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Assessment of the risk of developing type 2 diabetes using the Indian diabetes risk score in an urban community in Chandigarh, India: A cross-sectional study

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Abstract:

BACKGROUND: The urban poor is a group that is known to be vulnerable to the adoption of a more urbanized lifestyle that places them at a higher risk for diabetes. Identification of at-risk individuals using simple screening tools like the Indian diabetes risk score developed by Madras Diabetes Research Foundation (MDRF-IDRS) and appropriate lifestyle interventions could greatly help in preventing or postponing the onset of diabetes and thus reducing the burden of the disease on the community and the nation as a whole.

MATERIALS AND METHODS: A cross-sectional study was conducted on individuals ≥30 years (n = 1533) of both genders in an urban colony of Chandigarh during a period of 1 year. A stratified two-stage systematic random sampling was adopted. The risk of developing Type 2 diabetes mellitus was assessed using IDRS. The total risk score of each participant was analyzed and compared. Biochemical investigations, including blood glucose and lipid profiles for detecting diabetes, were conducted. Data were presented in percentages and proportions. The statistical analysis of the data was performed by using the Chi-square test and logistic regression analysis.

RESULTS: The prevalence of diabetes was 3.1% in the present study. Overall, the mean IDRS was found to be 52.14 ± 16.01. Elderly persons aged 60 years and above had higher IDRS. IDRS showed significant variability with age ($P < 0.001$). Females had significantly higher IDRS as compared to males ($P = 0.002$). The association between socioeconomic class and risk status was highly significant statistically ($P < 0.001$). IDRS among individuals with diabetes was found to be significantly higher (64.29 ± 13.92) as compared to non-diabetics. Among all, 749 (48.7%) had high IDRS, whereas 54 (3.5%) had low IDRS. There were 734 (47.8%) with moderate IDRS.

CONCLUSION: IDRS was found to be highly sensitive for detecting the risk of diabetes, suggesting its potential use as a screening tool in community setup for the purpose of detecting diabetes.

Keywords:

IDRS, risk, type 2 diabetes

Introduction

Diabetes mellitus has reached epidemic proportions worldwide and is now a major public health challenge. This disease affects 6.6% (285 million people) of the world population in the 20–79 age group, and this number is expected to grow to 380 million by 2025, making diabetes one of the greatest medical challenges of the 21st century.[1] India is home to 40.9 million people with diabetes—nearly 15 percent of the global disease burden—and this number is predicted to rise to almost 70 million by

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2025, by which time every fifth diabetic subject in the world would be an Indian.[2]

A diabetes risk score helps in devising effective screening strategies to unmask the hidden burden of the disease. The risk factor approach needs aggressive identification for planning prevention strategies and for an early diagnosis. Identification of at-risk individuals using simple screening tools like the Indian diabetes risk score (IDRS), (developed by Mohan V and his colleagues at the Madras Diabetes Research Foundation in Chennai in 2005) and appropriate lifestyle interventions could greatly help in preventing or postponing the onset of diabetes and thus reducing the burden of the disease on the community and the nation as a whole.[3]

The IDRS has a sensitivity of 72.5% and a specificity of 60.1%, which takes into account twonon-modifiablee risk factors (age and family history of diabetes) and two modifiable risk factors (waist circumference and physical inactivity), which may be amenable to intervention and easy to measure at a very low cost.[4] The individuals were classified as having high risk (score ≥60), moderate risk (score 30–50), and low risk (score <30) out of a total score of 100.[2]

A cross-sectional study conducted among 400 adults between 30 and 60 years of age residing in a settled slum in the Rukmini Nagar area of Belagavi city, Karnataka, showed proportions of low, moderate, and high risk of developing diabetes mellitus of 07%, 63%, and 30%, respectively. The prevalence of diabetes among the newly diagnosed cases was 10.25%. Moreover, 57.1% of them with positive family history were in the high risk category; 76.9% of the sedentary workers were at higher risk; overweight and obese individuals had a higher proportion of the high and moderate risk ($P < 0.0001$).[5]

Around 29% of study participants were found to have high scores in a cross-sectional study conducted in Bhopal. By applying IDRS, at a score >60, 32% sensitivity and 97% specificity were found. A statistically significant association of IDRS with age, gender, religion, socioeconomic status (SES), education, occupation, and Body Mass Index(BMI) was seen.[6]

In Chandigarh, the prevalence of diabetes in urban areas is higher than the rates in rural areas (urban: 14.2% vs rural: 8.3%, $P < 0.001$. Moreover, in Chandigarh, the rural areas are not really "rural," but a suburb of an urban area. In terms of glycemic control, Chandigarh also had the highest proportion of diabetic subjects under poor control.[7] A study conducted in Chandigarh from 2008 to 2015 says that with 13.6% of its population suffering from the disease, the city, in percentage terms, has the highest incidence of diabetes among India's 15 states. It also says 14.6% of the city's people have been diagnosed as pre-diabetic, and they carry the risk of becoming diabetics in the near future.[8]

Hence, this study was planned to screen the adult population aged 30 years and above in an urban colony of Chandigarh.[4]

This study aims to assess the risk of type 2 diabetes using IDRS as a screening tool and to find the risk factors associated with high IDRS.

Materials and Methods

Study design and setting

It was a cross-sectional community-based study conducted in the field practice area of the Urban Health Training Centre (UHTC), Department of Community Medicine, Government Medical College and Hospital, Chandigarh.

Study participants and sampling

The study was done on participants aged 30 years and above. The area is situated in Sector 44 of Chandigarh, which is divided into four blocks with a total population of 16,210. There are 4,180 houses in the area. The population of the area was stratified according to urban wards/sectors within selected clusters. A sample of households was selected in a systematic manner to cover the households in the entire cluster. Within selected households, all members eligible for inclusion in the study were included.

All pregnant women, individuals with any intellectual developmental disability, and all known cases of diabetes mellitus were excluded.

The sample size came out to be 1533 using the formula $N = 4pq/d^2$. The prevalence of high IDRS was taken as 14.9% on the basis of a study conducted in Lucknow.[9] The confidence level was assumed to be 90% and the relative precision to be 10%. The total number of study subjects included in the study was 1537.

Data collection tool and technique

Individuals selected for the study were interviewed to collect information on socio-demographic and lifestyle-related characteristics by means of a predesigned, pretested, and validated standard questionnaire. Anthropometric measurements were taken, and a 24-hour dietary recall was done for the calculation of their nutritional intake. IDRS scores were calculated for each individual. Biochemical investigations to detect diabetes were conducted. The diagnosis of diabetes mellitus and Impaired Glucose Tolerance (IGT) was made as per WHO criteria.[10] The socio-economic status of the subjects was measured using the modified Kuppuswamy Socio-economic scale.[11]

Weight was recorded for each person without shoes and heavy clothing in standing posture using a weighing machine to an accuracy of 0.5 kg. Height was measured with a standard measuring tape to the nearest precision of 0.1 cm, using a standard procedure. The waist circumference for each person was measured with the subject standing, using a standard measuring tape to an accuracy of 0.1 cm, at the level midway between the lower rib margin and the iliac crest, with the subject breathing out gently. Using the weight and height, the BMI was calculated in kg/m^2 for each subject. Individuals were categorized into different categories of nutritional status according to WHO criteria.[12] Levels of physical activity were graded based on WHO STEPS definitions of sedentary, mildly, moderately, or vigorously physically active.[13] Individuals were labeled as dyslipidemic according to National Cholesterol Education Programme guidelines.[7]

IDRS analysis was done with the help of all four parameters:[2]

Particulars	Score
Age	
<35 years	0
35–49 years	20
≥50 years	30
Family history	
No family history	0
Family history present in either parent	10
Family history present in both parents	20
Physical activity	
Vigorous exercise or strenuous work score	0
Moderate exercise at work/home	10
Mild exercise at work/home	20
No exercise and sedentary work/home	30
Waist circumference	
<80 cm for females and <90 cm for males	0
>80–89 cm for females and >90–99 cm males	10
≥90 cm for females and ≥100 cm for males	20

Ethical consideration

The study was done after taking approval from the Research and Institutional Ethics Committee, Govt. Medical College, Chandigarh. (IEC Regd No. ECR/658/Inst/PB/2014).

Statistical analysis

IDRS was evaluated on the basis of sensitivity, specificity, and predictive values with clinical diagnosis as gold standard. All the cases who opted for investigations were confirmed for diabetes mellitus. IDRS scores in different subgroups formed on the basis of patient's characteristics were compared by using *t*-test and Mann–Whitney test. For more than two categories, ANOVA technique was used. Risk analysis was done for investigating risk factors of high IDRS by using bivariate and multivariate analysis. Chi square test or Fisher's Exact test of association was used for testing significance of association between different characters. Odd's ratio along with their 95% confidence interval was calculated for different risk factors. Logistic regression analysis was used to find risk factors. SPSS version 22 software was used for data analysis.

Results

The major findings of the study are as follows:

- The mean age of study subjects was 43.81 + 11.14 years.

This table [Table 1] depicts the socio-demographic profile of the study participants. Out of 1537 individuals, 785 were males and 752 were females. The majority of the participants, that is, 61%, belonged to the age group of 30–45 years. Most of the study subjects, that is, 80.9%, were Hindus. Almost all, that is, 96.9%, were married. Most of the subjects, that is, 66.6%, were graduate or postgraduate. The majority of the participants, that is, 47.6%, were engaged in skilled work such as shop ownership, business, etc. The majority of the individuals (58.8%) belonged to the upper middle class, according to the modified Kuppuswamy socio-economic scale.

This table [Table 2] depicts that out of the total participants, 28.4% were labeled as having IGT and 3.1% were labeled as having newly detected diabetes (NDD) mellitus, with a higher number of female participants than male participants having IGT and NDD. More than half of the participants, that is, 65.9%, had normal test results. This relationship of IGT and NDD with gender was not found to be statistically significant.

This table [Table 3] depicts that out of total individuals with diabetes mellitus, the majority (81.3%) were in the high-risk group, and this relationship was found to be highly statistically significant ($P < 0.001$). With respect to age, among participants aged ≥60 years, the majority (93.2%) were at high risk, while in the age group 30–45 years, the majority (67.1%) were at moderate risk. The link between risk status and age group was highly significant statistically ($P < 0.001$). Among women, the majority (53.3%) were at high risk, while most of the males (51.8%) had moderate risk. This relationship between gender and IDRS was also statistically significant ($P = 0.002$).

The majority of Sikhs (55.5%) were at high risk, while the majority of Hindus (48.4%) were at moderate risk. This link between religion and risk status was also found to be highly statistically significant ($P < 0.001$). The relationship between marital status and IDRS also came out to be highly statistically significant ($P < 0.001$).

Of the 749 high-risk participants, the largest group, that is 359, were in the upper middle socioeconomic class, followed by 220 and 156 in the lower middle and upper middles, respectively. In addition to this,

80.8% of participants in the upper-lower socioeconomic class were at high risk, and 46.4% of participants in the upper socioeconomic class were at moderate risk. The association between socioeconomic class and risk status was highly significant statistically ($P < 0.001$). Among the individuals with a family history of diabetes present, the majority of the study subjects (60.6%) had a high risk of developing diabetes, while half of the study subjects (50.0%) had no family history of diabetes and had a moderate risk. This relationship between a family history of diabetes and risk status was also found to be highly statistically significant ($P < 0.001$).

Table 1: Distribution of study participants according to various sociodemographic variables (*n*=1537)

Characteristics	Gender	Total
	Male (*n*=785) *n* (%)	Female (*n*=752) *n* (%)
Age (years)		
30-45	509 (64.8)	425 (56.5)
46-65	242 (30.8)	291 (38.7)
66 and above	34 (4.3)	36 (4.8)
Religion		
Hindu	654 (83.3)	589 (78.3)
Sikh	118 (15.0)	138 (18.4)
Others	13 (1.7)	25 (3.3)
Marital status		
Married	752 (95.8)	738 (98.1)
Unmarried	33 (4.2)	14 (1.9)
Education		
Graduate-Postgraduate	572 (72.9)	452 (60.1)
Primary-Intermediate	204 (26.0)	277 (36.8)
Illiterate	9 (1.1)	23 (3.1)
Occupation		
Professional	31 (3.9)	13 (1.7)
Semiprofessional	72 (9.2)	49 (6.5)
Clerk	79 (10.1)	32 (4.3)
Skilled	391 (49.8)	341 (45.3)
Semiskilled	4 (0.5)	2 (0.3)
Unskilled	9 (1.1)	9 (1.2)
Unemployed	199 (25.4)	306 (40.7)
Socioeconomic status		
Upper	12 (1.5)	16 (2.1)
Upper middle	527 (67.1)	376 (50.0)
Lower middle	173 (22.0)	235 (31.2)
Upper lower	71 (9.0)	122 (16.2)
Lower	2 (0.3)	3 (0.4)

Around 62.5% of the study subjects who performed vigorous exercise had a low risk of developing diabetes, while 68.6% of the participants who performed no exercise had a high risk of developing diabetes. This association between physical activity and IDRS came out to be highly statistically significant ($P < 0.001$).

The link between waist circumference and risk status, as well as BMI and IDRS, also came out to be highly statistically significant ($P < 0.001$).

Around 50.5% of study participants had a high risk among those whose calorie intake was greater than or equal to the recommended dietary allowance (RDA). The link between RDA and the risk of developing diabetes came out to be statistically significant ($P = 0.009$). Around 56% and 54.4% of the study subjects having IGT and dyslipidemia had high IDRS. This relationship between IGT, dyslipidemia, and IDRS was found to be highly statistically significant ($P < 0.001$).

This table [Table 4] depicts that IDRS shows significant variability with gender, SES, age, BMI, IGT, and diabetes mellitus.

This table [Table 5] shows that on the basis of logistic regression analysis, risk factors for high IDRS included age 60 years and above, having a positive family history of diabetes, being married, being from higher socio-economic strata, having a sedentary lifestyle, having a high BMI, and being diabetic. These were more likely to develop high IDRS. On the basis of bivariate analysis, lower socio-economic strata, female gender, and Sikh religion were found to be significantly at risk of developing diabetes mellitus, as reflected by high IDRS. Whereas these factors reversed their risk status on the basis of all the factors considered simultaneously in the multivariate logistic regression analysis.

Discussion

The prevalence of NDD mellitus cases in this study is 3.1%, with a higher number of female cases having diabetes. Similar findings with a low prevalence of diabetes mellitus were also seen in other studies conducted by Ravikumar *et al.* in the same area.[14,15]

Table 2: Distribution of study subjects according to their Impaired glucose tolerance (IGT) levels and Diabetic status (*n*=1537)

Characteristic	Gender		Total *n* (%)
	Male *n* (%)	Female *n* (%)	
IGT	215 (27.4)	221 (29.4)	436 (28.4)
NDD	22 (2.8)	26 (3.5)	48 (3.1)
Normal	529 (67.4)	484 (64.4)	1013 (65.9)
Test results inconclusive/not available	19 (2.4)	21 (2.8)	40 (2.6)
Total	785 (100.0)	752 (100.0)	1537 (100.0)

χ^2=1.807 (*P*=0.613)

Table 3: Baseline characteristics of the participants included in the study

Characteristic	Total (*n*=1537)	IDRS			*P*
		High risk (IDRS >60) *n*=749 (48.8%)	Moderate risk (IDRS: 30-50) *n*=734 (47.8%)	Low risk (IDRS <30) *n*=54 (3.5%)	
Newly detected diabetic	48 (3.1)	39 (81.3)	8 (16.7)	1 (2.1)	χ^2=23.740 (*P*<0.001)
Age (years)					χ^2=696.896 (*P*<0.001)
30-45	933 (60.7)	254 (27.2)	626 (67.1)	53 (5.7)	
46-59	440 (28.6)	342 (77.9)	97 (22.0)	1 (0.2)	
60 and above	164 (10.7)	153 (93.2)	11 (6.7)	0 (0.0)	
Gender					χ^2=12.434 (*P*=0.002)
Male	785 (51.1)	348 (44.3)	407 (51.8)	30 (3.8)	
Female	752 (48.9)	401 (53.3)	327 (43.5)	24 (3.2)	
Religion					χ^2=26.468 (*P*<0.001)
Hindu	1243 (80.9)	594 (47.8)	602 (48.4)	47 (3.8)	
Sikh	256 (16.7)	142 (55.5)	111 (43.4)	03 (1.2)	
Others	38 (2.5)	13 (34.2)	21 (55.3)	04 (10.5)	
Marital status					χ^2=64.258 (*P*<0.001)
Married	1490 (96.9)	740 (49.7)	707 (47.4)	43 (2.9)	
Unmarried	47 (3.1)	09 (19.1)	27 (57.4)	11 (23.4)	
Socio-economic status					χ^2=123.639 (*P*<0.001)
Upper	28 (1.8)	11 (39.3)	13 (46.4)	04 (14.3)	
Upper middle	903 (58.8)	359 (39.8)	510 (56.5)	34 (3.8)	
Lower middle	408 (26.6)	220 (53.9)	175 (42.9)	13 (3.2)	
Upper lower	193 (12.6)	156 (80.8)	34 (17.6)	03 (1.6)	
Lower	05 (0.3)	03 (60.0)	02 (40.0)	0 (0.0)	
Family history of diabetes					χ^2=20.500 (*P*<0.001)
Family history present	282 (18.3)	171 (60.6)	106 (37.6)	05 (1.8)	
No family history	1255 (81.7)	578 (46.1)	628 (50.0)	49 (3.9)	
Physical activity					χ^2=263.741 (*P*<0.001)
Vigorous exercise and strenuous work	16 (1.0)	0 (0.0)	06 (37.5)	10 (62.5)	
Moderate exercise work/home	259 (16.9)	75 (29.0)	156 (60.2)	28 (10.8)	
Mild exercise work/home	1227 (79.8)	650 (53.0)	561 (45.7)	16 (1.3)	
No exercise and sedentary work/home	35 (2.3)	24 (68.6)	11 (31.4)	0 (0.0)	
Waist circumference (cm)					χ^2=771.491 (*P*<0.001)
Males <90 and females <80	64 (4.2)	01 (1.6)	33 (51.6)	30 (46.9)	
Males (90-99) and females (80-89)	653 (42.5)	145 (22.2)	484 (74.1)	24 (3.7)	
Males >100 and females >90	820 (53.4)	603 (73.5)	217 (26.5)	0 (0.0)	
BMI					χ^2=123.594 (*P*<0.001)
Underweight	10 (0.7)	03 (30.0)	06 (60.0)	01 (10.0)	
Normal	714 (46.5)	263 (36.8)	406 (56.9)	45 (6.3)	
Pre-obese	688 (44.8)	384 (55.8)	298 (43.3)	06 (0.9)	
Obese	125 (8.1)	99 (79.2)	24 (19.2)	2 (1.6)	
RDA					χ^2=9.455 (*P*=0.009)
Less than RDA	751 (48.9)	352 (46.9)	362 (48.2)	37 (4.9)	
Greater or equal to RDA	786 (51.1)	397 (50.5)	372 (47.3)	17 (2.2)	
IGT	436 (28.4)	244 (56.0)	180 (41.3)	12 (2.8)	χ^2=41.438 (*P*<0.001)
Dyslipidemia	753 (49.0)	410 (54.4)	317 (42.1)	26 (3.5)	χ^2=24.199 (*P*<0.001)

These findings are contradictory with the findings of a study conducted in Lucknow,[16] where the prevalence of diabetes among high IDRS was recorded to be 14.9%. This can be due to better awareness about the prevention of diabetes among the people of Chandigarh.

The maximum number of participants in the present study were from the age group of 30–45 years, with a higher number of males. The majority of the study subjects were Hindus. A similar finding was seen in another study.[6] Almost all of the participants, were married. Around 58.8% subjects belonged to the upper middle class, according to the modified Kuppuswamy socio-economic scale. This study was conducted in a posh area of Chandigarh.

In this study, the sensitivity of IDRS at ≥60 was found to be 81.25%, whereas the specificity was only 52.45%.

Table 4: ANOVA table showing variability of IDRS with different risk factors

Characteristic	Sum of squares	df	Mean square	*F*	Sig.
Gender					
Between groups	4518.523	1	4518.523	17.813	0.000<0.001
Within groups	389375.987	1535	253.665		
Total	393894.510	1536			
Socioeconomic status					
Between groups	28793.216	4	7198.304	30.205	<0.001
Within groups	365101.294	1532	238.317		
Total	393894.510	1536			
Age					
Between groups	231485.326	5	46297.065	436.433	<0.001
Within groups	162409.184	1531	106.080		
Total	393894.510	1536			
BMI					
Between groups	38249.103	5	7649.821	32.910	<0.001
Within groups	355640.811	1531	232.445		
Total	393889.914	1536			
IGT					
Between groups	14441.471	3	4813.824	19.448	<0.001
Within groups	379453.039	1533	247.523		
Total	393894.510	1536			
Diabetes Mellitus					
Between groups	7611.849	2	3805.924	15.114	<0.001
Within groups	386282.661	1534	251.814		
Total	393894.510	1536			

Table 5: Logistic Regression Analysis of Risk Factors of high IDRS

Characteristic	Characteristic	Coefficient (*B*)	Standard Error (SE)	*P*	Odds Ratio (OR) [Exp (*B*)]	95% Confidence Interval (CI) of OR	
						Lower	Upper
History of diabetes mellitus	Present vs absent	0.966	0.169	<0.001	2.627	1.887	3.659
Age (years)	>60 vs below 60	2.463	0.138	<0.001	11.739	8.949	15.399
Gender	Female vs male	0.168	0.128	0.187	1.183	0.921	1.520
Marital status	Married vs unmarried	1.576	0.455	0.001	4.836	1.981	11.805
Socio-economic status	High vs middle vs low	-0.917	0.221	<0.001	0.400	0.259	0.616
Exercise	No exercise vs exercise	1.319	0.442	0.003	3.740	1.572	8.898
BMI	Obese vs non obese	1.537	0.260	<0.001	4.651	2.793	7.743
Religion	Hindu vs others	0.106	0.165	0.519	1.112	0.805	1.535
Diabetes mellitus	Present vs absent	0.683	0.288	0.018	1.981	1.127	3.481
Constant		-2.863	0.582	<0.001	0.057		

It had a low positive predictive value (5.4%) but a high negative predictive value of 98.8%. It is probably because of the profile of the participants who were included in the study. Around 30.6% were <35 years of age, 41.3% between 35 and 49 years, and 28.0% above 50 years. As per MDRF-IDRS, the age group of 35–49 years gives the score of 20 directly, putting the participants score directly into the medium-risk category even if only one other positive parameter is there. As per Mohan *et al*.,[17] all those who had a medium or high risk in the MDRF-IDRS are to be screened for diabetes (FBG and OGTT), putting a maximum number of participants at risk and thereby including many false positives. The overall diagnostic accuracy of IDRS came out to be 53.4%.

This can be compared with the findings of the study conducted by Geetha Mani *et al*.[18] In the present study, an optimal sensitivity of 81.25% at a score ≥60 is similar to that reported by other studies, which makes IDRS an effective screening tool.

As per MDRF-IDRS risk classification, 48.7% of participants were at high risk, followed by moderate risk—47.8% participants and 3.5% participants at low risk. The observations in this study were almost similar to those of other studies.[19-21]

In studies conducted in Chennai by Mohan *et al*. and in Puducherry and Tamil Nadu by Gupta *et al*., 43%, 19%, and 31.2% of subjects, respectively, were found to be in

the high-risk category. This risk difference may be due to variance in ethnicity, eating habits, and lifestyles of the population, as the present study was done in North India, whereas Mohan *et al*.[22] conducted their study in Chennai, and Gupta *et al*.[23,24] conducted their study in rural and urban areas of South India.

The relationship between increasing age of study subjects as a risk factor for high IDRS was found to be statistically significant in this study. It is seen that as age increases, the risk of having diabetes mellitus also increases. It was evident in this study as in the age group of 30–45 years, the majority, that is, 67.1% of the subjects, had moderate risk, while in the age group above 60 years, the majority, that is, 93.2% of the subjects, had a high risk of developing diabetes mellitus. These findings were consistent with those of a study conducted in Karnataka.[5]

In the present study, it was found that females have more predilection of higher risk of diabetes, which came out to be statistically significant on bivariate analysis. It may be due to more tendency of fat accumulation among females. A similar finding was seen in a study by (Namdev *G).* in Bhouri (Bhopal).[6] But on multivariate analysis, its significance was lost. This can be compared with the findings of the study conducted by Acharya *et al.* (2017),[4] where no significant differences were found between gender and IDRS.

There was a significant association found between Sikh religion and a high IDRS score on bivariate analysis. But on multivariate analysis, its significance was lost. All individuals were at equal risk of developing diabetes mellitus, irrespective of their religion.

A statistically significant association was also found between marital status and the IDRS score. Around 49.7% of the individuals married had a high risk of developing diabetes mellitus.

On bivariate analysis, it was seen that as SES decreased, the risk of having diabetes mellitus increased. These findings match the findings of the study conducted by Patil RS, where a significantly higher risk of developing diabetes mellitus was seen in the lower socio-economic class.[25] This can be due to the paradigm shift that we are seeing nowadays, according to which non-communicable diseases are increasing in lower socio-economic strata.

But on multivariate logistic regression analysis, the upper socio-economic class was found to be a statistically significant risk factor for high IDRS. Similar findings were seen in another study conducted by Kinra S *et al*.,[26] where a significantly higher risk of developing diabetes mellitus was seen in the upper socio-economic class. The SES consists of occupation, income, and education. Increased monthly income can give easy access to faulty eating and drinking habits, which can in turn increase the risk of developing the disease.

In the present study, among obese individuals, majority, that is, 79.2% subjects had high risk, while among individuals with normal BMI, majority, that is, 56.9% had moderate risk of developing diabetes mellitus. This relationship was found to be statistically significant. As BMI increases, the risk of developing diabetes mellitus also increases. Similar findings were observed in studies done by Gupta SK *et al*.[23,24]

Positive family history of diabetes is a known risk factor for diabetes mellitus. A study done in Karnataka by Oruganti A showed a significant association of family history and risk of diabetes.[5] Present study findings were consistent with the findings of this study. A high risk of developing diabetes mellitus was seen more in subjects having positive family history of diabetes mellitus.

In this study, it was seen that the risk of developing diabetes mellitus increased as the level of physical activity decreased. Among subjects who performed no exercise, majority, that is, 68.6% of subjects had high risk, while majority, that is, 62.5% of the study subjects among those who performed vigorous exercise, had low risk of developing diabetes mellitus. This relationship was found to be statistically significant.

These findings match with the findings of a study done by Singh MM *et al*.[27] where 91.1% of subjects having low risk performed moderate-to-vigorous activities.

Among individuals who had higher waist circumference (Males ≥100 cm and Females ≥90 cm), a majority, that is, 73.5% had high risk, while among subjects who had lower waist circumference [Males (90–99) and Females (80–89)], a majority, that is, 74.1% had moderate risk of developing diabetes mellitus. This relationship was found to be highly statistically significant. Similar findings were seen in a study done by Shobha *et al*.[28] where the waist circumference and hip circumference was significantly more in the high-risk group when compared to other two groups.

Although the IDRS does not include all the risk factors, it can predict dyslipidemia also. A study by V. Mohan *et al*.[29] showed that the mean IDRS increase was associated with hypertriglyceridemia and hypercholesterolemia. In the present study, among the subjects having dyslipidemia, 3.5%, 42.1%, and 54.4% of subjects had low, moderate, and high risk of developing diabetes mellitus, respectively. This relationship of dyslipidemia with high IDRS was found to be statistically significant.

In the present study, among individuals having IGT, 56.0% had high risk, 41.3% had moderate risk, while only 2.8% subjects had low risk of developing diabetes mellitus. This relationship between IGT and high IDRS was found to be statistically significant.

These findings are similar with findings of the study done by Mani G *et al*.,[18] where out of 19 subjects having IGT, 18 subjects were in high risk group. It also matches with the findings of the study done by V. Mohan *et al*.[29] By these findings, we can predict that as the blood glucose levels increases, the risk of developing diabetes mellitus also increases.

A statistically significant association was seen between RDA and IDRS in the present study. It was observed that among individuals having calories intake greater than the RDA, a majority, that is, 50.5%, had high risk of developing diabetes mellitus.

Among individuals who were labeled as NDD mellitus, a majority, that is, 81.3%, subjects falls into high-risk group, while among subjects who had diabetes mellitus absent, a majority, that is, 49.0%, subjects falls into moderate-risk group. This relationship between the presence of diabetes mellitus and high IDRS was found to be statistically significant. This finding supports the validity of IDRS as a screening tool for diabetes mellitus.

The present study conducted had a large sample size of 1537, which resulted in a better population-based prevalence rate of risk factors for diabetes among individuals. The standard laboratory-based methods for DM diagnosis were conducted on almost all individuals, which increases the validity of the results obtained.

As the present study was conducted in only the urban field practice area of the Department of Community Medicine, GMCH, due to constraints of time and resources, results cannot be generalized.

One of the limitations of the MDRF-IDRS is that, as it was derived from an Asian Indian population, its use is probably restricted to South Asians, and for other ethnic populations, different IDRS scores may be required.

Recommendations

It seems diabetic patients with low SES face more challenges in their social environment together with less psychological support.[30] Screening and early diagnosis of diabetes, followed by early interventions, would aid in the effective management of diabetes and the prevention of its associated complications. The Development of suitable primary and secondary preventive strategies, including lifestyle and dietary modifications, is recommended for these high-risk participants. Implementation of an exercise regimen to reduce BMI can delay progression to disease onset. More focus should be placed on the elderly population from higher socio-economic classes with a positive family history of diabetes, as they are at higher risk of developing diabetes in the near future.

It is also recommended that subjects having IGT and dyslipidemia undergo regular testing for DM for timely diagnosis and management. This will prevent further complications from occurring due to diabetes.

Conclusion

To prevent the morbidity and mortality associated with diabetes, there is a need for some simple diagnostic tools that can identify people at risk at the first contact with the health systems. This study has proven the usefulness of IDRS for screening high-risk diabetic subjects in the community. The risk categories can be used to diagnose cases of DM and to generate very valuable awareness about the control of modifiable risk factors for DM like physical activity and BMI. IDRS can be used effectively in a high-risk population as a strategy for screening for diabetes in India in the most cost effective manner.

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Conflicts of interest

There are no conflicts of interest.

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