Comparison of IDRS And ADA Diabetes Risk Assessment
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Comparison of IDRS And ADA Diabetes Risk Assessment Tools Reveals Different Risk Score in Same Population: A Cross-Sectional Analysis in a Tertiary Care Hospital.

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Abstract

Background: To identify individuals at high risk of developing type2 diabetes (T2DM), use of a validated risk-assessment tool is currently recommended. Nevertheless, recent studies have shown that risk scores that are developed in the same country can lead to different results of an individual.The Objective of study was to reveal whether two different risk-assessment tools predict similar or dissimilar high-risk score in same population. **Method:** This cross-sectional analytical study was carried upon 336 non-diabetic adults visiting the outpatient department (OPD) of Medicine, MARKS Medical College & Hospital, Bangladesh from October 2018 to March 2019. Woman having previous history of Gestational Diabetes Mellitus (GDM) were also included. Both the Indian Diabetes risk Score (IDRS) and the American Diabetes (ADA) Risk Score questionnaire were used to collect the data on demographic and clinical characteristics, different risk factors of an individual subject, and to calculate predicted risk score for developing T2DM. **Results:** Among 336 subjects, 53.6% were female. The mean (±SD) age of the study subjects was 38.25±1.12 years. The average IDRS predicted risk score of developing T2DM was more in female subjects than male [$p<0.05$]. Whereas the ADA predicted increased risk score of developing type 2 diabetes was more in male subjects than female ($p<0.05$). IDRS categorized 37.2 % of individuals at high risk for developing diabetes; [$p=0.10$], while the ADA risk tool categorized 20.2% subjects in high risk group; [$p<0.001$]. **Conclusions:** The results indicate that risk for developing type 2 diabetes varies considerably according to the scoring system used. To adequately prevent T2DM, risk scoring systems must be validated for each population considered.

Keywords: Diabetes Risk Assessment Score, IDRS, ADA Diabetes Risk assessment Tools

Introduction

Diabetes mellitus (DM) is one of the most common non-communicable diseases (NCDs) globally. The prevalence and incidence of type 2 diabetes mellitus (T2DM) are increasing at fast speed in the world[1]. According to WHO (world health organization), the total number of people with diabetes is projected to rise to 366 million in 20302, but International Diabetes Federation (IDF)[3] estimated that the situation is much worsened as the burden would increase from 417 million (2030) to 486 million (2045).

The prevalence of diabetes is increasing in Bangladesh in both urban and rural areas[4]. It increases healthcare use and expenditure and imposes a huge economic burden on the healthcare systems. Recent studies[5] have shown that lifestyle or medication intervention could prevent the

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incidence of type 2 diabetes. Hence, screening tools are needed to identify participants with undiagnosed diabetes or those who are at risk for developing diabetes in the future.

Studies[4] also support the utilization of risk-assessment scor¬ing systems in quantifying individual's risk for developing T2DM. For this purpose, numerous risk scores[6] recently have been proposed. Participants at high risk of developing type 2 diabetes, according to the risk score threshold, are thus amenable to preventive measures. Some scores have been validated in selected populations[7], prompting their use in other countries[8,9]. Nevertheless, recent studies[8] have shown that risk scores that are developed in the same country can lead to different results. Likewise, one equation validated in one country might not provide adequate estimates in another[9]. Moreover, the risk score has to be accurate enough to provide targeted warnings for the patients.

Finally, and to the best of our knowledge, no study has ever compared the results of differing these two scoring systems in Bangladesh. The current study aimed to compare the results of scores that estimate the risk of developing type 2 diabetes using risk assessment tools of Indian Diabetes Risk Score (IDRS) and The ADA (American Diabetes Association) risk score.

Methods

The cross sectional analytical study was conducted among randomly sampled 336 adult Bangladeshi male & female subjects. The study population consisted of non-diabetic adults visiting the outpatient department (OPD) of Medicine, MARKS Medical College & Hospital, a tertiary care hospital in Dhaka, Bangladesh from October 2018 to March 2019. Individuals with known type 1 or type 2 diabetes or any endocrine illness and with an apparent communicative, cognitive impair¬ment or physical disability were excluded from the study. Woman having previous history of Gestational Diabetes Mellitus (GDM) were also included.

With written informed consent, both the Indian Diabetes risk Score (IDRS) and the American Diabetes (ADA) Risk Score questionnaire were used to collect the data including demographic and clinical characteristics, different risk factors of an individual subject, and to calculate predicted risk score for developing T2DM within 10 years. We took permission of the institutional review board of the hospital for conducting the study.

Risk Assessment Scores

In Bangladesh, still we don't have any diabetes risk assessment scoring system of our own. After review of literature regarding risk factors of developing diabetes in Bangladesh, we also reviewed some other well validated risk assessment scoring systems for DM of different countries. We found the risk assessment tools of the Indian diabetes Risk Score (IDRS)[10] and American Diabetes Association (ADA),[11] to calculate diabetes risk score was more useful for the Bangladeshi adults.

The ADA developing type 2 diabetes risk tool was well developed and tested for validity and reliability on different population in different coun¬tries. Study showed that ADA scores performed well and robustly, while the ADA score performed somewhat better than other scoring system[12]. The IDRS has a sensitivity of 72.5% and specificity of 60.1% and is derived based on the largest population based study on diabetes in India[13].

Methods of calculation of Risk Score

Anthropometric measurements of height and weight were measured by a reliable height scale and weighing scale, respectively. BMI (Body Mass Index): weight in kilograms/square of height in meters (kg/m2) was categorized as underweight (≤18.5 kg/ m2), normal weight (BMI: <25 kg/m2), overweight (BMI: 25 – <30 kg/m2), obese (BMI: ≥30 -<40 kg/m2) and morbid obese (BMI: ≥40 kg/m2)[14]. Waist circumferences was measured in a horizontal plane, midway between the inferior margin of the ribs and the superior border of the iliac crest using a reliable measuring inch tape. Hypertension was

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defined as a systolic blood pressure ≥140 mmHg and/or dias¬tolic blood pressure ≥90 mmHg, or in case of use of anti-hypertensive medications was measured by a manual sphygmomanometer in standard conditions (measured 2 times after a 5-min rest between each measurement)[15].

All the participants were assessed for both IDRS and ADA risk score. IDRS needs answers for three questions and waist measurement. Whereas, ADA risk score needed to answer six questions and BMI measurement.

ADA Risk score:

The ADA risk score system[16] has seven risk factors correlating with the risk of developing T2DM and was used to detect a diabetes risk based on age, sex, BMI, physical activity, past history of gestational diabetes mellitus, family history, and history of hypertension. It demonstrates the probability of developing T2DM. If anyone score 5 or more; that person are at increased risk for having type 2diabetes.

IDRS system:

The IDRS system[17] has four risk factors correlating with the risk of developing T2DM and was used to detect a diabetes risk based on age, waist circumference, physical activity, family history of diabetes. Subjects with an IDRS of <30 was categorized as low risk, 30-50 as moderate risk and those with >60 as high risk for diabetes.

Data were analyzed with Statistical Package for Social Science (SPSS Inc, Chicago, Illinois, USA) software version 16. The means and standard deviations were used to describe continuous data. For categorical data, frequencies and percentages were estimated. Categorical variables were compared with each other using the chi-square test. P value <0.05 was considered as significant.

Results

Baseline characteristics

A total of 336 subjects were included. Among them, 46.4 % were male and 53.6 % were female. The mean (±SD) age of the study subjects was 38.25 ±1.12 years. Maximum age was 68 years and minimum was 22 years. Average (±SD) BMI (kg/m2) was 25.16 ± 3.57 and waist circumference (cm) was 85.38±8.37. The mean (±SD) blood pressure (mm Hg) of the study subjects were SBP: 114.70 ±11.40 and DBP: 75.11 ±8.91 (Table 1).

Table 1: Comparison of clinical-demographic features, IDRS & ADA risk score between male and female subjects (n=336)

Variables	Male (Mean ± SD)	Female (Mean ± SD)	Total (Mean ± SD)
Age (years)	38.47 ± 1.16	38.06 ± 1.10	38.25 ± 1.12
Height (meter)	1.65 ± 0.08	1.56 ± 0.06	1.60 ± 0.08
Weight (kg)	70.87 ± 1.17	61.07 ± 9.89	65.62 ± 1.18
WC (cm)	86.52 ± 8.22	84.99 ± 8.40	85.38 ± 8.37
BMI (kg/m2)	25.69 ± 3.73	24.70 ± 3.37	25.16 ± 3.57
SBP (mm Hg)	114.55 ±11.20	114.83 ± 11.60	114.70 ± 11.40
DBP (mm Hg)	74.55 ± 8.82	75.61 ± 8.97	75.11 ± 8.91
IDRS	45.44 ± 17.20	51.50 ± 19.64	48.69 ± 18.76
ADA Risk Score	3.63 ± 1.70	2.47 ± 1.76	3.01 ± 1.83

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WC: Waist Circumference; BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; IDRS: Indian Diabetes Risk Score; ADA: American Diabetes Association

Risk assessment factors of IDRS

As stated in IDRS tool, most of the subjects (47.0%) were from < 35 years age group; [p=0.35]. According to waist circumference categories, female had high abdominal obesity in comparison to male (male vs. female: 4.5% vs.17.0%); [p<0.001]. Less than 50% of subjects do regular mild exercise or physical activities at home or work place (male vs. female: 18.8% vs. 24.7%); [p=0.14]. In the context of family history of diabetes, one diabetic parent had been found among 30.7 % of subjects and both diabetic parents had been found among 19.0% of subjects; [p=0.52] (Table-2).

Table 2. Prevalence of risk assessment factors for prediction of IDRS of developing type 2 diabetes among Bangladeshi subjects (n=336)

Risk Assessment Factors of IDRS			Male [N (%)]	Female [N (%)]	Total [N (%)]	p value
Age (years)		< 35 Years	76 (22.6)	82 (24.4)	158 (47.0)	0.351
		35-49 Years	47 (14.0)	67 (19.9)	114 (33.9)	
		≥ 50Years	33 (9.8)	31 (9.2)	64 (19.0)	
Waist Circumference (cm)	Male	Less than 90cm	73 (21.7)		73 (21.7)	<0.001
		≥ 90-99 cm	68 (20.2)		68 (20.2)	
		≥ 100 cm	15 (4.5)		15 (4.5)	
	Female	Less than 80 cm		54 (11.1)	54 (11.1)	<0.001
		80-89 cm		69 (20.5)	69 (20.5)	
		≥ 90cm		57 (17.0)	57 (17.0)	
Physical activity (30 min daily)		Regular Vigorous Exercise	1 (0.3)	0 (0.0)	1 (0.3)	0.147
		Regular Moderate Exercise	45 (13.4)	35 (10.4)	80 (23.8)	
		Regular Mild Exercise	63 (18.8)	83 (24.7)	146 (43.5)	
		No Exercise	47 (14.0)	62 (18.5)	109 (32.4)	
Family History of Diabetes		No Diabetes in Parents	81 (24.1)	88 (26.2)	169 (50.3)	0.585
		One Parent is Diabetic	49 (14.6)	54 (16.1)	103 (30.7)	
		Both Parents are Diabetic	26 (7.7)	38 (11.3)	64 (19.0)	

IDRS: Indian Diabetes Risk Score; Pearson chi-square test was done; P value <0.05 is significant.

Risk assessment factors of ADA

In accordance with ADA risk tool, most of the subjects (61.0%) were from <40 years age group; [p=0.28]. At best, 9.5 % of female subjects had previous history of GDM; [p<0.001]. More than 50% had a positive family history (mother, father, sister or brother) of DM (male vs. female: 25.0 % vs. 29.5 %); [p= 0.83]. A total 25.3% of the adults

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had past history of hypertension or were on anti-hypertensive medications; [p=0.37]. More than half of the adults (68.8 %) did not do daily physical activity; [p=0.44]. Some of the adults had high BMI [44.4 %were overweight and 11.0% were obese]; (p=0.11) (Table 3).

Table 3. Prevalence of risk assessment factors for ADA risk score of developing type 2 diabetes among Bangladeshi subjects (n=336).

Risk Assessment Factors for ADA Risk Score for Type 2 Diabetes		Male [N (%)]	Female [N (%)]	Total [N (%)]	p value
Age	< 40 Years	89 (26.5)	116 (34.5)	205 (61.0)	0.284
	40-49 Years	32 (9.5)	35 (10.4)	67 (19.9)	
	50-59 Years	22 (6.5)	22 (6.5)	44 (13.1)	
	≥ 60 Years	13 (3.9)	7 (2.1)	20 (6.0)	
History of GDM	Yes		32 (9.5)	32 (9.5)	<0.001
	No		148 (44.0)	148 (44.0)	
Family history of diabetes mellitus	Yes	84 (25.0)	99 (29.5)	183 (54.5)	0.832
	No	72 (21.4)	81 (24.1)	153(45.5)	
History of hypertension/ High Blood Pressure	Yes	43 (12.8)	42 (12.5)	85 (25.3)	0.374
	No	113 (33.6)	138 (41.1)	251(74.7)	
Daily Physical activity	Yes	52 (15.5)	53 (15.8)	105 (42.7)	0.443
	No	104 (31.0)	127 (37.8)	231(68.8)	
Weight Category; (BMI: kg/m^2)	Normal Weight (< 25 kg/m^2)	58 (17.3)	90 (26.8)	148 (44.0)	0.113
	Overweight (25 - <30 kg/m^2)	76 (22.6)	73 (21.7)	149 (44.3)	
	Obese (≥30 - <40 kg/m^2)	21 (6.2)	16 (4.8)	37 (11.0)	
	Morbid Obese (≥ 40 kg/m^2)	1(0.3)	1(0.3)	2(0.6)	

ADA: American Diabetes Association; BMI: body mass index; GDM: Gestational Diabetes Mellitus. Pearson chi-square test was done; p<0.05=significant.

Risk assessment score for type 2 diabetes among studied subjects

The mean IDRS predicted 10-year risk score of developing T2DM was more in female subjects than male; [p<0.05] (Table 1). According to IDRS system, 37.2 % of the subjects had high risk score for developing diabetes. Among them, 14.6% were male and 22.6 % were female. While 48.5% had moderate risk and 14.3% had low risk for developing diabetes; [p=0.10] (Figure 1).

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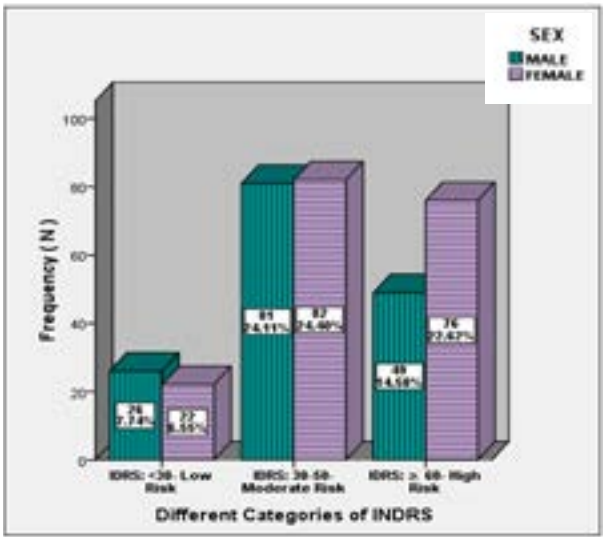
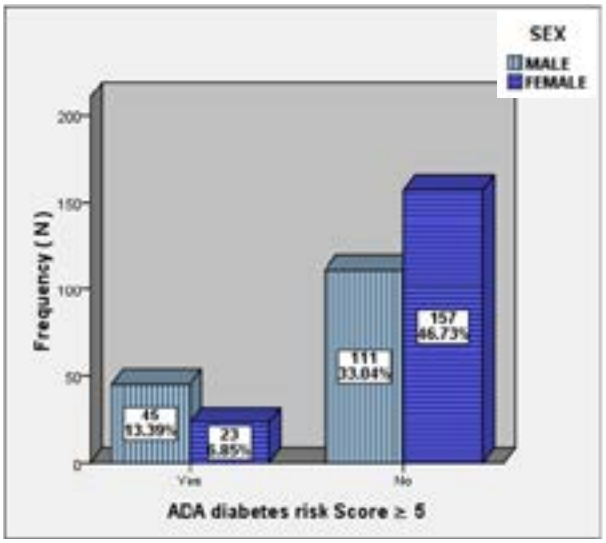
Figure 1: Different categories of IDRS assessment system among Bangladeshi subjects (n=336)



IDRS: Indian Diabetes Risk Score

Figure 2: Different categories of ADA risk score among Bangladeshi subjects (n=336)



ADA: American Diabete Association

IDRS predicts that 85.7% of the subjects may have moderate to high risk to develop T2DM within the consecutive 10 years, if no primary preventive measures are taken to curb it

The ADA predicted mean risk score of developing type 2 diabetes was more in male subjects than female; [p<0.001] (Table 1). A total 20.2 % of the subjects had high risk score (DRS ≥ 5) for developing dia¬betes. Among them, 13.4 % were male and 6.8 % were female; [p<0.001] (Figure 2).

Comparison between two risk scores

According to IDRS tools, 37.2% of the subjects were in high risk for developing diabetes (male vs. female: 14.8% vs. 22.6%); [p=0.10] (Figure 1). But the prediction of ADA risk tool for the same category was different. According to ADA risk tool, 20.2% of the subjects were in high risk group (male vs. female: 13.4 % vs. 6.8 %); [p<0.001] (Figure 2).

Discussion

The systematic review[18] shows that the predictive ability of diabetes risk scores, which have been developed in populations of varying ethnic backgrounds, differs considerably between populations. Several existing risk scores that enable prediction of type 2 diabetes based on information readily available in routine clinical practice or that can be gathered by questionnaires. Furthermore, these risk scores focus mainly on non modifiable risk factors such as age and family history or on the consequences of adverse health behaviors such as high body mass index and waist circumferences, high blood pressure, and medication use.

The feasibility of implementing any screening model will depend on the availability and completeness of the required risk factor data[19]. Risk scores show overall good discriminatory ability in populations for whom they were developed. However, discriminatory performance is more heterogeneous and generally weaker in external populations, which suggests that risk scores may need to be validated within the population in which they are intended to be used[19].

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The risk-scoring systems compared in this study shared several types of variables. For instance, both of them included family history, which can be explained by the association between certain genes and diabetes[20], and both of them also included age, which has been shown to be related to the risk of diabetes. Both scores also included obesity markers, such as BMI or waist circumference, all of which are involved in the metabolic syndrome definition[21]. Finally, these scores system included lifestyle habits (physical activity). For instance, age, obesity, and the other factors mentioned vary by country, and this may result in a differential importance to predict diabetes[22].

This study examined whether the adoption of two different validated risk-assessment tools would alter an individual's predicted risk of type2 diabetes. The risk assessments were chosen in this study primarily because they feature in the NICE guidance,[23] and also have some common risk variables that make comparisons feasible. Both the risk scores are based on noninvasive measurements that could be improved by adding commonly measured biochemical markers, in particular, measures of glycemia.

In agreement with previous studies[24,25] this study demonstrated that the risk of individual developing type2 diabetes was dependent on which risk-assessment tool was used. It was observed that the IDRS predicts that 37.2 % of the subjects may have high risk to develop T2DM within the consecutive 10 years. But the prediction of ADA risk tool was different for the same category. ADA risk assessment system predicts that 20.2 % of the subjects may have high risk to develop T2DM within the consecutive 10 years. Hence, diabetes risk scores demonstrated good discrimination in the study populations.

Conclusion

The adoption of a different valid risk assessment tool can alter the predicted risk of an individual and caution should be used to identify those individuals who really are at high risk of type 2 diabetes. To adequately prevent type2 diabetes, risk scoring systems must be validated for each population considered.

Limitation

This study is limited by the cross-sectional design and is not causal or effect study or measure of temporal changes. Validation of the risk assessment with a large sample size in different populations would have enhanced the generalizability of the results.

Future Research Proposal

This study reinforces the view that the main approach to managing this problem is to improve all stakeholders' understanding and compliance for development of national diabetes risk assessment tools and its widespread application campaigns. Unique diabetes risk assessment tools for Bangladeshi populations are needed. Population based study on risk factors that predicts future development of diabetes for our population should be carried out.

List of abbreviations

GDM : Gestational Diabetes Mellitus
OPD : Out Patient Department
IDRS : Indian Diabetes risk Score
ADA : American Diabetes Association Risk Score
SD : Standard Deviation
IDF : International Diabetes Federation
T2DM : Type 2 Diabetes Mellitus
WHO : world health organization
BMI : Body Mass Index
DRS : Diabetes risk score

Authors' contributions

Nazma Akter conceptualized, collected data, analyzed and wrote the manuscript. Nazmul Kabir Qureshi supervised and guided throughout the study from the beginning of the study and critically reviewed the manuscript. All authors read and approved the final manuscript.

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Declaration of conflicting interests
Nothing to declare

References

1. The Global Burden: IDF Diabetes Atlas; 5th edition. Brussels, Belgium: International Diabetes Federation; 2011.www.idf.org/ diabetes atlas/5e/the-global-burden.
2. Wild S, Roglic G, Green A, Sicree R, King H. Global Prevalence of Diabetes. Diabetes Care. 2004(27):1047-1053.
3. Diabetes prevalence; Geographical profile: IDF diabetes Atlas; 9th edition. Brussels, Belgium: International Diabetes Federation; 2019. http:// www.idf.org/diabetes atlas/9e (accessed 20 February 2020).
4. Mohiuddin AK. Diabetes Fact: Bangladesh Perspective. International Journal of Diabetes Research. 2019; 2(1):14-20.
5. American Diabetes Association. Standards of medical care in diabetes: 2009. Diabetes Care. 2009; 32(Suppl. 1):S13–S61.
6. Griffin SJ, Little PS, Hales CN, Kinmonth AL, Wareham NJ. Diabetes risk score: towards earlier detection of type 2 diabetes in general practice. Diabetes Metab Res Rev. 2000; 16:164–71.
7. Balkau B, Lange C, FezeuL, Tichet J, de Lauzon-Guillain B, Czernichow S, Fumeron F, Froguel P, Vaxillaire M, Cauchi S, Ducimetière P, Eschwège E, et al. Predicting diabetes: clinical, biological, and genetic approaches: data from the Epidemiological Study on the Insulin Resistance Syndrome (DESIR). Diabetes Care. 2008; 31:2056–61.
8. Mann DM, Bertoni AG, Shimbo D, Carnethon MR, Chen H, Jenny NS, Muntner P, et al.Comparative validity of 3 diabetes mellitus risk prediction scoring models in amultiethnic US cohort: the Multi-Ethnic Study of Atherosclerosis. Am J Epidemiol. 2010; 171:980–88.
9. Hense HW, Schulte H, Löwel H, Assmann G, Keil U. Framingham risk function ver estimates risk of coronary heart disease in men and women from Germany: results from the MONICA Augsburg and the PROCAM cohorts. Eur Heart J. 2003; 24:937–45.
10. Mohan V, Deepa R, Deepa M, Somannavar S, Datta M. A simplified Indian Dia-betes Risk Score for screening for undiagnosed diabetic sub¬jects. J Assoc of Physicians India. 2005; 53: 759–63.
11. Herman WH, Smith PJ, Thompson TJ, Engelgau MM, Aubert RE. A new and simple questionnaire to identify people at increased risk for undiag¬nosed diabetes. Diabetes Care. 1995; 18(3): 382–87.
12. Poltavskiy E, Kim DJ, Bang H. Comparison of screening scores for diabetes and prediabetes. Diabetes Res Clin Pract. 2016;118:146-53.
13. Sharma KM, Ranjani H, Nguyen H, Shetty S, Datta M, Narayan KM, Mohan V, et al. Indian Diabetes Risk Score helps to distinguish type 2 from non-type 2 diabetes mellitus (GDRC-3). J Diabetes Sci Technol. Mar 2011; 5(2):419-25.
14. Latchan Z, Seereeram R, Kamalodeen A, Sanchez S, Deonarine U, Sinanan R, et al. TRAQ-D (Trinidad Risk Assessment Questionnaire for Type 2 Diabe¬tes Mellitus): a cheap, reliable, non-invasive screening tool for diabetes. Br J Diabetes Vasc Dis. 2010; 10: 187–192.
15. Smith Liz. New AHA recommendations for blood pressure measurement: American Heart Association Practice Guide¬lines. Am Fam Physician. 2005; 72(7): 1391–98.
16. Bang H, Edwards A M, Bomback A S, Ballantyne CM, Brillon D, Callahan M A, et al. A patient self-assessment diabetes screening score: development, validation, and comparison to other diabetes risk assessment scores. Ann Intern Med. 2009;151:775–83.
17. Mohan V, Sandeep S, Deepa M, Gokulakrishnan K, Datta M, Deepa R. A diabetes risk score helps identify metabolic syndrome and cardiovascular risk in Indians – the Chennai Urban Rural Epidemiology Study

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(CURES-38). Diabetes, obesity & metabolism. May 2007; 9(3):337-43.
18. Herman WH. Predicting risk for diabetes: choosing (or building) the right model. Ann Intern Med. 2009; 150(11):812–14.
19. Brian B, Rebecca K. Simmons, Simon J. Griffin, Matthias B. Schulze. Risk Assessment Tools for Identifying Individuals at Risk of Developing Type 2Diabetes. Epidemiol Rev. 2011; 33:46–62.
20. Janes H, Pepe MS, Gu W. Assessing the value of risk predictions by using risk stratification tables. Ann Intern Med. 2008; 149(10):751–60.
21. Hosmer DW, Lemeshow S. Applied Logistic Regression. New York, NY: John Wiley & Sons, Inc; 1989.
22. Pencina MJ, D'Agostino RB Sr, D'Agostino RB Jr, Vasan RS. Evaluating the added predictive ability of a new marker: from area under the ROC curve to reclassification and beyond. Stat Med. 2008;27(2):157–72.
23. National Institute for Health and Care Excellence. Preventing type 2 diabetes: risk identification and interventions for individuals at high risk. London: NICE, 2012. http://www.nice.org.uk/guidance/ph38 (accessed 24 Sep 2015).
24. Lindstro¨m J, Neumann A, Sheppard KE, Gilis-Januszewska A, Greaves CJ, HandkeU, et al. Take action to prevent diabetes—the IMAGE toolkit for the prevention of type 2 diabetes in Europe. Horm Metab Res. 2010; 42(suppl1):S37–S55.
25. Chamnan P, Simmons RK, Sharp SJ,Griffin SJ, Wareham NJ. Cardiovascular risk assessment scores for people with diabetes: a systematic review. Diabetologia. 2009; 52(10):2001–14.