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Achutha Menon Centre Diabetes Risk Score: A Type 2 Diabetes Screening Tool for Primary Health Care Providers in Rural India

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Abstract

The authors aimed to develop a diabetes risk score for primary care providers in rural India. They used the baseline data of 451 participants (15-64 years) of a cohort study in a rural area of Kerala, India. The new risk score with age, family history of diabetes, and waist circumference identified 40.8% for confirmatory testing, had a sensitivity of 81.0%, specificity of 68.4%, positive predictive value of 37.0%, and negative predictive value of 94.0% for an optimal cutoff 4 with an area under the receiver operating characteristic curve of 0.812 (95% confidence interval = 0.765-0.860). The new risk score with 3 simple, easy-to-measure, less time-consuming, and less expensive variables could be suitable for use in primary care settings of rural India.

Keywords

diabetes; India; primary health care providers; risk score; rural

Introduction

Globally, diabetes has emerged as a major public health problem. In India, 61.3 million adults are estimated to have diabetes in 2011, and this will increase to 101.2 million by 2030.¹ In India, half to two thirds of people with diabetes are undetected,² and many have complications at diagnosis.^{3,4} As onset of diabetes occurs at least 4 to 7 years before its clinical diagnosis,⁵ early detection and treatment will prevent morbidity and mortality associated with diabetes.

Universal screening for diabetes is not practical nor recommended.⁶ Moreover, use of fasting or postprandial plasma glucose for early detection of diabetes is invasive, expensive, and not feasible in resource-limited settings. Therefore, screening tools (risk score, logistic

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regression equation, and classification tree form) have been developed to identify individuals with type 2 diabetes.⁷

In rural areas of India, where more than two thirds of India's population lives,⁸ the primary health care settings face severe shortage of the health workforce.⁹ To screen for diabetes in this scenario, a screening tool with a fewer number of variables that are simple, easy-to-measure, less time-consuming, and less expensive is preferred. Therefore, we aimed to develop a diabetes risk score that could be suitable for use by the primary health care providers in rural India.

Methods

Study Sample

Between 2003 and 2006, the World Health Organization (WHO)-Indian Council of Medical Research multicentric study on risk factors for noncommunicable diseases was conducted among 7449 participants (15-64 years of age) in urban (n = 2475), slum (n = 2464), and rural (n = 2510) areas of Thiruvananthapuram district in the state of Kerala (1 of the 6 centers of the study), India.¹⁰ From the rural sample of the study, 495 participants were selected through systematic random sampling for biochemical analysis (fasting plasma glucose and serum lipids). We conducted a follow-up study of this cohort (n = 495) from July 10 to September 27, 2010, in which 452 individuals (91.3%) participated. We used the baseline data of 451 participants, excluding that of 1 pregnant woman, for the present analysis. The study was approved by the institutional ethics committee of Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram. Written informed consent was obtained from all the study participants.

Measurements

Data collection for the present analysis has been described in detail elsewhere.¹⁰ In brief, information on demographic characteristics, tobacco use, alcohol use, fruit and vegetable intake, and physical activity were collected using a pretested modified WHO STEPS interview schedule.¹¹ Physical measurements such as height, weight, waist circumference, and blood pressure were measured using standardized tools and protocols.¹¹ Fasting plasma glucose was estimated by glucose oxidase/peroxidase-phenol-4-aminophenazone method,¹² and external quality control was performed by sending 10% of the blood samples to a standardized core laboratory at the All India Institute of Medical Sciences, New Delhi, India. During the follow-up study in 2010, data on family history of diabetes was obtained because it was not available at baseline.

Statistical Analysis

We compared the characteristics of study participants with and without diabetes using Pearson's χ^2 test and Fisher's exact test (for a 2×2 contingency table with fewer than 5 numbers in cells). We used multivariate logistic regression analysis (forward stepwise likelihood ratio method) to derive the risk factors for diabetes. Diabetes was defined as fasting plasma glucose ≥ 126 mg/dL and/or on antidiabetic medication.¹³ We chose variables for multivariate modeling by keeping our study objective in mind. These included age (<35 ,

35-44, 45-54, and 55-64 years), sex, years of schooling (<10 and ≥10 years), current smoking (any smoking in last 30 days), daily intake of fruits or vegetables, family history of diabetes (parents or siblings), and central obesity¹⁴ (waist circumference ≥80 cm in women and ≥90 in men). To keep the risk score simple and practical, we did not include interaction terms in the model. Model fitness was assessed by the Hosmer-Lemeshow test. A score for each category of variable was assigned by rounding its β coefficient to the nearest integer, with a score of 0 for the reference category. For the age groups 35 to 44 years, 45 to 54 years, and 55 to 64 years, the β coefficients were 1.66, 1.98, and 2.92, respectively. Therefore, scores for these age groups were 2, 2, and 3, respectively. Based on a method used previously,¹⁵ we broke the tie in the scores of 35 to 44 years and 45 to 54 years by assigning the next integers to 45 to 54 years and 55 to 64 years, which were then 3 and 4, respectively. The total score was obtained by adding the highest score of each variable. The optimal cutoff was obtained from the area under the receiver operating characteristic curve, which was drawn by plotting 1-specificity on the X-axis and sensitivity on the Y-axis. We computed sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, negative likelihood ratio, and the Youden index for the optimal cutoff. All data analyses were performed using Statistical Package for Social Sciences for Windows version 17.0 (SPSS Inc, Chicago, IL).

Results

Characteristics of Study Participants

Of the 451 participants, 84 (18.6%) had diabetes (diagnosed and undiagnosed). The mean age $\pm$ standard deviation (SD) of the study sample was 39.4 ± 14.1 (range = 15-64 years). Table 1 shows the characteristics of study participants according to their diabetes status. Participants with diabetes were significantly older and had a family history of diabetes, fewer years of schooling, history of high blood glucose, history of high blood pressure, history of antihypertensive medication, high blood pressure, high body mass index, and high waist circumference when compared with those without diabetes.

New Risk Score

Table 2 shows the results of multivariate logistic regression analysis. Age ≥35 years, family history of diabetes (parents or siblings), and central obesity (waist circumference ≥80 cm in women and ≥90 cm in men) were significant risk factors for diabetes. The model showed a good fit (Hosmer-Lemeshow $P = .886$). The total score ranged from 0 to 6 (mean $\pm$ SD = 2.8 ± 1.9). The mean $\pm$ SD total score of those with diabetes (4.4 ± 1.3) was significantly higher than that of those without diabetes (2.4 ± 1.8); $P < .001$. The total score was stratified into 3 categories: 0 to 1, 2 to 3, and ≥4. The prevalence of diabetes increased with higher risk score values (χ^2 for trend: 67.05, $P < .001$) as shown in Figure 1. The optimal cutoff ≥4 identified 40.8% for confirmatory testing, had a sensitivity of 81.0%, specificity of 68.4%, positive predictive value of 37.0%, negative predictive value of 94.0%, positive likelihood ratio of 2.56, and negative likelihood ratio of 0.28. The area under the receiver operating characteristic curve of the risk score was 0.812 (95% confidence interval = 0.765-0.860; Figure 2). Figure 3 shows the format of the Achutha Menon Centre Diabetes Risk Score.

Discussion

The new diabetes risk score with 3 simple, easy-to-measure, less time-consuming, and less expensive variables could be used for both opportunistic and community screening by a variety of primary health care providers, including doctors, nurses, and other nonmedical health care workers in rural India. By subjecting less than half of those screened to confirmatory testing, the risk score could identify more than three fourths of diabetics. The risk score has 1 anthropometric variable (waist circumference) along with age and family history of diabetes. Waist circumference is a simple, convenient, and more reliable tool than other measures of central obesity.¹⁶ The primary health care providers can be easily trained in measuring waist circumference accurately. We kept our scoring system very simple, with just a paper and pencil to required to fill in information and no calculation. The 3 variables of the risk score could be measured in any part of rural India, although estimation of family history of diabetes may vary depending on the level of awareness and use of health services. Because this new diabetes risk score was developed by researchers from the Achutha Menon Centre for Health Science Studies of SCTIMST, which hosts India's first Master of Public Health Program,¹⁷ we called the risk score the *Achutha Menon Centre Diabetes Risk Score*. Henceforth will be shortly referred as *AMC Diabetes Risk Score*.

So far, 3 diabetes risk scores have been developed for use in native Asian Indians.¹⁸⁻²⁰ Of these, 2 scores^{18,19} have used physical activity as a variable. These risk scores have focused on estimating the intensity^{18,19} and duration¹⁹ of physical activity, which we believe are difficult to measure accurately by the busy primary care providers. On the other hand, 1 screening tool included hypertension as a component.²⁰ Even though hypertension is a major risk factor associated with diabetes,²¹ its clinical diagnosis depends on measurements taken in more than 1 setting, requires calibrated equipment, and involves training to measure blood pressure accurately. Body mass index (BMI) was included in addition to waist circumference in the risk score by Ramachandran et al.¹⁹ Upper-body adiposity (measured by waist circumference or waist to hip ratio) showed a significant association with diabetes in Asian Indians with low rates of obesity (measured by BMI).²² Furthermore, calculation of BMI requires measurement of weight and height with expensive weighing machines and stadiometers, respectively, which are not usually available in the primary health care settings of rural India. Although variables such as history of high blood glucose, history of high blood pressure, and use of antihypertensive medication in some of the screening tools from other countries²³⁻²⁸ could be obtained in primary health care settings, they are less applicable to rural India, where the levels of awareness, treatment, and control of diabetes and hypertension are low.^{10,29,30}

Our study has certain limitations. First, we used total diabetes (diagnosed and undiagnosed) as our outcome variable rather than undiagnosed diabetes because the sample size of those with undiagnosed diabetes was small (n = 42). However, strong consistency in risk factors of undiagnosed and total diabetes is seen in rural Indian populations.^{20,31} Therefore, we expect that the new risk score would perform equally well in detecting undiagnosed diabetes as total diabetes. Second, we did not include postchallenge glucose level in defining diabetes because the oral glucose tolerance test was not performed. The latter test is expensive, time-consuming, and not feasible in resource-limited settings.

Conclusion

The new diabetes risk score with 3 simple, easy-to-measure, less time-consuming, and less expensive variables could be suitable for use in primary health care settings of rural India.

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Figure 1.
Prevalence of diabetes according to risk score categories.

Figure 2.

AROC showing the performance of the Achutha Menon Centre Diabetes Risk Score

Abbreviation: AROC, area under the receiver operating characteristic curve.

Question	Score allotted	Enter your patient's score
How old are you (in completed years)? < 35 35-44 45-54 55-64	0 2 3 4	
Do your parents or siblings have diabetes? No Yes	0 1	
Waist circumference (cm) < 80 in women, < 90 in men ≥ 80 in women, ≥ 90 in men	0 1	
Total score	6	
If your patient's score is ≥ 4 , he/she is at a high risk of having diabetes. Subject him/her to confirmatory testing. If your patient's score is < 4 , he/she is at low risk of having diabetes.		

Figure 3.
Format of the Achutha Menon Centre Diabetes Risk Score.

Table 1

Characteristics of Study Participants by Diabetes Status.

Characteristics, n (%)	Diabetes ^a (n = 84)	No Diabetes ^b (n = 367)	P Value
Age (years)			
<35	6 (7.1)	173 (47.1)	<.001
35-44	18 (21.4)	78 (21.3)	
45-54	26 (31.0)	70 (19.1)	
55-64	34 (40.5)	46 (12.5)	
Men	36 (42.9)	178 (48.5)	.350
Years of schooling			
<10	51 (60.7)	161 (43.9)	.005
10	33 (39.3)	206 (56.1)	
Current smoking (in the past 30 days)	12 (14.3)	55 (15.0)	.871
Daily intake of fruits or vegetables	74 (88.1)	330 (89.9)	.622
Physically less active (<600 MET-min/wk)	11 (13.1)	37 (10.1)	.624
Family history of diabetes (parents or siblings)	62 (73.8)	168 (45.8)	<.001
History of high blood glucose	38 (45.2)	4 (1.1)	<.001
History of high blood pressure	25 (29.8)	40 (10.9)	<.001
History of antihypertensive medication	17 (20.2)	20 (5.4)	<.001
Blood pressure ^c			
Optimal	12 (14.3)	104 (28.3)	<.001
Prehypertension	28 (33.3)	153 (41.7)	
Hypertension	44 (52.4)	110 (30.0)	
Body mass index (kg/m ²)			
<25	53 (63.0)	298 (81.2)	.001
25-29.9	26 (31.0)	60 (16.3)	
30	5 (6.0)	9 (2.5)	
Waist circumference (cm)			
< 80 in women, < 90 in men	25 (29.8)	218 (59.4)	<.001
80 in women, 90 in men	59 (70.2)	149 (40.6)	

Abbreviation: MET, metabolic equivalent.

^aFasting plasma glucose ≥ 126 mg/dL and/or on antidiabetic medication.^bFasting plasma glucose < 126 mg/dL and not on antidiabetic medication.^cOptimal: systolic < 120 mm Hg and diastolic < 80 mm Hg; prehypertension: systolic 120 to 139 mm Hg and/or diastolic 80 to 89 mm Hg; hypertension: systolic ≥ 140 mm Hg and/or diastolic ≥ 90 mm Hg and/or on antihypertensive medication.

Table 2Results of Multivariate Logistic Regression Analysis.^a

Variables	Prevalence (%)	β coefficient	OR (95% CI)	P Value	Score ^b
Age (years)					
<35	3.4		1.0		0
35-44	18.8	1.66	5.3 (2.0-14.0)	.001	2
45-54	27.1	1.98	7.2 (2.8-18.8)	<.001	3
55-64	42.5	2.92	18.6 (7.2-48.1)	<.001	4
Family history of diabetes ^c					
No	10.0		1.0		0
Yes	27.0	1.05	2.8 (1.6-5.1)	<.001	1
Waist circumference (cm)					
< 80 in women, < 90 in men	10.3		1.0		0
> 80 in women, > 90 in men	28.4	0.97	2.6 (1.5-4.6)	.001	1
Total score					6

Abbreviations: OR, odds ratio; CI, confidence interval.

^aVariables not significant in the model: sex, years of schooling, current smoking, and daily intake of fruits or vegetables.^bScore is β coefficient rounded to the nearest integer.^cHistory of diabetes in parents or siblings.