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# To Assess the Validity of the Indian Diabetic Risk Score and Its Association with Body Mass Index and Glycosylated Hemoglobin Levels

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**Abstract**

**Background:** India is considered the "diabetic capital" of the world with many cases remaining undiagnosed. Indian Diabetic risk score is a simple and cost-effective screening tool that can be used to identify undetected and high-risk individuals for developing diabetes. Study aims to assess the validity of the Indian Diabetic Risk Score for detecting the risk of type 2 diabetes mellitus and to evaluate the association of Indian Diabetic Risk Score with Body Mass Index and Glycosylated hemoglobin levels. **Material and Methods:** In this cross-sectional observational study, 180 patients with no previous diagnosis of type 2 diabetes were included. Detailed history and physical examination were noted. The risk factor profile was found using the Indian Diabetic Risk Score. **Results:** The mean age of the study population was 42.67±8.82 years. Out of 180 patients included in the study, 51 patients (28.33%) had low risk, 79 (43.88%) had moderate risk and 50 patients (27.79%) had high risk of developing diabetes. When HbA1c level was analyzed, 36 patients (20%) were in the prediabetic and 87 patients (48.34%) were in the diabetic range. Of the 87 diabetic subjects, 96.56% were at moderate to high risk of developing diabetes. High risk of developing diabetes was found to be associated with increasing age, history of alcohol consumption, waist circumference, sedentary lifestyle, and family history of diabetes, higher BMI and HbA1c levels. **Conclusion:** The results of the present study found a significant association between Indian diabetic risk score, HbA1c levels, and Body mass Index. Therefore, our study supports the validity of the Indian Diabetic Risk Score as a useful screening tool for detection of prediabetes, diabetes and initiation of appropriate intervention to delay disease progression.

**Keywords:** BMI, HbA1c, IDRS, Diabetes.

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## Introduction

Diabetes mellitus is a common metabolic disorder that restricts the quality of life of involved patients worldwide. As per National Non-Communicable Disease (NCD) Monitoring Survey in March 2022, in India, the prevalence of diabetes in adults has increased up to 9.3% with only 45.8% of the population aware of their diabetic status.[1] Now a days, non-invasive risk scores are more widely accepted by the public compared to invasive procedures for screening purposes as they are more cost-effective and feasible for widespread usage.[2] Indian Diabetic Risk Score (IDRS) is one such risk score developed by Dr. Mohan V and his colleagues at Madras Diabetes Research Foundation (MDRF), Chennai in the year 2005 from their ongoing cohort CURES (Chennai Urban Rural Epidemiology Study).[3]

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 02, 2024

IDRS uses 2 modifiable (waist circumference and physical activity) and 2 non- modifiable (age and family history) parameters to identify the undetected and high-risk individuals. The score ranges from a minimum score of 0 to a maximum score of 100. Study patients with a score of 60 or above are at high risk of developing diabetes.[4] The Indian Council of Medical Research (ICMR) reported that there is an inter-state variation in the prevalence of diabetes across India ranging from 4.3% in Bihar to 9.4% in Tripura and 10% in Punjab.[5] However, due to the heterogeneous composition of the Indian population, this risk score should be further validated in various regions of the nation. In a metropolitan city like Bangalore, there is no recent study related to this tool, which when adopted can pave way for early detection and treatment of diabetes and hence help in delaying the complications related to diabetes. The aims and objectives of this study are twofold: first, to evaluate the validity of the Indian Diabetic Risk Score in detecting the risk of type 2 diabetes mellitus; and second, to assess the association between the Indian Diabetic Risk Score and levels of Body Mass Index and Glycosylated haemoglobin.

**Material and Methods**

In this cross-sectional observational study, patients who came to the outpatient or inpatient department of tertiary care hospital with no previous diagnosis of type 2 diabetes and fulfilled the inclusion criteria were enrolled in the study during the period of one and half years from August 2022 to September 2023. Detailed history and thorough general examination including anthropometric measurements and systemic examination of the individual was done. Risk factor profile was found using the Indian Diabetic Risk Score. Individuals aged 25 years or above and those who have given consent for the study were included.

Previously known cases of diabetes, individuals on long-term Steroids, known cases of hypothyroidism (both clinical and subclinical), women with a history of gestational Diabetes, individuals with Type 1 Diabetics, pregnant females and individuals who denied giving consent were excluded. Waist circumference was measured in the standing position by placing a plastic tape horizontally midway between the 12th rib and iliac crest on the mid-axillary line. The measurements were repeated twice by using the same device and the mean value was recorded. Weight was recorded in kilogram (kg) with the subject standing on the weighing machine without shoes. The same weighing machine was used for all the study patients. Height was recorded in centimetres with the subject standing erect, barefooted with both feet together and looking straight ahead. BMI was calculated from the formula: BMI = weight in kilogram/square of height in meters.

Patients were categorized based on the Indian Diabetic Risk score as follows: high-risk individuals had an IDRS Score >60, moderate-risk individuals had an IDRS Score between 30 and 50, and low-risk individuals had an IDRS Score ranging from 0 to 20. Five-milliliter venous blood sample was withdrawn under aseptic conditions for Fasting Blood Sugar, Post Prandial Blood Sugar ,HbA1c, Thyroid profile (T3, T4, TSH), Renal function test and lipid profile estimation. HbA1c was measured by high-performance liquid chromatography-based method using ERBA H360 HbA1c auto analyser. Fasting and Post Prandial blood sugars were analysed using ERBA EM-360 automated chemistry by GOD-POD method. For lipid profile, 12 hour fasting blood sample was taken and using cholesterol esters and cholesterol oxidase containing reagent, trinder end point method, modified PVS/PEGME coupled classic precipitation method total cholesterol, triglycerides, HDL was estimated respectively. The lipid profile is interpreted based on The National cholesterol education program (NCEP) guidelines. The thyroid hormones T3, T4 and TSH were measured by chemiluminescence assay using MAGLUMI 800.

The sample size calculation utilized the formula $n = z^2pq/d^2$, where z represents the critical value and a standard value for the corresponding level of confidence (95% CI or 5% level of

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 02, 2024

significance), p denotes the expected prevalence based on previous research, q is calculated as 1 - p, and d represents the margin of error or precision. With a prevalence of 50.4%, a precision of 15% of p, and a critical value of 1.96, the calculated minimum sample size required was approximately 180 individuals.

All the data collected is entered in Microsoft Excel sheet. Analysis of data is done using Statistical package for social science 22.00 (SPSS 22.00 for windows; SPSS inc, Chicago, USA). For each assessment point, data were statistically analyzed using factorial ANOVA. Difference between two groups was determined using chi square test and the level of significance was set at $p < 0.05$.

## Results

**Table 1: Distribution of study variables among the study participants (N=180)**

| S. No | Variable | Frequency | Percentage |
|---|---|---|---|
| 1. | **Age** | | |
| | 25-35 years | 50 | 27.78% |
| | 36-49 years | 51 | 28.33% |
| | ≥50 years | 79 | 43.89% |
| 2 | **Gender** | | |
| | Male | 91 | 50.56% |
| | Female | 89 | 49.44% |
| 3 | **Habits** | | |
| | Smoking | 57 | 31.66% |
| | Alcohol | 46 | 25.26% |
| 4 | **Family history of diabetes** | | |
| | None of the Parent | 104 | 57.77% |
| | Either Parents | 61 | 33.88% |
| | Both Parents | 15 | 8.35% |
| 5 | **Hypertension** | | |
| | Yes | 30 | 16.67% |
| | No | 150 | 83.33% |
| 6 | **BMI** | | |
| | Underweight (<18.5) | 0 | 0 |
| | Normal (18.5-24.9) | 163 | 90.56% |
| | Overweight (25-29.9) | 10 | 5.56% |
| | Obese (>30) | 7 | 3.89% |
| 7 | **Waist circumference (in males)** | | |
| | <90 cm | 59 | 64.83% |
| | 90-99 cm | 19 | 20.87% |
| | 100 cm or more | 13 | 14.3% |
| 8 | **Waist circumference (in females)** | | |
| | <80 cm | | |
| | 80-89 cm | 59 | 66.29% |
| | 90 cm or more | 17 | 19.1% |
| | | 13 | 14.61% |
| 9 | **Physical activity** | | |
| | Regular exercise+ Strenuous work | 88 | 48.88% |
| | Regular exercise OR Strenuous work | 49 | 27.22% |
| 10 | **IDRS** | | |
| | Low risk (0-20) | 51 | 28.33% |
| | Moderate risk (30-50) | 79 | 43.88% |
| | High risk (>60) | 50 | 27.29% |

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 02, 2024

| | | | |
|---|---|---|---|
| 11 | **HBA1C** | | |
| | Normal (<5.7%) | 57 | 31.66% |
| | Pre diabetic (5.7-6.4%) | 36 | 20% |
| | Diabetes (>6.5%) | 87 | 48.34% |

In our study of 180 patients, the age distribution was as follows: 50 (27.78%) aged 25-35 years, 51 (28.33%) aged between 36-49 years, and 79 (43.89%) were ≥50 years old, with a mean age of 42.67±8.82. Gender distribution showed 91 (50.56%) males and 89 (49.44%) females. Regarding lifestyle factors, 57 (31.66%) were smokers, 123 (68.34%) were non-smokers, 46 (25.56%) reported alcohol consumption, and 134 (74.44%) never consumed alcohol. Family history of diabetes was noted in 15 patients (8.35%) for both parents, 61 (33.88%) for either parent, or 104 (57.77%) had no parental history. Hypertension was present in 30 patients (16.67%), while 163 (90.56%) had normal BMI, with 10 (5.56%) classified as overweight and 7 (3.89%) as obese. Regarding waist circumference, 59 males (64.83%) had <90 cm, while 59 females (66.29%) had <80 cm. Lifestyle-wise, 88 patients (48.88%) engaged in regular exercise and strenuous work, 49 (27.22%) did either, and 43 (23.9%) had a sedentary lifestyle. Indian Diabetic Risk Score categorized 51 patients (28.33%) as low risk, 79 (43.88%) as moderate risk and 50 (27.79%) as high risk. Lastly, HbA1c levels were normal in 57 patients (31.66%), 36 (20%) were prediabetic, and 87 (48.34%) had diabetes. [Table 1]

**Table 2: Association of IDRS with study variables among the study participants (N=180)**

| Variable | IDRS | | | Total | P value |
|---|---|---|---|---|---|
| | Low risk | Moderate risk | High risk | | |
| **Age** | | | | | <0.001 |
| 25-35 years | 28(56%) | 15(30%) | 7(14%) | 50(100%) | |
| 36-49 years | 23(46%) | 15(29.41%) | 13(25.49%) | 51(100%) | |
| ≥50 years | 2(4%) | 48(60.76%) | 29(36.71%) | 79(100%) | |
| **Gender** | | | | | 0.3<br>0.34 |
| Male | 24(48%) | 38(41.76%) | 29(31.87%) | 91(100%) | |
| Female | 29(58%) | 40(44.94%) | 20(22.47%) | 89(100%) | |
| **Smoking** | | | | | 0.48 |
| Yes | 18(31.57%) | 26(45.61%) | 13(22.82%) | 57(100%) | |
| No | 34(27.64%) | 53(43.08%) | 36(29.28%) | 123(100%) | |
| **Alcohol** | | | | | 0.022 |
| Yes | 8(17.39%) | 19(41.3%) | 19(41.3%) | 46(100%) | |
| No | 45(33.58%) | 59(44.03%) | 30(22.39%) | 134(100%) | |
| **Waist Circumference (in cm) (Males)** | | | | | <0.0001 |
| <90 cm | 23 (38.98%) | 30(50.84%) | 6(10.18%) | 59(100%) | |
| 90-99 cm | 1 (5.26%) | 8(42.11%) | 10(52.63%) | 19(100%) | |
| 100 cm or more | 0(0%) | 0(0%) | 13(100%) | 13(100%) | |
| **Waist circumference in cm (Females)** | | | | | <0.0001 |
| <80 cm | 27 (45.76%) | 30(50.84%) | 2(3.4%) | 59(100%) | |
| 80-89 cm | 2 (11.76%) | 6(35.29%) | 9(52.95%) | 17(100%) | |
| 90 cm or more | 0(0%) | 4(30.76%) | 9(69.24%) | 13(100%) | |
| **BMI** | | | | | 0.036 |

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 02, 2024

| | | | | | |
|---|---|---|---|---|---|
| Underweight | 0% | 0% | 0% | 0(100%) | |
| Normal | 53(32.53%) | 70(42.94%) | 40(24.53%) | 163(100%) | |
| Overweight | 0(0%) | 5(50%) | 5(50%) | 10(100%) | |
| Obese | 0(0%) | 3(42.86%) | 4(57.14%) | 7(100%) | |
| **Family History of diabetes** | | | | | |
| None of the parent | 8(7.7%) | 43(41.34%) | 53(50.96%) | 104(100%) | <0.001 |
| Either Parent | 6(9.84%) | 26(42.62%) | 29(47.54%) | 61(100%) | |
| Both Parents | **1 (6.67%)** | **5 (33.3%)** | 9 (60%) | 15 (100%) | |
| **Physical activity** | | | | | |
| Regular exercise + Strenuous Exercise | 48(54.54%) | 39(44.31%) | 1(1.15%) | 88(100%) | |
| Regular exercise OR Strenuous Exercise | 5(10.20%) | 30(61.22%) | 14(28.57%) | 49(100%) | <0.0001 |
| None | 0(0%) | 9(20.93%) | 34(79.07) | 43(100%) | |
| **HBA1C** | | | | | |
| Normal (≤5.6%) | 30(52.63%) | 22(38.6%) | 5(8.77%) | 57(100%) | <0.0001 |
| Pre-diabetic (5.7-6.4 %) | 20(55.56%) | 14(38.89%) | 2(5.56%) | 36(100%) | |
| Diabetic (>6.4%) | 3(3.54%) | 42(48.28%) | 42(48.28%) | 87(100%) | |

High diabetes risk was observed in 14% of patients aged 25-35 years, 25.49% aged 36-49 years, and 36.71% aged over 50 years. A statistically significant difference in diabetes risk was noted between younger and older patients ($p < 0.001$). There was no significant difference in diabetes risk between males (49.44%) and females (50.56%). Among smokers, 22.82% had high diabetes risk, while 29.28% of non-smokers were at high risk, with no significant difference between the two groups. Patients with a history of alcohol consumption had a higher risk (41.3%) compared to non-alcoholics (22.39%) ($p = 0.022$). Waist circumference correlated significantly with diabetes risk in both males ($p < 0.0001$) and females ($p < 0.0001$). Obesity and overweight were associated with moderate to high diabetes risk, with a significant correlation between BMI and diabetes risk ($p = 0.036$). Family history of diabetes significantly influenced diabetes risk ($p < 0.001$). Sedentary lifestyle correlated with a higher risk of diabetes ($p < 0.0001$), while regular exercise was associated with a lower risk. HbA1c levels showed a significant association with diabetes risk ($p < 0.0001$), with moderate to high IDRS present in a significant proportion of diabetic and prediabetic patients. [Table 2]

## Discussion

In a developing country like India, where there are a large number of diabetics and many of the cases remaining undiagnosed, risk scores would render great help in the early detection and management of prediabetes and diabetes.[6] Worldwide many risk assessment scores are in use and one such score is the Indian Diabetic Risk Score. The present study is conducted to assess the validity of the Indian Diabetic Risk Score and its correlation with BMI and HbA1c levels. In our study, the mean age of 180 study population is found to be 42.67±8.82 years. The demographic profile of the study population like age and sex are comparable with other studies. In our study, high diabetes risk is found among 14% of patients aged 25-35 years, 25.49% of patients aged between 36-49 years and 36.71% of the patients aged more than 50 years respectively, indicating that with increasing age, there is an increase in the risk of developing diabetes with statistically significant p value <0.001. Similar results are obtained

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 02, 2024

in the study conducted by Nittoori Sreeja et al,[7] (2019) in an urban slum area to assess the risk of development of diabetes using IDRS among 216 participants with a mean age of 51.20±15.11 years. In their study, they found high diabetes risk among 5 patients (33%) aged 25-35 years, 34 patients (63%) of patients aged between 36-49 years and 62 patients (92.5%) of the patients aged more than 50 years respectively. (p value <0.001) Also, Garima Namdev et al,[8] (2018) in their study to validate the use of IDRS as a screening tool for diabetes in a Rural Health Training centre among 270 study population with a mean age of 35±15.6 years, found a strong correlation between increasing age and IDRS with p value 0.0003. The results of both these studies indicate that the chance of developing T2DM rises with age in all risk score categories using IDRS with a statistically significant p value. In our study, there is no statistically significant difference between males and females in relation to the diabetes risk score. Similar results are obtained in the study conducted by Acharya et al,[9] (2017) to assess diabetes in an urban resettlement colony using IDRS among 580 study participants with 213(53.96%) females and 267 (46.03%) males. In their study, they found that both males and females have a similar risk of developing diabetes and statistically there is not much difference between diabetes risk related to gender (p value >2). In our study, high diabetes risk is found in 22.82% of smokers. When the smoking status is compared to diabetes risk, it is found to be statistically insignificant in our study. Similar results are obtained in the study conducted by Bharathi et al,[10] (2011) to assess the prevalence and determinants of diabetes in Puducherry among 1370 study participants with 58(4.2%) smokers and 1312 (95.8%) non-smokers. In their study, they found diabetes in 108 (8.2%) and 6 (10.3%) non-smokers and smokers respectively which is statistically insignificant. (OR 1.2 at 95% confidence interval). In our study, moderate to high risk of diabetes is reported in 38 (82.6%) of the patients who consume alcohol. When alcohol use is compared statistically to diabetes risk, it is found to be statistically significant in our study with p value <0.0001.

Similar results are obtained in the study conducted by Shrivastava SR et al,[11] to assess the prevalence and risk factors of diabetes among 1170 study participants of which 298 (25.48%) have a history of alcohol use and 872 (74.52%) are non-alcoholic. Among these, diabetes is found in 42 (14.53%) patients with alcohol use and 85 (9.74%) of non-alcoholics which is statistically significant. (OR 1.62 at 95% confidence interval). In our study, among the 180 patients, 91 patients (50.56%) are males. Among them, 59 patients (64.83%) have a waist circumference of <90 cm, 19 patients (20.87%) have a waist circumference of 90-100 cm and 13 patients (14.3%) have a waist circumference of 100 cm or more respectively. Similar results are obtained in the study conducted by Khan MM et al,[12] on the validity of Indian Diabetic risk score among 405 study participants in which it is found that the maximum number i.e. 194 (47.9%) of the patients are having waist circumference 80- 89 cm in females and 90-99 cm in males, followed by 162 patients (40%) with waist circumference ≥90 cm in females and ≥100 cm in males. Only 49 (12.1%) individuals are normal. Out of 198 (48.88%) patients who are obese, 79.3% are found at high risk for diabetes. The results of their study showed a statistically significant association between higher BMI and diabetes risk. In our study, a total of 15 patients (8.35%) are found to have a family history of diabetes in both parents, among these 9 patients (60%) have a high risk of diabetes as per IDRS. Out of 61 patients (33.88%) with a history of diabetes in either parent, 29 patients (47.54%) have high risk. Rest 104 patients (57.77%) have no history of diabetes in their parents. Among these patients with no family history of diabetes, 53 (50.96%) patients have a high risk of diabetes as per IDRS. The findings of our study suggest that patients with a history of diabetes in both parents are at higher diabetes risk compared to others with a significant p value <0.001. Similar results are obtained in a study done by Puja Dudeja et al,[3] (2017) to study the performance of IDRS as a screening tool for undiagnosed Type 2 diabetes cases. In their study, 155 patients are included among whom, 41 patients are found to have diabetes. Out of

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 02, 2024

these 41 newly diagnosed diabetics, 21 patients (51.21%) have a family history of diabetes in both parents. The findings of their study are significant statistically with p value of 0.007. A sedentary lifestyle increases the risk of developing diabetes. Being physically active has various advantageous effects as it helps in reducing body fat, increases body muscle mass, relieves stress and promotes overall well-being. It also helps in the preventionof diabetes and delaying complications.[13]

In the present study, out of 180 patients, 88 patients (48.88%) did regular exercise and strenuous work, 49 patients (27.22%) did either regular exercise or strenuous work and 43 patients (23.9%) had a sedentary lifestyle. Similar results are obtained in a study done by Patil et al,[14] in the slums of Maharashtra among 425 patients, in which 255 (66.6%) have a sedentary lifestyle and 128 patients (33.4%) are physically active. Among the patients with a sedentary lifestyle, 236 patients (92.6%) have a moderate to high risk of developing diabetes, compared to people who are physically active in which only 15 patients (14.8%) are found to have a high risk of developing diabetes. In their study, a significant association is found between patients with a higher risk score and physical activity as p value <0.0001.

In the present study, 51 patients (28.33%) have low risk, 79 patients (43.88%) have moderate risk and 50 (27.79%) have a high risk of developing diabetes according to the Indian Diabetic Risk Score. Similar results are obtained in a study done by Patil et al,[14] which showed a high risk of diabetes in 37% of patients and a moderate risk of diabetes in 54% of patients. The results of their study indicate the importance of diabetes screening and early initiation of intervention strategies. Assessment of HbA1c with diabetes risk is an essential tool to identify diabetes patients because HbA1c reduction in type 2 diabetes is associated with increased insulin sensitivity.[15]

In our study, around 36 (20%) are pre-diabetic and 87 patients (48.34%) are in the diabetic range. The remaining 57 patients (31.66%) have normal HbA1c levels. Of the 87 diabetic patients, 96.56% are having moderate to high risk of developing diabetes. Among the 103 pre-diabetic patients, 76.69% have a higher risk of developing diabetes as per IDRS criteria.

## Conclusion

The results of the present study found a significant association between Indian diabetic risk score, HbA1c levels and Body mass Index. Therefore, from our study, we conclude that the Indian Diabetic Risk Score is a useful screening tool that is non-invasive and feasible. It can help in the early detection of prediabetes, diabetes and initiation of appropriate intervention to delay disease progression. Our study supports the validity of the Indian Diabetic Risk Score as a simple and cost- effective screening tool.

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