Evaluation of risk for type 2 diabetes mellitus in rural population and its comparison with obesity indicators

Thamarai Rajappa[1], Sivakumar Karunanandham[2]

[1]Department of Biochemistry, Chennai Medical College Hospital and Research Center, Irungalur, Trichy, Tamil Nadu, India.
[2]Department of Medicine, Chennai Medical College Hospital and Research Center, Irungalur, Trichy, Tamil Nadu, India.
Correspondence to: Sivakumar Karunanandham, E-mail: siva200976@yahoo.com

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Abstract

Background: Owing to the increasing prevalence and the fact that diabetes mellitus has a long and well-defined preclinical phase, it is felt essential to employ screening methods at the earliest to identify the person at the risk of diabetes in developing countries. It is also mandatory to pinpoint the individuals in the prediabetic phase, because simple intervention and change of lifestyle can prevent the progression to diabetes.

Objective: To screen and identify the risk of developing type 2 diabetes mellitus in rural population using Indian Diabetes Risk Score and to compare the associations of diabetes and prediabetes with general and central obesity indicators.

Materials and Methods: This community-based, cross-sectional study was conducted in rural areas. Eight hundred individuals older than 20 years of age were randomly selected and assessed. Age, waist circumference, grade of physical activity, and family history of diabetes mellitus were assessed.

Result: On computing the Indian Diabetes Risk Score, 29% of the 800 persons studied showed low-risk score, 52% moderate-risk sore, and 19% high-risk score for diabetes.

Conclusion: Prevalence of diabetes and prediabetes in studied population was 13.62% and 16.5%, respectively. Waist circumference was positively correlated with diabetes ("*r*" value: 0.81). This screening method is simple and useful in detecting undiagnosed diabetes and prediabetes.

KEY WORDS: Cross-sectional, Indian Diabetes Risk score, rural population, screening, waist circumference

Introduction

In Asia, over 110 million people are estimated to be living with diabetes;[1] with the majority of the people with diabetes in the age range of 45–64 years in developing countries. It is projected that the worldwide prevalence would increase to 439 million by 2030.[2] India leads the world with the largest number of diabetic individuals earning the debatable perception of being termed the "diabetes capital of the world."[3] According to the International Diabetes Federation, diabetes in India is expected to rise to 69.9 million by 2025 unless imperative preventive measures are taken.[3] It has been established that 66% of the Indian diabetes cases are not diagnosed, when compared with 50% in Europe and 33% in the United States of America.[4] In rural areas, prevalence rates of diabetes have risen from 1% to 4%–10%, and, in another study, it is reported to be 13.2%.[5] Owing to the increasing prevalence, and the fact that diabetes mellitus (DM) has a long and well-defined preclinical phase, it is felt essential to employ screening methods at the earliest to identify people at the risk of diabetes in developing countries and to identify individuals in the prediabetic phase; at this stage, simple intervention and change of lifestyle can prevent progression to diabetes. A simple diabetic risk score has been

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found as a screening test to identify the likelihood of diabetes. This study was focused to assess the risk of DM in adults older than 20 years living in rural areas using the Indian Diabetes Risk Score (IDRS) accomplished by Mohan et al.[6] Subsequently, quite a few studies using IDRS to screen for diabetes have been undertaken in urban areas. Hence, this study was planned to conduct among the rural population to calculate the risk score using the IDRS and by correlating it with the blood glucose level, waist Circumference (WC), waist–hip ratio, and body mass index (BMI) to identify any significance of association of these indicators with risk for diabetes.

The objectives of this study were thus to screen the risk of developing type 2 DM using IDRS and to detect the individuals of diabetes and prediabetes in rural population. This study also aimed to compare the associations of diabetes and prediabetes with general and central obesity indicators.

Materials and Methods

Study Design

This community-based, cross-sectional study was carried out among the rural population of Trichy, Tamil Nadu. We enrolled 874 individuals from the rural population. Among 874 individuals, 23 did not respond and 14 did not want to participate. We excluded 37 people owing to comorbid illness. Thus, 375 men and 425 women were eligible for this study. Thus, 800 individuals older than 20 years were selected and assessed. Known diabetic patients, those with any chronic illness whether on medication or not, and pregnant women were excluded from the study. The period of the study was 6 months. In all the individuals, details on age, family history of diabetes, and physical activity were collected using a questionnaire. WC was measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, using a stretch-resistant tape that provides a constant 100 g tension.[7] Hip circumference was measured around the widest portion of the buttocks, with the tape parallel to the floor. Waist–hip ratio is the ratio of the circumference of the waist to that of the hips. This has been calculated as waist measurement divided by hip measurement.[7] The measurements were taken with the individuals in light clothes and when they were breathing quietly at the end of their expirations. The BMI is a value derived from the weight and height of an individual. The BMI is defined as the body mass divided by the square of the body height and is universally expressed in units of kg/m^2 resulting from weight in kilograms and height in metres.[7] Weight was measured with participants wearing light clothes and no shoes using SECA Integra 815 portable scales with an accuracy of 0.01 kg. Height was measured by using portable stadiometer with an accuracy of 0.1 cm.

Grade of physical activity was assessed by asking the following questions: A. How physical demanding is your work? B. Do you exercise regularly in your leisure time? and C. How would you grade your physical activity at home? Then the combined score of A + B + C was calculated: >3, vigorous/strenuous; 2, moderate; 1, mild; 0, sedentary. Analysis was done as per IDRS developed by Mohan et al.[6] and parameters comprising two modifiable (WC and physical activity) and two nonmodifiable risk factors (age and family history) for diabetes.[6] The data were computed as mentioned as per the reference.[6]

Blood samples were taken from the antecubital vein and collected in anticoagulant coated tubes

All the individuals were subjected to random blood glucose testing, and those with random blood sugar (RBS) > 110 mg/dL were advised to undergo oral glucose tolerance test to find out their blood glucose status. Fasting and 2-h postload (PL) glucose values were estimated. After 8–12 h of fasting, patient was allowed to drink 75 gm of anhydrous glucose dissolved in 250–300 mL of distilled water. Blood samples were taken from the antecubital vein and collected into tubes. Calibration of instruments and reagents was done before entering the study. Laboratory assistants were blinded to sample sources and clinical information until the end of the study. Blood glucose was estimated by glucose oxidase-peroxidase method (DiaSys Diagnostics, GmbH, Germany) in fully automated analyzer Mindray BS-380. This study was approved by institutional ethical committee. Informed written consent was obtained from the study population.

Statistical Analysis

Data were entered into the Excel sheet and analyzed statistically using SPSS software, version 17. Continuous variables were expressed as mean ± standard deviation, and comparison between the three groups was uttered using analysis of variance, wherever appropriate. For all analyses, "*p*" values <0.05 were considered as significant. Diabetes and prediabetes was correlated with obesity indicators using Pearson's correlation.

Result

A total of 800 patients who were older than 20 years and not known diabetic patients were taken for this study. Table 1 shows the demographic profile of the study participants. When the score for their age was assigned according to IDRS,[6] of the 800 individuals, 22.5% showed a score of 0 with age younger than 35 years, 47.5% showed a score of 20 with age of 35–49 years, and 30% showed a score of 30 with age 50 years and older. The WC was measured for the 800 individuals, and it was found that 52% presented a score of 0, 21.8% a score of 10, and 26.2% a score of 20, the score assigned for the different WC measurements differing for male and female subjects. Among the male subjects, 69.3% showed a score of 0, with WC less than 90 cm, 16% a score of 10, with waist 90–99 cm, 14.7% a score of 20, with waist 100 cm or more. Among the female subjects, 41.6% showed a score of 0, with WC less than 80 cm, 24.8% a score of 10, with WC 80–89 cm,

Table 1: Demographics of participants in rural area

Category	No.	%
Age (years)		
20–35	180	22.5
36–49	376	47
>50	244	30.5
Sex		
Male	375	46.87
Female	425	53.13

Table 2: Details of risk score component in rural population

Category	Risk score	*N* (%)
Age in years		
<35	0	180 (22.5)
35–49	20	376 (47)
>50	30	244 (30.5)
Waist circumference (cm) (males)		
<90	0	416 (52)
>90–99	10	172 (21.5)
>100	20	212 (26.5)
Waist circumference (cm) (females)		
<80	0	333 (41.6)
>80–89	10	198 (24.8)
>90	20	269 (33.6)
Physical activity		
Strenuous	0	416 (52)
Moderate	10	256 (32)
Minimal	20	116 (14.5)
Sedentary	30	12 (1.5)
Family history of DM		
No	0	600 (75)
Either parent	10	172 (21.5)
Both parents	20	28 (3.5)

Table 3: Number of individuals in each risk group based on IDRS

Group (risk score)	Mean risk score	No. of individuals (%)
Group I (<30)	21.8	232 (29)
Group II (30–50)	43.5	416 (52)
Group III (>60)	69.7	152 (19)

and as much as 33.6% a score of 20, with WC 90 cm or more. When the score for physical activity was analyzed, 52% showed the score of 0 implying low risk for type 2 diabetes according to IDRS, 32% a score of 10, 14.5% a score of 20, and 1.5% a score of 30, which corresponds to higher risk for diabetes according to physical activity. Among the 800 individuals studied, 75% showed a score of 0 for family history, 21.5% a score of 10, and 3.5% a score of 20 [Table 2]. On computing the IDRS, 29% of the 800 persons showed low risk score, 52% moderate risk score, and 19% high risk score for diabetes [Table 3]. All the individuals were tested for RBS. Ninety-eight (64.69%) of the high-risk group, 162 (39.04%) of medium-risk group, and 37 (15.8%) of low-risk group showed RBS more than 110 mg/dL. Those with RBS more than 110 mg/dL, totally 297 (37.12%) individuals, underwent glucose tolerance test. Fifty-seven, 41, and 11 individuals showed diabetes and 20, 95, and 17 individuals showed prediabetes in the high-risk, medium-risk, and low-risk groups, respectively [Table 4]. According to guidelines of American Diabetes Association, fasting blood glucose <100 mg/dL: no diabetes; 100–125 mg/dL: prediabetes; ≥126 mg/dL: diabetes; 2-h PL glucose value < 140 mg/dL as no diabetes; 140–199 mg/dL as prediabetes; ≥200 mg/dL: diabetes.[8] A total of 109 individuals (44 male and 65 female subjects) and 132 individuals (58 male and 74 female subjects) were found to show diabetes and prediabetes, respectively. A total of 143 (33.6%) female subjects in high-risk score showed WC of >90 cm, which is significantly higher than male subjects. Fifty-five (14.7%) male subjects showed WC of >100 cm. In total, 363/800 (45.37%) individuals showed increased WC than the normal reference range. As per the WHO, the International Obesity Task Force (IOTF) and the International Association for the Study of Obesity (IASO) (2000),[7] the following cutoff values of the WC were used to assess the abdominal obesity for women and men, respectively: WC < 80 cm: normal and WC ≥ 80 cm: abdominal obesity; < 90 cm: normal and WC ≥ 90 cm: abdominal obesity. We used the definitive guidelines by the Indian Consensus Group (for Asian Indians) to classify BMI of 18.5–22.9 kg/m^2, ≥23 kg/m^2, and ≥25 kg/m^2 as normal, overweight, and obese, respectively.[9] On the basis of BMI, diabetes risk score among the normal weight, overweight, and obese individuals were not significant [Table 4]. For Asians, waist–hip ratio cutoff point values are 0.90 and 0.80 for men and women, respectively.[7] Prevalence of diabetes was not correlated with waist–hip ratio [Table 4]. It was observed that individuals with normal WC showed low IDRS, whereas individuals with WC in obese category showed high IDRS, and difference between these two groups are significantly high ($p < 0.05$). Table 4 shows a correlation between WC, BMI, waist–hip ratio, and the risk score, by using the Pearson's correlation coefficient.

Discussion

This study has been done to identify the risk of evolving type 2 DM in rural population using IDRS. In our study, 19% of the population was found to show high-risk score for diabetes. In the study conducted by Mohan et al. in the metropolitan city, 43% was found to fall in high-risk category, and urban area of Pondicherry showed 31.2% in high-risk category.[10,11] This risk difference may be owing to the differences in lifestyle factors such as physical activity, and prevalence of obesity may vary in rural and urban areas. This difference could be

Table 4: Mean of plasma glucose, WC, waist–hip ratio, and BMI of diabetes

Parameters	Diabetes			Prediabetes			*p*
	Group I	Group II	Group III	Group I	Group II	Group III	
Fasting plasma glucose	145 ± 4.1	175 ± 3.7	163 ± 5.1	117 ± 3.8	114 ± 4.3	119 ± 4	0.01
2-h PL glucose	201 ± 4.7	214 ± 7.1	234 ± 8.7	160 ± 4.5	170 ± 5.5	167 ± 4.5	0.01
WC							
Males	88 ± 3.7	97 ± 1.8	105 ± 2.3	85 ± 3.3	96.1 ± 1.5	97 ± 1.7	0.001
Females	75 ± 2.9	86 ± 1.6	97 ± 3.1	73 ± 2.3	84 ± 1.9	93 ± 1.5	0.001
BMI (kg/m²)	23.1 ± 1.7	26.2 ± 3.2	25.4 ± 2.8	24.7 ± 1.5	25.3 ± 2.2	26.1 ± 2.4	0.12
Waist–hip ratio	0.81 ± 0.7	0.83 ± 1.1	0.82 ± 0.9	0.83 ± 0.3	0.82 ± 0.5	0.81 ± 0.8	0.11

*$p \leq 0.05$, significant.

Table 5: Pearson's correlation between Indian Diabetes Risk Score, FPG, postglucose load, WC, waist–hip ratio, and BMI.

Correlation coefficient between	*r*
Fasting plasma glucose and 2-h PL glucose	0.84*
IDRS and diabetes	0.64*
Diabetes and WC	0.81*
Diabetes and BMI	0
Diabetes and waist–hip ratio	0

*, Positively correlated; 0, Not correlated.

accounted by the fact that agricultural labor is the main work of these people. Rural people showed a higher total energy and more fiber intake than urban men. About 46.5% were involved in mild to moderate physical activity and 52% engaged in vigorous/strenuous physical activity. Overall, 109/800 (13.62%) and 132/800 (16.5%) individuals in this rural population showed diabetes and prediabetes, respectively. The prevalence of diabetes was significantly higher among participants with a high IDRS 57/152 (37.5%) and a medium IDRS 41/416 (9.85%) when compared with those with a low IDRS score 11/232 (4.74%), and the *p* value was significant ($p = 0.01$). This indicates that IDRS has distinctive predictive value for detecting undiagnosed diabetes in the community. Mohan and Anbalagan[12] in their CURES-24 study reported that IDRS of 60 or more was found to show optimum sensitivity (75%) and specificity (60.1%) for determining diabetes. In this study, 132 individuals were found to show prediabetes. Prevalence of prediabetes is more than diabetes in our study. Prediabetes is an intermediate state of hyperglycemia with glycemic parameters above normal but below the diabetes threshold. Prediabetes is generally an asymptomatic condition, and there is invariably presence of prediabetes before the onset of diabetes.[13] Prediabetes remains a state of high risk for developing diabetes with yearly conversion rate of 5%–10%.[13] Prediabetes, if identified early, can be reversed from progressing into full-blown type 2 diabetes. It is so important for diabetes and prediabetes individuals to set the goal to reduce the weight (7% of body weight) and at least 150 min of physical activity per week.[14] Studies have proven that lifestyle intervention considerably decreases the progression of prediabetes to diabetes. In our study, the prevalence of diabetes is more in female than male subjects. Even though more abdominal fat is accumulated in men than women, abdominal fatness seems more strongly associated with diabetes in women than men.[15,16] About 45% of the individuals showed WC more than the normal reference range. In this study, increased WC is closely associated with an increased risk of diabetes and prediabetes, and this is consistent with the studies of Derakhshan et al.[17] WC is positively correlated significantly with the IDRS and prevalence of diabetes with "*r*" value of 0.81 [Table 5]. Measurement of WC helps to assess the levels of visceral fat. Visceral fat tissue seems to be metabolically more active than nonvisceral fat and secretes more cytokines, which may be imperative for the progression of diabetes.[18] In our study, BMI is not correlated with IDRS score [Table 5]. Although the BMI measures the degree of overweight and obesity, it ignores body fat distribution. Even though BMI is the frequently used criterion for assessment of obesity, it measures only the depiction of body composition and regional body fat distribution, because it is a marker of general obesity rather than central obesity. WC reveals greater ability in predicting abnormal blood glucose levels when compared with BMI. In our study, the mean waist–hip ratio of the study population (0.81 ± 0.05) did not vary greatly from that of the diabetes (0.82 ± 0.03) and prediabetes (0.81 ± 0.07). In this study, IDRS score of ≥60 showed the optimum sensitivity (87.69%) and specificity (77.01%) for detecting undiagnosed diabetes in the community, with a positive predictive value of 64.17%, negative predictive value of 81.92%, and positive likelihood ratio of 3.09. In the studies of Mohan and Anbalagan,[12] IDRS value of ≥60 showed the optimum sensitivity (72.5%) and specificity (60.1%) for determining undiagnosed diabetes in the community, with a positive predictive value of 74.03% and negative predictive value of 89.33%. We presumed that a simple diabetes risk score might be used as an initial screening tool to identify subjects at high risk of DM, where resources are limited. Those with high-risk scores could then to be subjected to definitive tests to confirm the presence of DM.

Of the 800 individuals screened for diabetes using IDRS, 19% was found to show a high-risk score for diabetes, 52% moderate-risk score and 29% low-risk score. Among the screened rural population, 109 (13.62%) and 132 (16.5%)

individuals were diagnosed to show diabetes and prediabetes, respectively. IDRS is significantly correlated with the occurrence of diabetes and prediabetes. Thus, IDRS can be used as a cost-effective tool to screen diabetes. WC is significantly correlated with IDRS and diabetes prevalence using Pearson's correlation coefficient. BMI and waist–hip ratio are not correlated with risk score, diabetes, and prediabetes. However, further studies are suggested with large number of samples to confirm or refute the present observation. The study was conducted in a single center. The sample size was not enough to empower for cause-specific analyses. HbA1C had not been measured, which is not feasible for 800 individuals. Physical activity could have been measured in triaxial accelerometer.

Conclusion

Prevalence of diabetes and prediabetes in studied population was 13.62% and 16.5%, respectively. WC was positively correlated with diabetes (*r* value: 0.81). This screening method is simple and useful in detecting undiagnosed diabetes and prediabetes.

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