Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/mjafi

Original Article

Performance of Indian Diabetes Risk Score (IDRS) as screening tool for diabetes in an urban slum

Lt Col Puja Dudeja^{a,*}, Maj Gurpreet Singh^b, Maj Tukaram Gadekar^c,
Air Cmde Sandip Mukherji^d

^a Assistant Professor, Department of Community Medicine, Armed Forces Medical College, Pune 411040, India

^b Clinical Tutor, Department of Community Medicine, Armed Forces Medical College, Pune 411040, India

^c Resident, Department of Community Medicine, Armed Forces Medical College, Pune 411040, India

^d Professor & Head, Department of Community Medicine, Armed Forces Medical College, Pune 411040, India

ARTICLE INFO

Article history:

Received 24 February 2016

Accepted 16 August 2016

Available online 18 October 2016

Keywords:

Screening

Diabetes

Sensitivity

Specificity

ROC curve

ABSTRACT

Background: India is diabetic capital of world, with maximum number of diabetic patients. There is large burden of undetected diabetic cases in community. There is increasing risk of diabetes in urban slum, because of illiteracy, lack of awareness, low socioeconomic status and unhealthy life style. Madras Diabetes Research Foundation (MDRF) has developed Indian Diabetes Risk Score (IDRS) to detect undiagnosed Type 2 diabetes. The aim of this article is to study the performance of IDRS as screening tool for undiagnosed cases of Type 2 diabetes and to find the prevalence of undiagnosed Type 2 diabetes in an urban slum.

Methods: Screening for diabetes was carried out in an urban slum. The sample size was 155 (assumed prevalence of undiagnosed diabetes 9%). IDRS tool comprising of two modifiable (waist circumference, physical activity) and two non-modifiable risk factors (age, family history) for diabetes was used to assess the risk of diabetes anthropometry data was obtained. Confirmation of diabetes was done using blood sugar levels on fasting venous sample.

Results: Mean and SD for age of study subjects were 49.68 ± 14.80 years, BMI 26.60 ± 8.51 kg/m², waist hip ratio (females) 0.87 ± 0.06 cm, waist hip ratio (males) 0.95 ± 0.06 cm, waist circumference (females) 89.99 ± 10.95 cm, waist circumference (males) 89.44 ± 10.9 cm. IDRS predicted the risk of diabetes mellitus with sensitivity of 95.12% and specificity of 28.95% in individuals with score >60 .

Conclusion: IDRS can be used as an effective tool for screening undiagnosed diabetes in the community.

© 2016 Published by Elsevier B.V. on behalf of Director General, Armed Forces Medical Services.

* Corresponding author.

E-mail address: puja_dudeja@yahoo.com (P. Dudeja).

<http://dx.doi.org/10.1016/j.mjafi.2016.08.007>

0377-1237/© 2016 Published by Elsevier B.V. on behalf of Director General, Armed Forces Medical Services.

Introduction

India is diabetic capital of the world with home to 64.5 million diabetic patients. It has been projected that number of diabetics are likely to increase to 87 million by 2030.¹ The factors responsible for existence of this epidemic are due epidemiological transition associated with changes in dietary patterns and decreased physical activity.² With changing times, apart from the prosperous urban class, people in urban slums have to become susceptible. The process of sanskritisation in urban slum dwellers imitating the dietary and lifestyle practices of rich urban class has been mainly responsible for this. Moreover, lack of knowledge about healthy diet and nutrition and role of exercise compounds their susceptibility. Globalization and Urbanization has led to increase in consumption of High Fat, Salt and Sugar (HFSS) foods. In India, a plethora of research studies have been done among the urban population but only few of them have focused on population residing in urban slums.³⁻⁵ Diabetes is one of the contender diseases for which the community can be screened as it qualifies criteria of having a long latent asymptomatic stage that may be present for up to seven years before diagnosis, is treatable, and testing is acceptable to patients.⁶ Early treatment of diabetes improves micro as well as macro vascular outcomes in the long run. In communities sizeable percentage of people with type 2 diabetes remain undiagnosed. As per the International Diabetes Federation (IDF), more than half (66%) of Indians are unaware of their diabetic status as compared to 50% in Europe and 33% in USA.⁷ Approximately 44 lakh Indians are not aware that they are diabetic and hence are at increased risk of complications. Ramachandran et al., in their urban diabetes survey brought out that the ratio of previously undiagnosed to known diabetes in India is 1.2.⁸ Khan et al. in their study have acknowledged that screening for diabetes can actually lead to increase in quality of life-years gained by the patients over a period of time.⁹ Thus the present priority is to screen high risk population in the community, diagnose and then treat them in the community. It has been acknowledged that diabetic screening can add quality of life years. The battle against diabetes epidemic needs to be fought at all levels of prevention put into action simultaneously. Screening for undetected diabetes primarily addresses the role of secondary prevention in diabetes. Type 2 diabetes can be screened for by using risk assessment questionnaires, laboratory tests and combinations of the two. It is imperative that the risk assessment tool used in diabetes screening is 'population specific'. Such tools are effective in unmasking the real burden of disease. Madras Diabetes Research Foundation (MDRS) gave the countrymen the Indian Diabetes Risk Score (IDRS) which effectively screens for those at high risk of developing diabetes. This score is based on an extremely large population base study on Diabetes in India 'CURES'. This screening score has a sensitivity of 72.5% and specificity of 60.1% in the Indian community.¹⁰ The advantages of this tool encompasses it is no cost, non-invasive, simple, and easy applicability by the target population during mass screening programmes. However, it is required to estimate the worthiness of the IDRS tool in detecting undiagnosed diabetes in urban slums and offer early

therapy to them. Hence, the present study was done to assess the performance of IDRS as screening tool for diabetes and determine the prevalence of undiagnosed diabetes in an urban slum.

Materials and methods

The study was carried out in an Urban Health Training Centre of a medical college located in an urban slum. It covers a total population of 3000. Screening for diabetes was conducted with prior wide publicity in that area. The sample size with an assumed prevalence of undiagnosed diabetes to be 9% and maximum acceptable difference of 5% was calculated to be 126. All known cases of diabetes were excluded from the study. A total of 155 residents participated. Written informed consent was taken from the participants. IDRS tool used is given as Table 1. Anthropometry measurements were made by trained resident doctors. This included weight to nearest 100 g and height, waist circumference and hip circumference to nearest cm. Blood pressure of the subjects was recorded to nearest mmHg in right arm sitting position. Grade of physical activity was assessed by asking the participants how do they go to their place of work and how far is that from their home, how demanding is their occupation, what kind of physical activities they do at home and do they exercise regularly in leisure time? Fasting venous blood was collected for evaluation of blood glucose levels. Subjects who were not fasting were excluded from the study. Venous blood samples were collected in fluoride vacutainers. Blood sugar estimation was done by glucose oxidase peroxidase (GOD-POD) method. All those having fasting glucose levels more than 126 mg/dL on venous blood sample were referred and followed up in medical OPD of the hospital for further management. Awareness about prevention of diabetes was provided to all participants. Data

Table 1 – Components of Indian Diabetes Risk Score (IDRS).

Risk factors	Score
Age (years)	
<35	0
35–49	20
>50	30
Abdominal obesity (waist circumference)	
<80 cm (females)	0
<90 cm (males)	
≥80–89 cm (females)	10
≥90–99 cm (males)	
≥90 cm (females)	20
≥100 cm (males)	
Physical activity	
Exercise regular + strenuous work	0
Exercise regular or strenuous work	20
No exercise and sedentary work	30
Family history	
No family history	0
Either parent	10
Both parents	20
Minimum score: 0	
Maximum score: 100	

analysis was done using SPSS ver 20. For every cutoff point of IRDS validity (sensitivity and specificity) was calculated and receiver operator characteristic (ROC) curves were plotted.

Results

Data for 155 participants was analyzed. The mean age of the study participants was 49.68 ± 14.80 years. The mean waist circumference and waist hip ratios of the participants, both male and females was found to be higher than the prescribed limits for Asian Indians. The anthropometry profile of patients is given in Table 2. A total of 41 cases of previously undiagnosed diabetes were confirmed out of which 39 (97%) had IDRS of more than 60 and none of them scored low (less than 30). There was a significant association between occurrence of high score (>60) and presence of diabetes ($p < 0.05$) (Table 3). Significant association between risk factors for diabetes like age, family history, waist circumference, waist hip ratio and occurrence of diabetes ($p < 0.05$) was found (Table 4). The sensitivity, specificity, positive predictive value and negative predictive value for IDRS as compared to gold standard of fasting venous blood sugar levels of 126 mg/dL is depicted in Table 5. Receiver operator characteristic curve showed that for IDRS ≥ 60 , area under the ROC curve was 0.651 (Table 6 and Fig. 1).

Discussion

The theme for World Health Day 2016 has been aptly selected to be 'Diabetes'. India is at present in the midst of an epidemic of diabetes and a rising trend is being witnessed in low socio-economic urban areas.¹¹ Once referred to as disease of affluence it would be more appropriate to label it as a disease of urbanization which brings challenges by creating a more enabling environment for life style diseases.¹² There are many diabetes risk scores available like Finnish Diabetes Risk Score,

Table 4 – Association between diabetes risk factors and undiagnosed Type 2 diabetes.

Risk factors	Diabetes		p value
	Absent	Present	
Age			
<35 years	26	2	0.01
>35 years	88	39	
Family history			
Absent	75	17	0.007
Present	39	24	
Waist hip ratio (male)			
Within normal limits	8	0	— ^a
Abnormal	26	11	
Waist hip ratio (female)			
Within normal limits	33	6	0.04
Abnormal	47	24	
Waist (male)			
Within normal limits	16	2	0.09
Abnormal	18	9	
Waist (female)			
Within normal limits	12	1	0.09
Abnormal	68	29	

^a Chi-square test not applied as one of the cells contain '0'.

German Diabetes Risk score, Dutch Diabetes Risk Score using different variables. Various countries and different studies have used diverse diabetes risk scores to detect undiagnosed diabetes.^{13–19} In the present study, we tried to validate the IDRS, which is a handy tool with the public health specialists to screen for high risk cases without any laboratory support.²⁰ Our results show high prevalence of modifiable risk factors viz. lack of physical activity and presence of central obesity. High prevalence of behavioural risk factors like sedentary lifestyle, obesity and consumption of fatty and sugary food by in urban areas has already been described in various other studies also.^{21–24}

The prevalence of undetected diabetes in the current study was 26.4%. There exists a high proportion of such cases globally, and especially in developing countries. Beagley et al. in their study have given global estimates of undiagnosed diabetes in adults to vary between 24.1% to 75.1% across different regions of the world.²⁵ Dasappa et al. have reported prevalence of diabetes, pre-diabetes in urban slums of Bangalore as 12.33% and 11.57% respectively.²⁶ Lower prevalence of 6.3% was found by Ravikumar et al. in Chandigarh Urban Diabetes Study (CUDS).²⁷ However, in CUDS study participants were not from slums and diagnosis was done by estimating fasting plasma glucose (FPG) and 2-h plasma glucose (2hPG) following ingestion of 75 g of an anhydrous glucose equivalent by glucometer. The Diabetes Epidemiology: Collaborative Analysis of Diagnostic Criteria in Asia (DECODA) studies showed that there are 1.6 cases undiagnosed for every known case of diabetes in the community.²⁸ Results of different study vary depending upon the population profile, socio cultural practices, dietary habits and different criteria adopted for diagnosing diabetes.

The undiagnosed diabetes is very dangerous as unaware individuals of their disease status are left untreated and end up with dreadful complications. The population covered in the current study had higher prevalence of central obesity as was

Table 2 – Anthropological parameters of study subjects.

Variable	Mean $\pm$ SD (n = 155)
Age years	49.68 $\pm$ 14.80
BMI, kg/m ²	26.18 $\pm$ 4.27
Waist circumference (females), cm	89.99 $\pm$ 10.95
Waist circumference (males), cm	89.44 $\pm$ 10.95
Waist hip ratio (males)	0.87 $\pm$ 0.06
Waist hip ratio (females)	0.95 $\pm$ 0.06
Systolic blood pressure, mmHg	137.30 $\pm$ 24.32
Diastolic blood pressure, mmHg	81.94 $\pm$ 11.54

Table 3 – Association between IDRS score and occurrence of diabetes.

Level of risk	Presence of diabetes	Absence of diabetes	Total	p value
<60 (low/moderate)	02	33	35	0.0032
>60 (high)	39	81	120	
Total	41	114	155	

Table 5 – Sensitivity and specificity of IDRS.

IDRS	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
≥20	100 (91.40,100)	2.63 (0.55,7.50)	26.97 (20.10,34.76)	100 (29.24,100)
≥30	100 (91.40,100)	6.14 (2.50,12.24)	27.70 (20.67,35.65)	100 (59.04,100)
≥40	100 (91.40,100)	11.40 (6.21,18.71)	28.87 (21.58,37.07)	100 (75.29,100)
≥50	97.56 (87.14,99.14)	17.54 (11.06,25.79)	29.85 (22.26,38.36)	95.24 (76.18,99.88)
≥60	95.12 (83.47,99.40)	28.95 (20.84,38.19)	32.50 (24.23,41.65)	94.29 (80.84,99.30)
≥70	75.61 (59.70,87.64)	46.49 (37.10,56.07)	33.70 (29.17,44.30)	84.13 (72.74,92.12)
≥80	43.90 (28.47,60.25)	71.93 (62.74,79.94)	36.01 (22.92,50.81)	78.10 (68.97,85.58)
≥90	21.95 (10.56,37.61)	85.96 (78.21,91.76)	36.00 (17.97,57.48)	75.38 (67.06,82.51)
100	4.88 (0.60,16.53)	95.61 (90.06,98.56)	28.57 (3.67,70.96)	73.65 (65.78,80.54)

Bold values at cut off of score of 60.

Table 6 – Area under the curve at different values of cut off.

Cut off IDRS	Area under curve (AUC)	95% confidence interval		Significance
20	0.513	0.411	0.615	0.803
30	0.531	0.430	0.631	0.560
40	0.566	0.469	0.663	0.212
50	0.605	0.513	0.698	0.046
60	0.651	0.562	0.740	0.004
70	0.681	0.592	0.771	0.001
80	0.689	0.592	0.786	0.000
90	0.581	0.474	0.687	0.127

evident from anthropometry data and lack of physical activity. The higher prevalence in slums can be due to lack of awareness about healthy diet and exercise coupled with lack of facilities/space for exercise in these slums. Moreover they lack awareness about health hazards of consuming HFSS foods are not known.

Our study shows that IDRS score which consists of non-modifiable risk factors like age and family history and modifiable ones like abdominal obesity and physical activity has a sensitivity of 95.12% and specificity of 28.9% when the score is 60 and above. The results of landmark CURES study by Mohan et al. (2005) were 72.5% sensitivity and 60.1% specificity

Fig. 1 – Receiver operator characteristic curve for different values of cut off of Indian diabetes risk score.

for score of 60. Stanley et al. during their validation in South Indian population reported values of 100% and 17%.²⁹ Adhikari et al. in their validation studies on IDRS in different sets of Indian population were in agreement for a cut off of 60 for identifying undiagnosed diabetes.^{30–32} However, Bhadoria et al. in their study among adult population in central India recommended the cut off value of 40.³³

Total area under ROC curve is a single index for measuring the performance a test.³⁴ An area of less than 0.6 is not significant. The larger the AUC, the better is overall performance of diagnostic test to correctly pick up diseased and non-diseased subjects. In our study receiver operator area under the curve at cut of 60 was 0.651 and was much less as compared to 0.838 in the study by Patel et al.³¹ at cut off of 60 and Bhadoria with 0.736 at cut off of 40. The reasons for variation in AUC could be because of the study population which was done on high risk population (policemen) and method of assessment of physical activity. In our study, we did not take cut off of 70 or 80 for IDRS despite having more AUC as the sensitivity which is the essence of a screening test decreased at these values.

Positive family history plays a vital role in occurrence of diabetes. Ramachandran et al. in a study in south India found that 47% of the people who had diabetes had a positive family history.³⁵ Similarly in our study also 24 (58%) of the newly diagnosed diabetics gave a positive family history. Other covariates for diabetes were increased waist circumference and waist hip ratio which have been significantly associated with diabetes in other studies also.

IDRS can be given the title of 'Appropriate technology' in public health which is a strong tool in the hands of public health experts and community health workers to screen and then confirm out the hidden cases of undiagnosed diabetes. It is user friendly, simple, fast, economical and effective. It is easy to administer and at the same accurate too. Moreover, it can be used by community health workers like Auxiliary nurse Midwife (ANM), Multipurpose Worker Male (MPW), Accredited social Health Activist (ASHA) and Anganwadi workers after a short training. In the Armed forces set up paramedical workers (Nursing/Health Assistants) can be trained to apply this tool to the target population and identify high risk individuals for early interventions for modifiable risk factors. Even the Battle field nursing Assistants can be trained at the unit levels to use this tool. Identifying these risk factors has a crucial role in public health as it helps to reduce the time lag between exposure and disease. Government of India's initiative on tackling NCDs through National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Disease and Stroke (NPCDCS) also focuses on health promotion for behaviour change and early diagnosis. Use of tools adapted for local community such as IDRS can provide simple, cost effective method for the public health system for screening of diabetes at an early stage and prevent complications draining majority of resources of already stretched health care system of the country. In the long run it would help to prevent or to delay the onset of diabetes mellitus in the community. In comparison with other risk factor scoring system³⁶, IDRS developed by Mohan et al. (2005), where only single waist measurement and three simple questions, is one of the best diabetic risk score with very high sensitivity and specificity.

Our study substantiates the IDRS score 60 and above shows the optimal sensitivity and specificity.

Conclusion

This study was conducted to assess the performance of IDRS score in urban slum. This study validates that IDRS is a cost effective, simple, non-invasive and fairly accurate tool for screening of diabetes in the community.

Conflicts of interest

The authors have none to declare.

REFERENCES

1. *The Global Burden*. 6th ed. IDF Diabetes Atlas. www.idf.org/diabetesatlas/5e/the-global-burden Assessed 01.01.16.
2. Ramachandran A, Das AK, Joshi SR, Yajnik CS, Shah S, Prasanna KM. Current status of diabetes in India and need for novel therapeutic agents. *JAPI*. 2010;58:7–9.
3. Iyer SR, Iyer RR, Upasani SV, Baitule MN. Diabetes mellitus in Dombivli: an urban population study. *J Assoc Phys India*. 2001;49:713–716.
4. Prabhakaran D, Shah P, Chaturvedi V, Ramakrishnan L, Manhapra A, Reddy KS. Cardiovascular risk factor prevalence among men in a large industry of northern India. *Natl Med J India*. 2005;18:59–65.
5. Reddy KS, Prabhakaran D, Chaturvedi V, et al. Methods for establishing a surveillance system for cardiovascular diseases in Indian industrial populations. *Bull World Health Organ*. 2006;84:461–469.
6. Wilson JM, Jungner G. *Principles and Practice of Screening for Disease*. Public Health Paper (34). World Health Organization; 1968
7. Tyagi A, Patel S, Waran M, Garudkar S, Telang S. Evaluation of risk for type 2 diabetes mellitus in medical students using Indian Diabetes Risk Score (IDRS). *Sch J Appl Med Sci*. 2015;3 (7C):2591–2593.
8. Ramachandran A, Snehalatha C, Kapur A, et al. Diabetes Epidemiology Study Group in India (DESI). *Diabetologia*. 2001;44(9):1094–1101.
9. Kahn R, Alperin P, Eddy D, et al. Age at initiation and frequency of screening to detect type 2 diabetes: a cost-effectiveness analysis. *Lancet*. 2010;23(375): 1365–1374.
10. Mohan V, Deepa R, Deepa M, Somannavar S, Datta M. A simplified Indian Diabetes Risk Score for screening for undiagnosed diabetic subjects. *J Assoc Physicians India*. 2005;53:759–763.
11. Nath A, Garg S, Deb S, Ray A, Kaur R. A study of the profile of behavioral risk factors of non-communicable diseases in an urban setting using the WHO steps 1 approach. *Ann Trop Med Public Health*. 2009;2:15–19.
12. Anand K, Shah B, Yadav K, et al. Are the urban poor vulnerable to non-communicable diseases? A survey of risk factors for non-communicable diseases in urban slums of Faridabad. *Natl Med J India*. 2007;20(3).
13. Glumer C, Carstensen B, Sandbaek A, Lauritzen T, Jorgensen T, Borch-Johnsen K. Inter99 study: a Danish diabetes risk score for targeted screening. *Diabetes Care*. 2004;27:727–733.

14. Lindstrom J, Tuomilehto J. The diabetes risk score: a practical tool to predict type 2 diabetes risk. *Diabetes Care*. 2003;26:725–731.
15. Spijkerman AM, Yuyun MF, Griffin SJ, Dekker JM, Nijpels G, Wareham NJ. The performance of a risk score as a screening test for undiagnosed hyperglycemia in ethnic minority groups: data from the 1999 health survey for England. *Diabetes Care*. 2004;27:116–122.
16. Nelson KM, Boyko EJ. Third National Health and Nutrition Examination Survey. Predicting impaired glucose tolerance using common clinical information: data from the Third National Health and Nutrition Examination Survey. *Diabetes Care*. 2003;26:2058–2062.
17. 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(3):164–171.
18. Saaristo T, Peltonen M, Lindström J, et al. Cross-sectional evaluation of the Finnish Diabetes Risk Score: a tool to identify undetected type 2 diabetes, abnormal glucose tolerance and metabolic syndrome. *Diabetes Vasc Dis Res*. 2005;2(2):67–72.
19. Lin JW, Chang YC, Li HY, et al. Cross-sectional validation of diabetes risk scores for predicting diabetes, metabolic syndrome, and chronic kidney disease in Taiwanese. *Diabetes Care*. 2009;32(12):2294–2296.
20. Mohan V, Anbalagan VP. Expanding role of the Madras Diabetes Research Foundation – Indian Diabetes Risk Score in clinical practice. *Indian J Endocrinol Metab*. 2013;17(1):31–36.
21. Sochaliya KM, Parmar DV, Yadav SB. A study on prevalence of life-style diseases and its risk factors in urban area of Jamnagar City. *Natl J Community Med*. 2012;3(4):595–600.
22. Acharyya T, Kaur P, Murhekar MV. Prevalence of behavioral risk factors, overweight and hypertension in the urban slums of North 24 Parganas District, West Bengal, India, 2010. *Indian J Public Health*. 2014;58:195–198.
23. Thankappan KR, Shah B, Mathur P, et al. Risk factor profile for chronic non-communicable diseases: results of a community-based study in Kerala, India. *Indian J Med Res*. 2010;131(1):53–63.
24. Basu G, Biswas S, Chatterjee C. Behavioral risk factors of non-communicable diseases: experience from a village of Hoogly district, West Bengal. *J Dent Med Sci*. 2013;4(3):19–24.
25. Beagley J, Guariguata L, Weil C, Motala AA. Global estimates of undiagnosed diabetes in adults. *Diabetes Res Clin Pract*. 2014;103(2):150–160.
26. Dasappa H, Fathima FN, Prabhakar R, Sarin S. Prevalence of diabetes and pre-diabetes and assessments of their risk factors in urban slums of Bangalore. *J Family Med Primary Care*. 2015;4(3):399–404.
27. Ravikumar P, Bhansali A, Ravikiran M, et al. Prevalence and risk factors of diabetes in a community-based study in North India: the Chandigarh Urban Diabetes Study (CUDS). *Diabetes Metab*. 2011;37(3):216–221.
28. Qiao Q, Nakagami T, Tuomilehto J. Comparison of the fasting and 2 h glucose criteria for diabetes among Filipino-Americans in the Houston. Texas metropolitan statistical area. Diabetes in different Asian cohorts. *Diabetologia*. 2000;23:1470–1475.
29. Stanley JM, Elantamilan D, Mohanasundaram K, Kumaravel TS. Evaluation of Indian diabetic risk score for screening undiagnosed diabetes subjects in the community. *Indian J Sci Technol*. 2012;5(6):2798–2799.
30. Adhikari P, Pathak R, Kotian S. Validation of the MDRF-Indian Diabetes Risk Score (IDRS) in another south Indian population through the Boloor Diabetes Study (BDS). *J Assoc Physicians India*. 2010;58:434–436.
31. Patel ND, Shah MC, Ahir GN, Amin DV, Singh MP. A study on validity of Indian diabetes risk score (MDRF) for screening of diabetes mellitus among the high risk group (policemen) of Diabetes mellitus of Bhavnagar city. *Innov J Med Health Sci*. 2012;109–111.
32. Taksande B, Ambade M, Joshi R. External validation of Indian diabetes risk score in a rural community of central India. *J Diabetes Mellitus*. (2):2012;(2):109–113.
33. Bhadoria AS, Kasar PK, Toppo NA. Validation of Indian diabetic risk score in diagnosing type 2 diabetes mellitus against high fasting blood sugar levels among adult population of central India. *Biomed J*. (38):2015;(38): 359–360.
34. Kumar R, Indrayan A. Receiver operating characteristic (ROC) curve for medical researchers. *Indian Paediatrics*. 2011;48:277–287.
35. Ramachandran A, Jali MV, Mohan V, Snehalatha C, Viswanathan M. High prevalence of diabetes in an urban population in south India. *BMJ*. 1988;297:587–590.
36. Ramachandran A, Snehalatha C, Vijay V, Wareham NJ, Colagiuri S. Derivation and validation of diabetes risk score for urban Asian Indians. *Diabetes Research and Clinical Practice*. 2005;70:63–70.