Risk of developing Diabetes Mellitus among urban poor South Indian population using Indian Diabetes Risk Score

Aditya Oruganti[1], Avinash Kavi[1], Padmaja R. Walvekar[1]

[1]*Department of Community Medicine, Jawaharlal Nehru Medical College, KLE Academy of Higher Education and Research, Nehru Nagar, Belagavi, Karnataka, India*

Abstract

Background: Diabetes mellitus is increasing its share of burden to the health-related problems in developing countries such as India. Urban slum residents constitute the "vulnerable population" who lack the basic health amenities. Lack of effective screening for primary prevention has been one of the reasons for the rising burden. **Materials and Methods:** The cross-sectional study was conducted among 400 adults aged between 30 and 60 years residing in a settled slum of Rukmini Nagar area of Belagavi city, Karnataka. Data were collected after taking written informed consent from each participant using a pretested questionnaire that included demographic information and details of the risk factors. Risk of developing diabetes was assessed by using Indian Diabetes Risk Score. Results are expressed as proportions, and analysis was done using Chi-square test and multiple logistic regression analysis. **Results:** The mean age of participants was 44.3 ± 8.7 years. The proportion of low, moderate, and high risk of developing diabetes mellitus was 7%, 63%, and 30%, respectively. The prevalence of newly diagnosed cases was 10.25%. Moreover, 57.1% of them with positive family history were in the high risk category; 76.9% of the sedentary workers were at higher risk; overweight and obese individuals had higher proportion of the high and moderate risk ($P < 0.0001$). Correlation coefficient (R) was 0.782, and coefficient of determination (R^2) was 0.61. **Conclusions:** Our study demonstrated that advancing age, low physical activity, family history, overweight, and obesity were the prominent factors that predicted the risk of diabetes in the near future. Hence, focused interventions for urban slum dwellers are imperative and draw special attention.

Keywords: Community based, diabetes mellitus, focused interventions, Indian Diabetes Risk Score, risk, urban slum

Introduction

Globe is witnessing a rapid socioeconomic and epidemiological transition. As a result of this transition, there is a reversal trend in terms of communicable diseases; whereas, the noncommunicable diseases such as cardiovascular diseases, diabetes mellitus (DM), and obesity are taking the toll of major mortality and morbidity. This is evident across all the regions, ethnic and classes of people.[1] Lack of effective health programs for primordial and primary prevention of these diseases and ineffective screening methods has been one of the reasons for this new epidemic in the developing world. Prevalence of DM is increasing significantly throughout the globe and especially in a developing world including India thus becoming a major public health concern. The number of individuals with diabetes mellitus in India is 40.9 million by the end of 2010, and it is predicted to increase to 69.9 million individuals by 2025 and 79.4 million individuals by 2030.[2]

The incidence and prevalence of diabetes mellitus and its risk factors vary across different geographical locations in India.

Address for correspondence: Dr. Avinash Kavi, Department of Community Medicine, Jawaharlal Nehru Medical College, KLE Academy of Higher Education and Research, Nehru Nagar, Belagavi - 590 010, Karnataka, India. E-mail: dravinashkavi@gmail.com

Access this article online

Quick Response Code:

Website: www.jfmpc.com

DOI: 10.4103/jfmpc.jfmpc_388_18

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Oruganti A, Kavi A, Walvekar PR. Risk of developing Diabetes Mellitus among urban poor South Indian population using Indian Diabetes Risk Score. J Family Med Prim Care 2019;8:487-92.

Numerous studies in India have shown that the prevalence of diabetes is more in urban regions than in rural regions.[2] The prevalence diabetes is also noticed to be more among south Indians than in north Indians.[3] Diabetes causation is multifactorial and includes genetic factors coupled with environmental influences such as obesity associated with rising living standards, steady urban migration, and lifestyle changes, which has resulted in a rapid increase in its prevalence.[3-5] Madras Diabetic Research Foundation has proposed a score called "Indian Diabetes Risk Score" (IDRS).[4] This Technique will enable the family physicians to stratify the risk for DM and will aid the proper management to deliver appropriate health care services at primary care level to the targeted populations in a cost-effective manner.

In the current decade, the migration of rural community to the urban area has resulted in an increase in the proportion of urban slum residents. They lack all the basic amenities that are available for urban people, and they lack the natural benefits that people who stay in rural places enjoy. So adding up all these factors, they constitute "vulnerable population." Family physicians are the primary contact of care for these groups of individuals. Studies done in north India showed increase in prevalence of risk factors for diabetes among the urban slum residents.[6,7] A study done in urban slums of Chennai city showed prevalence of diabetes to be 20.8%.[8] Due to epidemiological and social transition, people living in urban slums will continue to increase in India with unplanned urbanization and rural unemployment.[9,10] Therefore, tools such as IDRS will help us in formulating effective screening strategies to unmask the hidden burden of this disease and also help us use our resources in a cost-effective manner. Hence, this study focuses on assessment of the risk of developing diabetes and its prevalence among urban poor south Indian population using IDRS.

Materials and Methods

The community-based cross-sectional study was conducted in a settled slum of Rukmini Nagar area under city corporation limits of Belagavi city, Karnataka. The sample size was calculated using the formula: $n = 4pq/d^2$. By taking prevalence of overweight and obesity as 57.3% (one of the important risk factors for diabetes mellitus)[8] and absolute error of 5%, the total sample size obtained was (n) = 392, rounded off to 400. Adults aged between 30 and 60 years and who were residing in the urban slum of Rukmini Nagar area for ≥1 year were included in the study. Persons already diagnosed with diabetes mellitus in the past were excluded. Sampling frame was prepared by enlisting all the adults aged between 30 and 60 years residing in the urban slum of specified area using voters list. By using random number table, study subjects were selected by simple random sampling method.

Data were collected after taking written informed consent from each participant. Ethical clearance was obtained from the Institutional Ethics Committee of Jawaharlal Nehru Medical College, KLE Academy of Higher Education and Research, Belagavi. Data collection instrument used was a pretested questionnaire that included demographic information and details of the risk factors for diabetes mellitus viz. family history of diabetes mellitus, tobacco and alcohol use, diet, and physical activity.

Physical measurements including height, weight, waist and hip circumferences, and body mass index (BMI) were calculated. Based on WHO and International Obesity Task Force BMI cut-off standards for Asians, obesity was defined as BMI ≥25.0 kg/sq.m.[11] Blood pressure was measured twice using mercury sphygmomanometer, 5 min apart and average of both readings was noted. Systolic blood pressure >140 mm of Hg and diastolic blood pressure >90 mm of Hg were classified as hypertensive.[12] Random blood glucose levels were measured by using capillary blood.[13] Participants with blood glucose levels more ≥200 mg/dL were considered to be newly diagnosed as diabetic.[14]

Risk of developing diabetes was assessed by using IDRS including scores for each of the risk factors as given in the chart below.[4] Age was categorized into three groups: participants with age <35 years was scored as 0, 35–49 years as 10, and ≥50 years as 20. Abdominal obesity was scored based on gender; Males: Individuals with waist circumference ≥90–99 cm as 10, those with ≥100 cm as 20, and the rest as 0; Females: individuals with waist circumference ≥80–89 cm as 10, those with ≥90 cm as 20, and the rest as 0. Family history of diabetes was scored as follows: individuals with no family history of diabetes were 0, those with one diabetic parent as 10, and those with both parents diabetic as 20. For physical activity, individuals were scored as 0 if they did leisure time exercise and in addition had physically demanding work in their occupation; individuals who either did exercise or performed physically demanding work were scored as 10 and the rest as 20. The participants were classified based on the total scores as follows: Score ≥60: Very HIGH RISK of having diabetes; Score 30–50: The risk of having diabetes is MODERATE, and Score <30: Risk of having diabetes is probably LOW.[4] Health education was given to the persons, who are found to be having high risk of developing diabetes, and participants with blood glucose level ≥200 mg/dL were referred to tertiary care hospital attached to the medical college, for further evaluation and appropriate management [Table 1].

Data were expressed as proportions. Statistical analysis was done using the Statistical Package for Social Sciences (SPSS) Software version 21.0. Chi-square test was used for the categorical variables. Multiple logistic regression analysis was done using newly detected diabetes as the dependent variable and the various risk factors as independent variables to obtain the risk scores. Correlation coefficient and Beta coefficient were calculated. "P" value ≤0.05 was considered as statistically significant.

Results

In the study, men constituted 38% (152) and women constituted 62% (248) of the participants. Most study participants were self-employed (48.5%) followed by homemakers (39.0%).

Considering the highest level of education of the study participants, nearly half of the study participants did not receive any kind of formal education (49.5%), and only 4.5% of them were graduates. Among the participants, 28 (7.0%) of them had low risk of developing DM; most of them, that is, 252 (63.0%) were in the moderate risk category, and 120 (30.0%) of them were in the high risk category.

The mean age of the study participants was 44.3 ± 8.7 years. Age distribution of the study participants was as follows: 48.5% of them were between 31 and 40 years, 25.0% of them were between 41 and 50 years, and 26.5% of them were between 51 and 60 years. Among the participants, 14% had a family history of DM. Among them, 75.5% had single parental history, 13.2% of them had both parents with diabetes, and 11.3% of them had positive history among their siblings. Overweight and obesity constituted important risk factors for diabetes and were assessed using BMI categories. Moreover, 36.5% of them were obese, 23.0% of them were overweight, 33.0% of them had normal weight, and 7.5% of them were underweight. Job-related physical activity was assessed among the participants as follows: 19.5% of them were sedentary, 66.5% were involved in moderate activity, and 14.0% of them were vigorous workers. Newly diagnosed diabetics (Random Blood Sugar (RBS) ≥ 200 mg/dL) were 41 (10.25%).

Table 1: Details of Indian diabetes risk score assessment[4]

Particulars of IDRS	Score
Age (years)	
<35	0
35-49	20
>50	30
Abdominal obesity	
Waist<80 cm (female), <90 cm (male)	0
Waist>80-89 cm (female), 90-99 cm (male)	10
Waist>80-89 cm (female), 90-99 cm (male)	20
Physical activity	
Exercise regular + strenuous work	0
Exercise regular or strenuous work	20
No exercise or sedentary work	30
Family history	
No family history	0
Either parent	10
Both parents	20
Minimum score	0
Maximum score	100

When risk categories were cross tabulated with age group, it was found that the risk of developing diabetes increases with increasing age. This was well evident that 71.7% of the participants between 51 and 60 years were in the high risk category as compared to 7.2% of them in the age group of 31–40 years. This difference was found to be statistically significant ($P < 0.0001$). Family history of diabetes was an important predictor of diabetes occurrence. Moreover, 57.1% of the individuals with positive family history were in the high risk category, and 32.2% of them were in the moderate risk category. This difference was found to be statistically significant ($P < 0.0001$) [Table 2].

Sedentary activity is an important risk factor for diabetes. In our study, 76.9% of the sedentary workers were at high risk of developing diabetes as compared to vigorous workers, where only 3.6% of them were in the high risk. This difference was found to be statistically significant ($P < 0.0001$). In our study, the proportion of the individuals with high and moderate risk was more with overweight and obese individuals, and this difference was found to be statistically significant ($P < 0.0001$) [Table 3].

The correlation coefficient for the multiple logistic regression analysis using newly detected diabetes as the dependent variable and the various risk factors as independent variables was 0.782. Coefficient of determination was 0.61. Thus, the IDRS will predict the diabetes in 61.0% of the individuals with these risk factors. Among the risk factors, lack of physical activity (26.48%) and the advancing age (25.41%) are the best predictors as compared to BMI (6.79%) and family history (3.06%). P value was < 0.001 at 95% confidence interval for all the variables [Table 4].

The prevalence of tobacco use among the study participants in any form was found to be 43.5% (174). Among them, 85.0% (148) used smokeless forms of tobacco viz. chewing tobacco and ghutka were the common ones. Among the study participants, 14.0% (56) consumed alcohol and among them 53.6% (30) consumed more than five times a week. Prevalence of systolic hypertension was found to be 20.0% and diastolic hypertension was found to be 31.5%.

Discussion

The study used the IDRS to identify the individuals at risk for diabetes and to determine the association of various risk factors with their risk status. IDRS is a cost-effective, simple, noninvasive,

Table 2: Association between IDRS risk categories with participants age and family history of diabetes mellitus (n=400)

Risk factors	Low risk (%)	Moderate risk (%)	High risk (%)	Total (%)	χ^2	*P*
Age categories (in years)						
31-40	22 (11.3)	158 (81.4)	14 (7.2)	194 (100)	138.60 (Df=4)	<0.0001
41-50	4 (4.0)	66 (66.0)	30 (30.0)	100 (100)		
51-60	2 (1.9)	28 (26.4)	76 (71.7)	106 (100)		
Family history of diabetes mellitus						
Present	6 (10.7)	18 (32.2)	32 (57.1)	56 (100)	27.11 (Df=2)	<0.0001
Absent	22 (6.4)	234 (68.0)	88 (25.6)	344 (100)		

Table 3: Association between IDRS risk categories with job-related physical activity and BMI of the participants (*n*=400)

Risk factors	Low risk (%)	Moderate risk (%)	High risk (%)	Total (%)	χ^2	*P*
Job-related physical activity						
Sedentary	4 (5.1)	14 (18.0)	60 (76.9)	78 (100)	187.16 (Df=4)	<0.0001
Moderate	4 (1.5)	204 (76.7)	58 (21.8)	266 (100)		
Vigorous	20 (35.7)	34 (60.7)	2 (3.6)	56 (100)		
BMI categories (kg/m^2)						
Underweight (<18.5)	8 (26.7)	18 (60.0)	4 (13.3)	30 (100)	35.39 (Df=6)	<0.0001
Normal (18.5-22.9)	14 (10.6)	80 (60.6)	38 (28.8)	132 (100)		
Overweight (23.0-24.9)	4 (4.3)	66 (71.8)	22 (23.9)	92 (100)		
Obese (≥25.0)	2 (1.4)	88 (60.3)	56 (38.3)	146 (100)		

Table 4: Multiple logistic regression analysis of the risk factors and the IDRSs

Risk factor variables	Unstandardized coefficients		Standardized coefficients	*t*	*P*	95.0% confidence interval for B	
	B	Std. error	Beta			Lower bound	Upper bound
(Constant)	14.63	5.108	-	2.86	0	4.58	24.67
Age	0.76	0.07	0.404	11.38	0.0001	0.62	0.89
BMI	0.90	0.13	0.213	6.75	0.0001	0.64	1.17
Physical activity	−12.23	1.01	−0.430	−12.16	0.0001	−14.21	−10.25
Family history	5.58	1.17	0.150	4.77	0.0001	3.28	7.87

and accurate tool for screening of diabetes, which can be used at the community and the primary care settings.[15] The assessment at primary care level is imperative to stratify the persons with risk factors and decide the accessibility and affordability, so as to implement the primary preventive strategies.

This study also elucidates the need for assessment of risk for type 2 diabetes in urban slum dwellers. Comparing the risk categories with a study done by Choudary R, *et al.*, 46% had moderate risk (IDRS: 30–50), 31.5% had high risk (IDRS ≥60), and 22.5% had low risk (IDRS <30). Moreover, when compared to our study, participants with low risk were 6%, 64% had moderate risk, and 30% were at high risk.[16] Similar findings were published by Gupta SK, *et al.*, who reported that 31.2% of the population in urban Pondicherry had a high risk score.[17] A study conducted in an Urban Resettlement Colony of Delhi reported a lower proportion (5.3%) of low risk and 94.6% of the individuals with moderate and high risk.[18] Although both results were similar, our study had more participants with moderate risk followed by high risk. However, study conducted in the urban slums of Pune by Dudeja P, *et al.*, reported a higher proportion (77.4%) of high risk individuals.[15]

In our study, 36.5% of participants were obese and 23.0% of them were overweight. The INDIAB (India-Diabetes) Study done in four states revealed a similar prevalence of generalized obesity in Tamil Nadu state, 31.3%.[19] However, our study involved more number of female participants, and most of them were homemakers. In a study on derivation and validation of diabetes risk score for urban Asian Indians by A Ramachandran *et al.*, it was proved that a low risk threshold for age, BMI, upper body adiposity, and a high propensity of familial aggregation of diabetes are well known in Indians, which was consistent with our study.[20]

The proportion of newly diagnosed diabetes among the urban slum dwellers in our study was lower (10.25%) as compared to a similar study done by Vigneswari A, *et al.* (20.8%) in Chennai and Dudeja P, *et al.* in Pune.[8,15] However, this does not represent the true prevalence as all the known diabetic patients were excluded. Also, in another study done in urban slums of Bangalore, the prevalence was 12.33%.[21] Moreover, in a similar study done in Pune urban slum dwellers, the prevalence of newly diagnosed diabetes was 9.88%.[22] Study conducted in the North Indian state of Punjab reported the prevalence to be 8.3%.[23] There was a wide variation in the prevalence of diabetes in various urban slums probably due to different demographic profiles.

Our study demonstrated that the risk of developing diabetes increases with increasing age. It was evident as more number of individuals in the age group of 51–60 years were in the high risk category (71.7%), and was consistent with the study conducted in the urban slums of Pune.[22] Family history of diabetes was an important predictor of diabetes mellitus. Studies done at Bengaluru and Pune showed significant association of family history and risk of diabetes ($P < 0.05$).[21,22] Our study findings were consistent with both of these studies. In our study, 76.9% of the sedentary workers were at high risk of developing diabetes as compared to vigorous workers, and 3.6% of them were in the high risk category. Two studies conducted in Pune also demonstrated that sedentary activity is an important risk factor for diabetes.[15,22] The proportion of the individual with high and moderate risk was more with overweight and obese individual in our study, which also showed the significant difference among the groups. The chance of diabetes risk score was low (6.38%) among individuals who are underweight than obese (44.54%) with a statistical significant difference in the study done by Gupta SK, *et al.*[17] Similarly, study conducted in

Lucknow by Khan MM, *et al.*, also suggested the association of risk of diabetes with BMI.[24]

Multiple logistic regression analysis of the risk factors as the independent variables predicted 61.0% of the diabetes risk among the undiagnosed individuals. Physical activity and advancing age were the best predictors, and this finding was consistent with the study done among urban slum residents in Pune.[25] However, a study conducted in the urban area of Rohtak, by Rajput M, *et al.*, reported that the age, family history of diabetes, and BMI were independent predictors of diabetes.[26]

The prevalence of tobacco use among the study participants in any form was found to be 43.5%. A study done by Gupta A, *et al.*, also showed a similar overall prevalence of tobacco usage of 41.0%, with higher proportion of use of smoking form unlike in our study 85.0% of them used smokeless forms of tobacco.[25] Prevalence of systolic hypertension was found to be 20.0% and that of diastolic hypertension was found to be 31.5%. In a study done in Chennai reported an overall prevalence of hypertension as 24.2%.[8] The risk factor assessment and stratification at the primary care level especially in the urban slums will complement the appropriate referral to the higher care and thereby combat the rising burden of diabetes mellitus.

Limitations

Only one slum of a single urban area was selected due to constraints of time and resource; hence, the results cannot be generalized. Fasting and postprandial blood glucose estimation would have been better predictors for the estimation of prevalence of diabetes as well as prediabetes (Impaired Fasting Glucose and Impaired Glucose Tolerance) that could not be measured.

Implications

Urban slum dwellers lack the health care benefits available in urban area due to a variety of constraints including the low socioeconomic status and lack of education. The results of this study have provided necessary inputs to categorize individuals with risk factors and to assess the risk of developing diabetes mellitus using a simple, safe, and inexpensive tool. Moreover, it will also act as a guiding tool for the primary care physicians to do selective screening instead of universal screening. Thus, targeted interventions can be undertaken to minimize modifiable risk factors and hence combat the problem of increasing diabetes-related mortality and morbidity in the economically disadvantaged group of the society.

Conclusions

Diabetes mellitus is no more a "rich man's disease." Our study demonstrated higher proportion of moderate and high risk of diabetes using IDRS. Advancing age, low physical activity, family history of diabetes, overweight, and generalized obesity were the prominent factors associated in predicting the risk of diabetes in the near future. Our study also demonstrated the ease of use of IDRS for risk prediction in the community-based settings. Furthermore, our study throws light on the need for the "focused interventions" for urban slum dwellers, as they are also at a higher risk for developing diabetes mellitus.

Ethical approval

Ethical clearance was obtained from the Institutional Ethics Committee of Jawaharlal Nehru Medical College KLE Academy of Higher Education and Research, Belagavi (Ref. No. MDC/DOME/502 dated 18.03.2016). All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed written/thumb print consent was obtained from all respondents after a full explanation of the nature, purpose, and procedures used for the study.

Acknowledgements

We acknowledge the support of the health assistants and staff of Urban Primary Health Centre, Rukmini Nagar for their support and assistance in data collection.

Author contributions

AK developed the protocol, conceptualized the project design, analyzed and interpreted the data, and drafted the article; AO developed the idea, collected the data, and assisted in analysis and writing the manuscript; PRW supervised and monitored all aspects of this study and revised the manuscript critically for important intellectual content, and finally approved the version to be published. All authors have read and approved the final draft of the manuscript.

Financial support and sponsorship

Indian Council of Medical Research (ICMR), New Delhi.

Conflicts of interest

There are no conflicts of interest.

References

1. Sicree R, Shaw J, Zimmet P. Diabetes and impaired glucose tolerance. Diabetes Atlas. International Diabetes Federation. 3rd ed. Belgium: International Diabetes Federation; Vol. 2, 2006. p. 15-23.
2. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes estimates for the year 2000 and projections for 2030. Diabetes Care 2004;27:1047-53.
3. Kaveeshwar SA, Cornwall J. The current state of diabetes mellitus in India. Australas Med J 2014;7:45-8.
4. Mohan V, Deepa R, Deepa M, Somannavar S, Datta M. A simplified Indian diabetes risk score for screening for undiagnosed diabetic subjects. J Assoc Physician India 2005;53:759-63.
5. Mohan V, Shanthirani S, Deepa R, Premalatha G, Sastry NG, Saroja R, *et al.* Intra-urban differences in the prevalence

of the metabolic syndrome in southern India-the Chennai Urban Population Study (CUPS No. 4). Diabet Med 2001;18:280-7.

6. Anand K, Shah B, Yadav K, Singh R, Mathur P, Paul E, *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;20:115-9.
7. Singh R, Mukherjee M, Kumar R, Singh R, Pal R. Study of risk factors of coronary heart disease in urban slums of Patna. Nepal J Epidemiol 2012;2:205-12.
8. Vigneswari A, Manikandan R, Satyavani K, Archana S, Rajeswari R, Viswanathan V. Prevalence of risk factors of diabetes among urban poor south Indian population. J Assoc Physicians India 2015;63:32-4.
9. Roglic G. The burden of mortality attributable to diabetes: Realistic estimates for the year 2000. Diabetes Care 2005;28:2130-5.
10. Mohan V, Mathur P, Deepa R, Deepa M, Shukla DK, Menon GR, *et al.* Urban rural differences in prevalence of self-reported diabetes in India- the WHO- ICMR Indian NCD risk factor surveillance. Diabetes Res Clin Pract 2008;80:159-68.
11. Redefining obesity and its treatment. Asia – Pacific perspective. Available from: http://www.wpro.who.int/internet/resources.ashx/NUT/Redefining and obesity.pdf. [Last accessed on 2018 Aug 08].
12. Venkata SR. Hypertension guidelines: Good-bye to confusion and welcome to clarity. Indian Heart J 2015;67:18-22.
13. Miranda P, Anjana RM, Pradeepa R, Jayashri R, Deepa M, Bhansali A, *et al.* Comparison of capillary whole blood versus venous plasma glucose estimations in screening for diabetes mellitus in epidemiological studies in developing countries. Diabetes Technol Ther 2011;13:1-6.
14. Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia: Report of a WHO/IDF Consultation. Geneva, World Health Organization; 2006. p. 39.
15. Dudeja P, Singh G, Gadekar T, Mukherji S. Performance of Indian Diabetes Risk Score (IDRS) as screening tool for diabetes in an urban slum. Med J Armed Forces India 2017;73:123-8.
16. Chowdhury R, Mukherjee A, Saibendu LK. A study on distribution and determinants of Indian diabetic risk score (IDRS) among rural Population of West Bengal. Natl J Med Res 2012;2:282-7.
17. Gupta SK, Singh Z, Purty AJ, Vishwanathan M. Diabetes prevalence and its risk factors in urban Pondicherry. Int J Diabetes Dev Ctries 2009;29:166-9.
18. Acharya AS, Singh A, Dhiman B. Assessment of diabetes risk in an adult population using Indian diabetes risk score in an urban resettlement colony of Delhi. J Assoc Physicians India 2017;65:46-51.
19. Pradeepa R, Anjana RM, Joshi SR, Bhansali A, Deepa M, Joshi PP, *et al.* Prevalence of generalized & abdominal obesity in urban & rural India-the ICMR-INDIAB study (phase-I) [ICMR-INDIAB-3]. Indian J Med Res 2015;142:139-50.
20. Ramachandran A, Snehalata C, Vijay C, Wareham NJ, Colagiuri S. Derivation and validation of diabetes risk score for Urban Asian Indians. Diabetes Res Clin Pract 2005;70:63-70.
21. Dasappa H, Farah NF, Rugmani P, Sarin S. Prevalence of diabetes and pre-diabetes and assessments of their risk factors in urban slums of Bangalore. J Family Med Prim Care 2015;4:399-404.
22. Patil RS, Gothankar JS. Assessment of risk of type 2 diabetes using the Indian diabetes risk score in an urban slum of Pune, Maharashtra, India: A cross-sectional study. WHO South-East Asia J Public Health 2016;5:53-61.
23. Tripathy JP, Thakur JS, Jeet G, Jain S. Structural equation modeling to identify the risk factors of diabetes in the adult population of North India. Trop Med Health 2018;46:23.
24. Khan MM, Sonkar GK, Alam R, Mehrotra S, Khan MS, Kumar A, *et al.* Validity of Indian diabetes risk score and its association with body mass index and glycosylated hemoglobin for screening of diabetes in and around areas of Lucknow. J Family Med Prim Care 2017;6:366-73.
25. Gupta A, Gupta R, Sharma KK, Lodha S, Achari V, Asirvatham AJ, *et al.* Prevalence of diabetes and cardiovascular risk factors in middleclass urban participants in India. BMJ Open Diabetes Res Care 2014;2:1-9.
26. Rajput M, Garg D, Rajput R. Validation of simplified Indian diabetes risk score for screening undiagnosed diabetes in an urban setting of Haryana. Diabetes Metab Syndr 2017;11(Suppl 2):S539-42.