assessment of type 2 diabetes mellitus using Indian diabetes risk score among females aged 30 years and above in urban Delhi

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ABSTRACT

Objectives: It is crucial to identify diabetes risk factors and screen young people for the disease to stop diabetes from developing. An effective and validated approach to assessing population diabetes risk is the Indian diabetes risk score (IDRS). Diabetic women are more vulnerable to many unfavorable outcomes. The objective of this study was to determine the risk of type 2 diabetes mellitus (T2DM) among females aged 30 years and more using IDRS.

Materials and Methods: A cross-sectional study was conducted among 626 self-declared non-diabetic females from July 2022 to January 2023 using a semi-structured interview schedule. IDRS was used to assess diabetes risk.

Results: IDRS categorization revealed 15.8%, 44.6%, and 39.6% participants in low-, moderate-, and high-risk categories, respectively. Sensitivity and specificity were 67.5 (60.6–74.4) and 41.6 (34.3–48.9), respectively, compared to the gold standard test (Fasting blood sugar). At a 95% confidence interval, the area under the curve of receiver operating characteristic was found to be 0.6 (0.47–0.68).

Conclusion: Nearly two-fifths (39.6%) of the participants had a high risk of getting T2DM. Increments in age, family history of diabetes, lack of physical activity, and abdominal obesity were the most frequent factors associated with a high risk of developing T2DM.

Keywords: Indian diabetes risk score, Type 2 diabetes mellitus, Risk, Urban

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is highly prevalent in India and is rising alarmingly. With most cases being concealed (undiagnosed), diabetes demonstrates the best example of the Iceberg phenomenon. The clinical, social, and economic impact of the condition can be lessened by detecting diabetes early with the right screening techniques, especially in people with higher risk.[1]

India had a 9.3% prevalence of diabetes.[2] In India, 10.2% of females between the ages of 18 and 69 had diabetes.[3] East Delhi had a diabetes prevalence of 18.3% (known as 10.8% and recently discovered as 7.5%).[4]

In the 21st century, non-communicable diseases have grown in importance as a major public health issue in India due to epidemiological changes. Diabetes being a crucial disease, considered a "disease of urbanization." While T2DM is becoming more frequent among urban Indian adults, it is important to remember that undiagnosed diabetes is still common.[5-7]

Women playing various tasks at home and in the community are more likely to have more specific risk factors, such as physical inactivity and central obesity, which increase the chance of developing diabetes. Gestational diabetes mellitus (GDM) represents high blood glucose levels in pregnant women. GDM is a potential risk factor for poor perinatal consequences, and long-term danger to children of developing glucose intolerance and obesity. GDM is strongly linked to hypertensive adversities during pregnancy and a high risk of T2DM afterward.[8]

Studies specifically focusing on diabetes risk among females in urban areas using the Indian diabetes risk score (IDRS) are scarce. Most of the studies were concerned with the urban adult population. Data collection was done during the forenoon when most of the adult males were not present in the house probably due to occupation. Therefore, an effort was made to conduct this study, particularly among urban Delhi women.

IDRS was created at the Madras Diabetes Research Foundation by Mohan *et al*. It is a verified tool for locating people with a high risk of acquiring T2DM. It consists of two non-modifiable risk factors, age, and family history, and two modifiable risk factors, abdominal obesity, and physical activity.[9] Details of IDRS are shown in [Table 1].

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Received: 18 March 2023 **Accepted:** 18 June 2023 **EPub Ahead of Print:** 20 July 2023 **Published:** 19 October 2023 **DOI**: 10.25259/IJMS_53_2023

Low, moderate, and high risk of diabetes are determined by IDRS scores of <30, 30–59, and >60, respectively.

According to the population-based survey, the adult population ≥30 years is considered for screening for diabetes.[10] By assessing the risk of T2DM among females aged ≥30 years, proper intervention can be done on time related to lifestyle. Thus, it is important to detect this large number of participants with undiagnosed T2DM in India and start early initiation of treatment.

The objectives of the study were to:

1. To determine the risk of T2DM among females aged 30 years and more using IDRS in an urban resettlement colony, Dakshinpuri, Delhi
2. To study selected factors associated with the risk of T2DM among females aged 30 years and more among the study participants.

MATERIALS AND METHODS

This was a community-based cross-sectional study. Due to logistic reasons, two blocks of Dakshinpuri extension, New Delhi were purposively selected. All females aged 30 years and more without diagnosed T2DM, residing in that area at least for the past 1 year considered to be included. Those who were already diagnosed with diabetes were excluded from the study.

Study period

This study was from July 2022 to January 2023.

Sample size calculation

The study conducted in Hyderabad by Bala *et al*., in 2019,[11] found that T2DM was 38% prevalent (high-risk group in IDRS). Sample size was obtained as 666 by the formula $4pq/d^2$ (p = 0.40, q = 100-p, absolute precision [d] = 0.04) and non-response rate = 10%. All the eligible participants were requested for fasting capillary blood sugar (FBS) testing. Only consenting participants were taken for validating the IDRS results.

Operational definitions

High-risk cases of diabetes: IDRS ≥ 60[9]

Positive family history of diabetes: one or both of a participant's parents was/were diabetic.[12]

The WHO STEPS criteria were used to grade sedentary, mild, moderate, or vigorous physical activity.[13]

Waist circumference was calculated by the standard procedures and when women's waist measurements were ≥80 cm, central obesity was deemed to be present.[14]

A semi-structured pretested questionnaire was administered by trained personnel through house visits. Trained personnel consist of 3rd year M.B.B.S. students, postgraduate residents of community medicine, All India Institute of Medical Sciences (AIIMS), Delhi who were trained by senior residents and faculty of the same department beforehand. From all participants, informed written consent was taken. On the following morning, FBS measurement was done among the high-risk and non-high risk for T2DM who gave consent for finger pricking, with a standardized digital glucometer (Accu-Check, Roche Diagnostics, Germany).[15] Diabetes was established considering FBS levels >126 mg/dL and a referral was done to Urban Health Center, AIIMS for further management.[16]

Statistical analysis

Compilation of data and analysis was done in Excel and STATA v. 15, respectively. Data cleaning was done to find data errors and missing values. Descriptive statistics

Table 1: Indian diabetic risk score.

Parameter	Criteria	Score
Age (completed years)	<35	0
	35–49	20
	≥50	30
Abdominal obesity-Waist circumference (cm)	<80	0
	80–89	10
	≥90	20
Physical activity	Regular exercise plus strenuous work	0
	Regular exercise or strenuous work	20
	No exercise and sedentary work	30
Family history of diabetes	No diabetes in parents	0
	One diabetic parent	10
	Both diabetic parents	20

IDRS: Indian diabetic risk score

were performed using frequency and proportion. Logistic regression was made; the IDRS score being the dependent variable and others as the independent variable. Variables with $P < 0.2$ were included for multivariable analysis. $P < 0.05$ and < 0.001 would reflect statistical significance and high significance, respectively.

Ethics

AIIMS Ethics Committee permitted ethical clearance.

RESULTS

A total of 626 women aged 30 years and more without diagnosed T2DM were included in the study. IDRS categorization revealed 99 (15.8%), 279 (44.6%), and 248 (39.6%) participants in low-, moderate-, and high-risk categories, respectively. [Table 2] is showing the baseline features of the participants.

More than half (104; 56.5%) of the illiterate study participants were at high risk and 27 (65.9%) graduate participants were at moderate risk. There was a high statistically significant association between low education status with high-risk status ($P < 0.0001$).

The mean (standard deviation [SD]) age of the participants was 43.9 (12.2) years. More the three-quarter (143; 76.1%) of participants aged >50 years were at high risk. More than half and two-thirds (125; 69.1%) of the participants (136; 52.9%) aged 35–49 years and 30–34 years were at moderate risk, respectively. The association between risk status and age group was highly significant ($P < 0.0001$).

Table 2: Baseline features of the participants.

Features	Total (%), *n*=626	High risk (IDRS ≥60), *n*=248 (39.6%)	Moderate risk (IDRS 30–59), *n*=279 (44.6%)	Low risk (IDRS <30), *n*=99 (15.8%)	Chi-squared *P*-value
Education (minimum)					
Illiterate	184 (29.5)	104 (56.5)	48 (26.1)	32 (17.4)	<0.0001
Primary school certificate	128 (20.5)	50 (39.0)	61 (47.7)	17 (13.3)	
Middle school certificate	106 (16.9)	36 (33.9)	53 (50.0)	17 (16.1)	
High school certificate	101 (16.1)	29 (28.7)	54 (53.5)	18 (17.8)	
Intermediate or diploma	66 (10.4)	23 (34.8)	36 (54.6)	7 (10.6)	
Graduate	41 (6.6)	6 (14.6)	27 (65.9)	8 (19.5)	
Age (years)					
30–34	181 (28.9)	2 (1.1)	125 (69.1)	54 (29.8)	<0.0001
35–49	257 (41.1)	103 (40.1)	136 (52.9)	18 (7.0)	
>50	188 (30.0)	143 (76.1)	18 (9.6)	27 (14.4)	
Family history of diabetes					
No diabetes in parents	517 (82.6)	192 (37.1)	237 (45.9)	88 (17.0)	<0.037
One parent is diabetic	104 (16.6)	52 (50.0)	41 (39.4)	11 (10.6)	
Both parents are diabetic	5 (0.8)	4 (80.0)	1 (20.0)	0 (0.0)	
Physical activity					
Regular exercise+strenuous work	33 (5.3)	0 (0.0)	18 (54.6)	15 (45.4)	<0.0001
Regular exercise or strenuous work	373 (59.6)	119 (31.9)	195 (52.3)	59 (15.8)	
No exercise and sedentary activities at home/work	220 (35.1)	129 (58.6)	66 (30.0)	25 (11.4)	
Waist circumference					
<80 cm	178 (28.5)	20 (11.2)	103 (57.9)	55 (30.9)	<0.0001
80–89 cm	280 (44.7)	114 (40.7)	148 (52.9)	18 (6.4)	
>90 cm	168 (26.8)	114 (67.8)	28 (16.7)	26 (15.5)	
Any comorbidity*					
No	461 (73.6)	174 (37.7)	240 (52.1)	47 (10.2)	<0.0001
Yes	165 (26.4)	74 (44.9)	39 (23.6)	52 (31.5)	
Tobacco usage					
No	587 (93.8)	230 (39.2)	263 (44.8)	94 (16.0)	<0.0001
Yes	39 (6.2)	18 (46.2)	16 (41.0)	5 (12.8)	
Alcohol consumption					
No	616 (98.4)	244 (39.6)	274 (44.5)	98 (15.9)	0.867
Yes	10 (1.6)	4 (40.0)	5 (50.0)	1 (10.0)	

*One participant can have multiple comorbidities (e.g., Hypertension, dyslipidemia, hypothyroidism, seizure disorder, cancer, stroke, heart disease, and other chronic conditions). IDRS: Indian diabetic risk score

Among the participants with a history of one parent diabetic, half (52, 50.0%) of them were considered as high risk. Of participants with both diabetic parents, the majority (4, 80.0%) of them were considered as high risk. The link between diabetic family history was statistically significant with risk status ($P = 0.037$).

More than half (129; 58.6%) of participants with a history of no exercise and sedentary activities at home/work were considered as high risk. Physical there was a significant association between physical activity and risk status ($P < 0.0001$).

More than 2/3 (114, 67.8%) of participants with waist circumference (>90 cm) were considered as high risk. Statistically significance ($P < 0.0001$) was found between risk status and waist circumference.

Almost half (74; 44.9%) of the participants with any comorbidities were at high risk which was significantly associated ($P < 0.0001$). Almost half (18.46.2%) of the participants with tobacco usage history were considered as high risk, where statistical significance ($P < 0.0001$) association was seen. 40% of the study participants with a history of alcohol consumption were considered as high risk, where statistical significance ($P = 0.867$) was not seen.

Univariate logistic regression for the high-risk participants [Table 3] showed that minimum education up to graduation had 87% less chance of having high-risk status (odds ratio [OR]: 0.13; 95% confidence interval [CI]: 0.05–0.33), where statistical significance ($P < 0.0001$) was seen. Participants aged ≥50 years had 10.07 times more odds of having high-risk status with respect to the non-high-risk group, where

Table 3: Univariate and multivariable logistic regression of risk of diabetes and associated risk factors among the high-risk group with respect to moderate- and low-risk groups.

Characteristics	Participants		Univariate		Multivariable	
	Total (%), *n*=626	High risk (IDRS ≥60), *n*=248 (39.6%)	Crude odds ratio (95% Confidence interval)	*P*-value	Adjusted odds ratio (95% Confidence interval)	*P*-value
Education (minimum)						
Illiterate	184 (29.5)	104 (56.5)	Reference	-	Reference	-
Primary school certificate	128 (20.5)	50 (39.0)	0.49 (0.31–0.78)	0.003	0.68 (0.37–1.26)	0.224
Middle school certificate	106 (16.9)	36 (33.9)	0.39 (0.24–0.65)	<0.0001	0.74 (0.37–1.47)	0.388
High school certificate	101 (16.1)	29 (28.7)	0.31 (0.18–0.52)	<0.0001	0.46 (0.22–0.95)	0.037
Intermediate or diploma	66 (10.4)	23 (34.8)	0.41 (0.23–0.74)	0.003	0.79 (0.36–1.73)	0.555
Graduate	41 (6.6)	6 (14.6)	0.13 (0.05–0.33)	<0.0001	0.16 (0.05–0.48)	0.001
Age (years)						
<50	438 (70.0)	105 (24.0)	Reference	-	Reference	-
>50	188 (30.0)	143 (76.1)	10.07 (6.75–15.04)	<0.0001	13.26 (7.61–23.09)	<0.0001
Family history of diabetes						
No	517 (82.6)	192 (37.1)	Reference	-	Reference	-
Yes	109 (17.4)	56 (51.4)	1.79 (1.18–2.71)	0.006	5.47 (3.02–9.91)	<0.0001
Physical activity						
No exercise and sedentary activities at home/work	220 (35.1)	129 (58.6)	Reference	-	Reference	-
Regular exercise and/or strenuous work	406 (64.9)	119 (29.3)	0.29 (0.21–0.41)	<0.0001	0.23 (0.14–0.36)	<0.0001
Waist circumference						
<80 cm	178 (28.4)	20 (11.2)	Reference	-	Reference	-
>80 cm	448 (71.6)	228 (50.9)	8.18 (4.96–13.51)	<0.0001	12.26 (6.47–23.21)	<0.0001
Any comorbidity						
No	461 (73.6)	174 (37.7)	Reference	-	Reference	-
Yes	165 (26.4)	74 (44.9)	1.34 (0.94–1.92)	0.111	0.40 (0.24–0.68)	0.001
Tobacco usage						
No	587 (93.8)	230 (39.2)	Reference	-	-	-
Yes	39 (6.2)	18 (46.2)	1.33 (0.69–2.55)	0.392	-	-
Alcohol consumption						
No	616 (98.4)	244 (39.6)	Reference	-	-	-
Yes	10 (1.6)	4 (40.0)	1.02 (0.28–3.64)	0.98	-	-

IDRS: Indian diabetic risk score

statistical significance ($P < 0.0001$) was seen. Diabetic family history in at least one parent had 1.79 times more odds of having high-risk status considered statistical significance ($P < 0.0001$). Participants performing regular exercise and/or strenuous work had 71% less chance of having high-risk status, where statistical significance ($P < 0.0001$) was seen. Participants with waist circumference >80 cm had 8.18 times more odds of having high-risk status where statistical significance ($P < 0.0001$) was seen. Participants with any comorbidity had 34% more chance of having high-risk status which was not significant statistically ($P = 0.111$).

On multivariable logistic regression for high-risk group [Table 3], age 50 years or more (OR: 13.2; 95% CI: 7.57–23.02; $P < 0.0001$), family history of at least one parent diabetic (OR: 5.5; 95% CI: 3.03–9.98; $P < 0.0001$), participants performing regular exercise and/or strenuous work (OR: 0.22; 95% CI: 0.14–0.36: $P < 0.0001$), and participants having waist circumference >80 cm (OR:12.56, 95% CI: 6.59–23.91; $P < 0.0001$) had a highly statistically significant association. Significant statistical associations ($P < 0.05$) were seen between minimum education (high school; OR 0.45; 95% CI: 0.22–0.94: $P = 0.033$ and graduate; OR: 0.16; 95% CI: 0.05–0.48; $P = 0.001$) and high-risk group.

FBS was collected from consenting participants from high-risk group, non-high-risk group using simple random sampling. Overall, the prevalence of T2DM was 22.6% (16.5–28.7) among all the participants.

The sensitivity and specificity among study participants by dividing the IRDS score into 2 categories is shown in [Table 4].

[Table 5] provides the sensitivity and specificity of different cutoffs for IDRS. IDRS >60 had optimum sensitivity (67.5%) and specificity (41.6%) for identifying diabetes. The receiver operating characteristic (ROC) curve, made for validation of IDRS to detect diabetes using comparison against FBS values, provides an area (area under the curve [AUC]) of 0.6 (95% confidence interval [CI]: 0.47–0.68) under the curve ($P < 0.001$, denoting the sufficient level of accuracy) [Figure 1].

Table 4: Sensitivity and specificity among study participants**.

IDRS	Diabetes-Mellitus *Positive* (FBS ≥126 mg/dL)	Diabetes-Mellitus *Negative* (FBS <126 mg/dL)	Total
≥60	27 (TP)	80 (FP)	107
<60	13 (FN)	57 (TN)	70
Total	40	137	177

IDRS: Indian diabetic risk score. Sensitivity (95% CI) = TP/TP+FN=27/40=67.5 (60.6–74.4), Specificity (95% CI) = TN/TN+FP=57/137=41.6 (34.3–48.9), Positive Predictive Value (95% CI) = TP/TP+FP=27/107=25.23 (18.8–31.6), Negative Predictive Value, (95% CI) = TN/TN+FN=57/70=81.4 (75.7–87.2). **TP: True positive, FP: False positive, FN: False negative, TN: True negative, FBS: Fasting capillary blood sugar

Table 5: Sensitivity and specificity value at different cutoffs of IDRS detected by the study.

IDRS	Sensitivity (%)	Specificity (%)
≥20	100.0	0.0
≥30	97.5	4.4
≥40	92.5	11.7
≥50	77.5	22.6
≥60	67.5	41.6
≥70	45.0	66.4
≥80	25.0	86.9
≥90	7.5	99.3

IDRS: Indian diabetic risk score

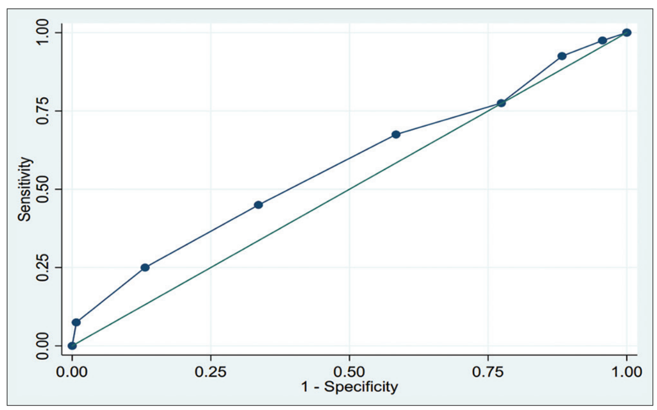

Figure 1: ROC curve showing performance of IDRS. AUC (95% CI) of ROC= 0.6 (0.47–0.68). ROC: Receiver operating characteristic, AUC: area under the curve, IDRS: Indian diabetic risk score.

DISCUSSION

This study comprised 626 female participants residing in an urban resettlement area, Dakshinpuri near the urban health center, AIIMS, Delhi. This consists of around two-fifths (41.1%) of the participants aged 35–49 years followed by aged >50 years (30.0%) and <30 years (28.9%) with a mean (SD) age of 43.9 (12.2) years. The majority were married (87.1%) and residing in a nuclear family (53.9%). Almost one-third were illiterate (29.5%) followed by educated up to primary (20.5%).

Bala *et al.*,[11] in their study, conducted among 150 females from the industrial area in Hyderabad in 2019 found the mean (SD) age to be 35.39 (13.3) years and the majority of females aged group 31–35 years came up with 57.4%. More than 50% were married (52%) residing in a nuclear family (78 almost one-third were educated up to intermediate (30.7%).

A study conducted by Raghavendra *et al.*[17] in urban East Delhi (Gazipur) found the majority of women (42.6%) aged 31–40 years with illiteracy among 50%.

The proportion of participants with a high risk of T2DM was 39.6%. Patil and Gothankar published findings that were comparable[18] at Pune in 2016 (36.55% high-risk group), Mohan *et al*.[9] in urban Chennai (43% high risk), Nagarathna *et al*.[19] in multiple sites in India in 2020 (40.9% high risk), Bala *et al*. at[11] Hyderabad in 2019 (38% high risk), and Sengupta and Bhattacharjya[20] in Tripura (34.2% high risk).

A relatively lesser proportion of high-risk status was obtained by Gupta *et al*.[21] at urban Puducherry (31.2% high risk), Singh *et al*.[22] in the assessment of risk among north Indian young medical students (high risk 0.6%), Sahai and Ahuja at.[23] Gwalior (0% high risk), and Ashok *et al*.[24] at multiple sites in India (7% high risk). These variations are probably due to variations in sample size and study settings, the inclusion of younger age groups, the inclusion of both male and female participants, higher literacy rates, increased physical activity, etc.

A relatively higher proportion of high-risk status was found by Sankar *et al*.[25] in a semi-urban hospital in southern India (48.5% high risk), Acharya *et al*.[26] at Delhi (51.8% high risk), and Nittoori and Wilson[27] in North Telangana (74.3% high risk). These variations are probably due to variations in sample size and study settings, the inclusion of the elder age group, the inclusion of both male and female participants, higher illiteracy rates, decreased physical activity, etc.

Our study coined that, with the progression of age, the risk for diabetes increases. Studies conducted by Mohan *et al*.,[9] Patil and Gothankar,[18] Singh *et al*.,[28] and Menon *et al*.[29] found similar results. A high risk of diabetes was observed among participants with at least one diabetic parent in this study. Similar results were found in several studies.[15,26]

Over the previous years, a sizable section of the working population transitioned from physically demanding agricultural manual labor to less strenuous office labor. Rapid urbanization in India is accompanied by rising obesity rates and a decline in physical activity, which have changed people's lifestyles, and diets, and transitioned them from manual labor to less physically demanding jobs.[28] Increasing physical activity has a beneficial effect with a lesser risk of diabetes.[7,15,18] Waist circumference is an important determinant of the risk of T2DM; various studies have found that waist circumference and undiagnosed diabetes had a significant association, which was similar to the present study results.[15,18]

In the present study, participants with any comorbidity had a 60% less chance of having a high risk of diabetes, probably due to chance alone.

In this study, IDRS more than equal to 60 had optimum sensitivity (67.5%) and specificity (41.6%) for determining diabetes. A study conducted by Bala *et al*. produced almost equal findings,[11] (sensitivity 59.4% and specificity 37.3%), Mohan *et al*.[9] (sensitivity 72.5% and specificity 60.1%), Adhikari *et al*.[30] (sensitivity 62% and specificity 73%), Sharma *et al*.[31] (Sensitivity 72.5% and specificity 60.1%).

At 60 cutoff value, different results were found in the study conducted by Khan *et al*.[32] (sensitivity 29.9% and specificity 98.1%), Agarwal *et al*.[33] (sensitivity 45.5% and specificity 88%), Taksande *et al*.[34] (Sensitivity 97.5% and specificity 81.9%), Dudeja *et al*.[35] (sensitivity 95% and specificity 29%), and Sengupta and Bhattacharjya[20] (sensitivity 83.1% and specificity 82.6%).

Bhadoria *et al*. found optimum sensitivity and specificity at a level of ≥40, which was unlike from our study.[36] Kaushal *et al*. in Shimla, reported optimum specificity and sensitivity as 56.14% and 61.33%, respectively, at IDRS cutoff point ≥70.[37]

This difference could be described by the variation in eligibility criteria, sample size, training of the investigator, and study setting in various study designs. Our study included only women. There was a difference in the physical activity, denoting the variations in sensitivity and specificity.

The present study reported an AUC (95% CI) of 0.6 (0.47–0.68) at the IDRS cutoff point ≥60. This value is lower than the study by Mohan *et al*.[9] (AUC 0.69: 95% CI 0.66–0.73), Adhikari *et al*.[30] (AUC 0.66), Sengupta and Bhattacharjya[20] (AUC 0.83; 95% CI 0.77–0.88), and Patel *et al*.[38] (AUC 0.838). These variations occurred as freshly diagnosed diabetics were included in the above studies except in the study by Sengupta and Bhattacharjya, where both freshly diagnosed diabetics and pre-diabetics were included in the study. Other causes might be differences in inclusion criteria, study settings, presence of trained data collectors, etc. In a study conducted by Barjatya *et al*.,[39] at the IDRS cutoff point ≥35, AUC was 0.704 (95% CI 0.52–0.89).

Strengths

A community-based study was carried out among 626 participants. Thus, the sample size was adequate. The tool used (IDRS) has been developed and validated in India.[9] It studied the relationship between IDRS and other comorbid conditions which has not been done before in this study setting. Interviewers were trained; the process was standardized to avoid interviewer bias.

Limitations

Since it was a cross-sectional study, temporality cannot be established between the risk of diabetes and associated factors. Non-probability sampling was used. Comorbidities were assessed based on the history given by the participants during data collection. Thus, the chance of recall bias was high. Physical activity was recorded only by interview, high chance of social desirability bias.

CONCLUSION

For community-based research to identify people at high risk for diabetes, IDRS is a straightforward, non-invasive method. Non-modifiable risk factors, for example, increment in age and family history of diabetes, and modifiable risk factors, for example, lack of physical activity and abdominal obesity found to be the most common factors associated with high diabetes risk. This study also validates that IDRS is an accurate, simple, and efficient method to screen undiagnosed diabetes in the community with public health importance.

Acknowledgment

To all the study participants, I would like to express my sincere gratitude.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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How to cite this article: Halder P, Jeer G, Nongkynrih B. Risk assessment of type 2 diabetes mellitus using Indian diabetes risk score among females aged 30 years and above in urban Delhi. Indian J Med Sci 2023;75:136-43.