Recalibrating the Non-Communicable Diseases Risk Prediction Tools for the Rural Population of Western India

Manoj Kumar Gupta (✉ drmkgbhu@gmail.com)

All India Institute of Medical Sciences

Pankaja Raghav

All India Institute of Medical Sciences

Tooba Tanvir

All India Institute of Medical Sciences

Vaishali Gautam

All India Institute of Medical Sciences

Amit Mehto

Veer Chandra Singh Garhwali Govt. Institute of Medical Science & Research

Yachana Choudhary

All India Institute of Medical Sciences

Ankit Mittal

All India Institute of Medical Sciences

Gyanendra Singh

All India Institute of Medical Sciences Bhopal

Garima Singh

All India Institute of Medical Sciences

Pritish Baskaran

All India Institute of Medical Sciences

Rehana VR

All India Institute of Medical Sciences

Shaima Abdul Jabbar

All India Institute of Medical Sciences

S Sridevi

All India Institute of Medical Sciences

Akhil Dhanesh Goel

All India Institute of Medical Sciences

Pankaj Bhardwaj

All India Institute of Medical Sciences

Suman Saurabh

All India Institute of Medical Sciences

S Srikanth

All India Institute of Medical Sciences

Naveen KH

All India Institute of Medical Sciences

T Prasanna

All India Institute of Medical Sciences

Neeti Rustagi

All India Institute of Medical Sciences

Prem Prakash Sharma

All India Institute of Medical Sciences

Research Article

Keywords: NCD, Diabetes, Hypertension, CVD, IDRS, CBAC, BMI, Waist Hip Ratio

Posted Date: September 22nd, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-657433/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Version of Record: A version of this preprint was published at BMC Public Health on February 22nd, 2022. See the published version at <https://doi.org/10.1186/s12889-022-12783-z>.

Abstract

Background: The present study was conducted to recalibrate the effectiveness of Indian Diabetes Risk Scores (IDRS) and Community-Based Assessment Checklist (CBAC) by opportunistically screening for Diabetes Mellitus (DM) and Hypertension (HT) among the patients attending health centres, and to estimate the risk of fatal and non-fatal Cardio-Vascular Diseases (CVDs) using WHO/ISH chart

Methods: All the people of age ≥ 30 years attending the health centers were screened for DM and HT. Weight, height, and waist and hip circumferences were measured and BMI and Waist Hip Ratio (WHR) were calculated. Risk categorization of all participants was done using IDRS, CBAC, and WHO/ISH risk prediction charts. Individuals diagnosed with DM or HT were started on treatment. The data was recorded using Epicollect5 and was analyzed using SPSS v.23 and MedCalc v.19.8. ROC curves were plotted for DM and HT with the IDRS, CBAC score and anthropometric parameters. Sensitivity (SN), specificity (SP), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Accuracy and Youden's index were calculated for different cut-offs of IDRS and CBAC scores.

Results: A total of 942 participants were included for the screening, out of them, 6.42 % (95% CI: 4.92-8.20) were diagnosed with DM. Hypertension was detected among 25.7% (95% CI: 22.9-28.5) of the participants. A total of 447 (47.3%) participants were found with IDRS score ≥ 60 , and 276 (29.3%) with CBAC score >4 . As much as 26.1% were at moderate to higher risk ($\geq 10\%$) of developing CVDs. Area Under the Curve (AUC) for IDRS in predicting DM was 0.64 (0.58-0.70), with 67.1% SN and 55.2% SP (Youden's Index= 0.22). While the AUC for CBAC was 0.59 (0.53-0.65). For hypertension the both the AUCs were 0.66 (0.62-0.71) and 0.63 (0.59-0.67), respectively.

Conclusions: Instead of CBAC, the present study emphasizes the usefulness of IDRS as an excellent tool for screening for both DM and HT. This is the time to expose the hidden part of the NCDs iceberg by having high sensitivity of non-invasive instruments (like IDRS), so, we propose a cut-off value of 50 for the IDRS to screen for diabetes in the rural Indian population.

Background

India has been described as the diabetic capital of the world. It is home to 19% of the total world's diabetic population. In terms of absolute numbers is expected to rise to 69.9 million by 2025 and 80 million by 2030.(1) Unfortunately, these figures are just the tip of the iceberg as more than half of the diabetics in the country remain undiagnosed.(2) This increases the risk of developing diabetic complications. The ICMR-INDIAB (ICMR-India Diabetes) study has reported that the ratio of undiagnosed to diagnosed diabetes (DM) is higher in rural areas as compared to urban areas.(3) This highlights the importance of mass awareness, screening and early interventions at the community level.

The Government of India has already started opportunistic screening of major Non-Communicable Diseases (NCDs) under the National Programme for Prevention & Control of Cancer, Diabetes, Cardiovascular Diseases & Stroke (NPCDCS). The Indian Diabetes Risk Score (IDRS), which is based on two modifiable (waist circumference and physical inactivity) and two non-modifiable (age and family history of diabetes) known risk factors of DM, was developed at the Madras Diabetes Research Foundation (MDRF), Chennai. It has emerged as a simple and cost-effective tool to predict undiagnosed diabetes. It has a sensitivity of 72.5% and a specificity of 60.1%.(4) Several other studies have also validated the sensitivity, specificity and accuracy of IDRS.(5, 6)

In India, a Community Based Assessment Checklist (CBAC) is used under NPCDCS to identify high-risk individuals for Non-Communicable Diseases (NCDs).(7) It is based on four modifiable (smoking, alcohol, waist circumference and physical inactivity) and two non-modifiable (age and family history of blood pressure/DM/heart disease) known risk factors of NCDs. Grassroots level health workers widely use this checklist, but literature supporting effectiveness is sparse.

Cardiovascular diseases (CVDs) accounts for near about half of all NCDs-related deaths.(8) It has been consistently proved in the scientific literature that risk factor identification and reduction is a comparatively better strategy for reducing mortality due to CVDs rather than its diagnosis and treatment (secondary prevention).(9–11) In this regard, the World Health Organization (WHO) and the International Society of Hypertension (ISH) have developed risk prediction charts to estimate the total 10-year risk of CVDs.(12) These are simple color-coded charts that can be used by frontline health workers in field settings.

In order to explore the ever increasing burden of NCDs, it is essential to identify the hidden spectrum with the help of simple, non-invasive screening tools, tailored for the general population. In this regard, various available tools (IDRS, CBAC and WHO/ISH) should be validated according to different geographical locations in a large country like India. Therefore, the present study was conducted to recalibrate the effectiveness of IDRS and CBAC by opportunistically screening for DM and hypertension (HT) among the patients attending health centers, and to estimate the risk of fatal and non-fatal CVDs using WHO/ISH chart.

Methods

This hospital-based cross-sectional study was carried out from January to December 2019 in the three Rural Health Training Centres (RHTCs) of the Department of Community Medicine and Family Medicine at a tertiary care hospital of Jodhpur, India. Out of these three centers, one is Community Health Centre (CHC) and the other two are Primary Health Centres (PHCs). The catchment areas of all the three health centres serve approximately

one lakh sixty thousand population. All the patients of age ≥ 30 years attending these health centres for various ailments were included in the study. Already diagnosed patients of diabetes mellitus type 1 or type 2 or hypertension, pregnant females, and those not willing to give consent were excluded from the study.

Screening of DM was done through Random Capillary Blood Glucose (RCBG). Those with a blood glucose of more than 140 mg/dl were sensitized about their risk to acquire diabetes and were asked to attend the health center the subsequent day for Fasting Plasma Glucose (FPG) after maintaining at least 8 hours of fasting (13). RCBG and FPG were assessed using glucometer by pricking the pulp of the left ring finger with a sterile lancet after applying the spirit swab. DM was diagnosed when a participant had an FPG level of ≥ 126 mg/dl. Prediabetes was diagnosed if the FPG value was 110–125 mg/dl.

Blood Pressure (BP) was measured using digital blood pressure monitor. It was ensured that the participants had not consumed caffeine or tobacco or exercised in the last 30 minutes and that the patient has been sitting still for the past 5 minutes. To assess BP, the patients were asked to sit with their back straight, feet flat and legs uncrossed with their arm on a flat surface at the heart level and two blood pressure reading were taken at 1-minute interval using a cuff of appropriate size and the average of the two readings was taken as the blood pressure reading of the subject. Hypertension was diagnosed using the Joint National Committee (JNC) VIII criteria (14). Those with systolic BP ≥ 140 mmHg and/or diastolic ≥ 90 mmHg were diagnosed as hypertensive.

A pre-validated and pretested (through a pilot study on 30 participants in a non-study area) interview schedule was administered to collect the information about sociodemographic details and risk factors for diabetes and hypertension. Risk assessment of obesity was done by measuring weight of all the participants with the help of a digital weighing machine, height with a stadiometer, and waist and hip circumferences with the help of a measuring tape. BMI and Waist Hip Ratio (WHR) were calculated. Asian cut-off for BMI was used categorizing it into three categories: <18.5 underweight, 18.5–22.9 (normal), 23–24.9 (overweight), and ≥ 25 (obese). (15)

Risk categorization of all participants was done using three instruments; IDRS, CBAC, and WHO/ISH risk prediction charts for 10-year risk of fatal or non-fatal cardiovascular event. In IDRS the total score ranges between 0 and 100 and based on the score the participants were categorized as low risk (<30), moderate risk (30–50), and high risk (≥ 60) (16). In CBAC a score above 4 indicates a higher risk of developing NCDs (13). WHO/ISH chart for SEAR (D) of WHO epidemiological sub-region was used to estimate the total 10-year risk of CVD of all participants. The chart is used to stratify an individual into one of the possible 5 categories: less than 10%; 10 to $<20\%$; 20 to $<30\%$; 30 to $<40\%$; and $\geq 40\%$.

All the data was recorded using Epicollect5 developed by Imperial College, London. Data was analyzed using SPSS v.23 and MedCalc v.19.8. Descriptive statistics were presented in tables. ROC curves were plotted for diabetes and hypertension with the dependent variables like NCD risk scoring (IDRS, CBAC) and anthropometric parameters. Sensitivity (SN), specificity (SP), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Accuracy and Youden's index were calculated for different cut-offs of IDRS and CBAC scores.

The study was approved by Institutional Ethics Committee. Informed consent was obtained from all participants. All participants were explained about the risk factors for NCDs. Individuals diagnosed with diabetes or hypertension were started on treatment and referred to tertiary care hospital to screen for complications. These patients were given comprehensive counselling about their disease, its complication and the necessary lifestyle and dietary modification required. Pre-diabetics and pre-hypertensive were explained about their risk to develop diabetes or hypertension and were recommended frequent follow-ups.

Results

A total of 984 participants were eligible to participate, of which 942 consented to undergo the screening process (non-consent rate; 4.2%). Socio-demographic, anthropometric and risk-related variables of the participants are depicted in supplementary table 1. Of these 942 participants, 223 (23.7%) were identified as screen-positives for diabetes and were invited to undergo FPG. Out of these, 200 responded (response rate 89.6%). After excluding non-responders, the proportion of participants with prediabetes and DM was 6.42 % (95% CI: 4.92–8.20) & 9.2% (95% CI: 7.45–11.31), respectively. All the consenting participants (942) were screened for HT and 25.7% (95% CI: 22.9–28.5) were found to be suffering from HT.

A total of 447 (47.3%) study participants had a high risk of developing DM (IDRS score ≥ 60). According to CBAC score, 276 (29.3%) study participants were categorized as high-risk (CBAC score >4) for NCDs. As much as 26.1% of the participants were at moderate to higher risk ($\geq 10\%$) of developing CVDs as per WHO's risk prediction status. (Table 1)

Table 1
Risk prediction of participants according to different scores (n = 942)

Variable	Category	n (%)
IDRS	< 30	54 (5.7)
50 (IQR:40–60)	30–50	442 (46.9)
	≥ 60	446 (47.3)
CBAC	< 4	666 (70.7)
4 (IQR: 3–5)	≥ 4	276 (29.3)
WHO RISK category	< 10%	696 (73.9)
	10% to < 20%	184 (19.5)
	20% to < 30%	33 (3.5)
	30% to < 40%	12 (1.3)
	≥ 40%	17 (1.8)

Cut-off points of IDRS, CBAC scores and anthropometric parameters (WC, WHR and BMI) were estimated using ROC curves for DM, HT and any NCD (DM and/or HT). (Fig. 1)

The Area Under the Curve (AUC) and level of significance for ROC curves are depicted in Table 2.

Table 2
Area Under the Curve (AUC) and level of significance for ROC curves

Variables	Diabetes		Hypertension		Any NCD (HT or DM)	
	AUC (95% CI)	Sig.	AUC (95% CI)	Sig.	AUC (95% CI)	Sig.
IDRS	0.64 (0.58–0.70)	< 0.001	0.66 (0.62–0.71)	< 0.001	0.64 (0.60–0.67)	< 0.001
CBAC	0.59 (0.53–0.65)	0.006	0.63 (0.59–0.67)	< 0.001	0.61 (0.57–0.65)	< 0.001
WC	0.58 (0.51–0.65)	0.016	0.64 (0.60–0.68)	< 0.001	0.62 (0.58–0.66)	< 0.001
WHR	0.59 (0.53–0.66)	0.004	0.61 (0.57–0.65)	< 0.001	0.60 (0.56–0.64)	< 0.001
BMI	0.55 (0.48–0.61)	0.151	0.64 (0.60–0.68)	< 0.001	0.62 (0.58–0.66)	< 0.001

Tables 3, 4 and 5 provides the sensitivity, specificity, PPV, NPV and accuracy of different cut-offs for IDRS and CBAC for diagnosis of DM, HT and any NCD. An IDRS value ≥ 50 and CBAC value of ≥ 3 had the optimum sensitivity (89.4% and 84.7%, respectively) for determining diabetes. At the same cutoff values both the scores (IDRS and CBAC) were able to predict hypertension with the sensitivity of 82.6% and 83.9%, respectively.

Table 3
Sensitivity, Specificity, PPV, NPV, Accuracy and Youden's index of IDRS and CBAC to diagnose diabetes

Score	Screen Positive	SN (%)	SP (%)	PPV (%)	NPV (%)	Accuracy (%)	Youden's index
IDRS							
≥ 10	98.7	98.8	1.3	9.3	91.7	10.3	0.00
≥ 20	98.0	97.6	2.0	9.2	89.5	10.9	0.00
≥ 30	94.3	96.5	6.1	9.5	94.4	14.5	0.03
≥ 40	83.5	91.8	17.5	10.2	95.4	24.4	0.09
≥ 50	70.0	89.4	32.1	11.8	96.8	37.4	0.22
≥ 60	47.3	67.1	55.2	13.2	94.3	56.3	0.22
≥ 70	24.4	36.5	77.1	14.0	92.3	73.3	0.14
≥ 80	8.7	15.3	92.0	16.3	91.4	84.9	0.07
≥ 90	0.4	1.2	99.6	25.0	90.8	90.5	0.01
≥ 100	0.1	0.0	99.9	0.0	90.7	90.6	0.00
CBAC							
≥ 1	97.6	98.8	2.6	9.4	95.7	11.5	0.01
≥ 2	91.1	96.5	9.6	9.8	96.4	17.6	0.06
≥ 3	75.3	84.7	25.7	10.4	94.3	31.1	0.10
≥ 4	53.3	65.9	48.1	11.5	93.3	49.7	0.14
≥ 5	29.3	38.8	71.7	12.3	92.0	68.7	0.11
≥ 6	11.9	16.5	88.7	13.0	91.2	82.0	0.05
≥ 7	4.0	8.2	96.4	18.9	91.2	88.2	0.05
≥ 8	1.1	2.4	99.2	22.2	90.9	90.2	0.02
≥ 9	0.1	0.0	99.9	0.0	90.7	90.6	0.00

Table 4
Sensitivity, Specificity, PPV, NPV, Accuracy and Youden's index of IDRS and CBAC
to diagnose hypertension

Score	SN (%)	SP (%)	PPV (%)	NPV (%)	Accuracy (%)	Youden's index
IDRS						
≥ 10	99.6	1.6	25.9	91.7	26.8	0.01
≥ 20	99.2	2.4	26.0	89.5	27.3	0.02
≥ 30	97.5	6.9	26.6	88.9	30.1	0.04
≥ 40	90.9	19.0	28.0	85.8	37.5	0.10
≥ 50	82.6	34.4	30.3	85.2	46.8	0.17
≥ 60	63.6	58.3	34.5	82.3	59.7	0.22
≥ 70	35.5	79.4	37.4	78.1	68.2	0.15
≥ 80	12.8	92.7	37.8	75.5	72.2	0.06
≥ 90	0.0	99.4	0.0	74.2	73.9	-0.01
≥ 100	0.0	99.9	0.0	74.3	74.2	0.00
CBAC						
≥ 1	99.6	3.1	26.2	95.7	27.9	0.03
≥ 2	97.1	11.0	27.4	91.7	33.1	0.08
≥ 3	83.9	27.7	28.6	83.3	42.1	0.12
≥ 4	67.4	51.6	32.5	82.0	55.6	0.19
≥ 5	40.5	74.6	35.5	78.4	65.8	0.15
≥ 6	19.0	90.6	41.1	76.4	72.2	0.10
≥ 7	6.6	96.9	42.1	75.0	73.7	0.04
≥ 8	1.2	99.0	30.0	74.4	73.9	0.00
≥ 9	0.0	99.9	0.0	74.3	74.2	0.00

Table 5
Sensitivity, Specificity, PPV, NPV, Accuracy and Youden's index of IDRS and CBAC to diagnose any NCD (diabetes and/or hypertension)

Score	SN (%)	SP (%)	PPV (%)	NPV (%)	Accuracy (%)	Youden's index
IDRS						
≥ 10	99.3	1.6	32.0	83.3	32.7	0.01
≥ 20	98.6	2.4	32.0	78.9	33.0	0.01
≥ 30	96.9	7.1	32.7	83.3	35.7	0.04
≥ 40	90.8	19.9	34.6	82.4	42.5	0.11
≥ 50	83.4	36.2	37.8	82.4	51.2	0.20
≥ 60	63.1	60.0	42.4	77.7	61.0	0.23
≥ 70	33.9	80.3	44.4	72.3	65.5	0.14
≥ 80	11.9	92.9	43.8	69.3	67.1	0.05
≥ 90	0.3	99.5	25.0	68.2	68.0	0.00
≥ 100	0.0	99.8	0.0	68.2	68.1	0.00
CBAC						
≥ 1	99.3	3.3	32.4	91.3	33.8	0.03
≥ 2	96.6	11.5	33.7	88.0	38.6	0.08
≥ 3	83.1	28.3	35.1	78.2	45.7	0.11
≥ 4	65.4	52.4	39.1	76.5	56.6	0.18
≥ 5	38.6	75.0	41.9	72.4	63.5	0.14
≥ 6	17.6	91.0	47.7	70.3	67.7	0.09
≥ 7	6.1	97.0	48.6	68.9	68.1	0.03
≥ 8	1.0	99.1	33.3	68.2	67.9	0.00
≥ 9	0.0	99.8	0.0	68.2	68.1	0.00

Discussion

In this study, facility-based opportunistic screening of rural people of Western Rajasthan was conducted for DM and HT to estimate the proportion of newly diagnosed cases. The ten-year CVD risk of the participants was assessed using WHO's risk prediction charts. The prediction capacity of the IDRS and CBAC scores was recalibrated to screen for DM and HT, and the appropriate cut-offs were determined.

In our study, AUC for IDRS score in predicting DM was 0.64 (95%CI: 0.58–0.70), with 89.4% sensitivity and 32.1% specificity at the cut-off of ≥ 50 , and with 67.1% sensitivity and 55.2% specificity at the cut-off of ≥ 60 . Both the cut-offs were having the same Youden's Index (0.22). A large population-based study in the Indian urban and rural population has shown a 72.5% sensitivity and 60.1% specificity for the score of ≥ 60 .(4) Another study conducted in an urban slum in India has depicted the sensitivity of 95.12% and specificity of 28.9% at ≥ 60 scores.(17) Bhadoria et al. in their study among the adult population in central India recommended the IDRS cut-off value of 40 with a sensitivity, specificity, and Youden index of 60.4%, 70.7%, and 0.31, respectively.(18)

Though IDRS score is traditionally used for screening for Diabetes, in the present study we demonstrated its application in screening for hypertension (AUC: 0.66, 95% CI:0.62–0.71) with 82.6% sensitivity and 34.4% specificity at the cut-off of ≥ 50 (Youden's Index, 0.17), and 63.6% sensitivity and 58.3% specificity at the cut-off of ≥ 60 (Youden's Index, 0.22). There is a lack of scientific literature exploring the prediction capacity of IDRS for other NCD. The association of IDRS with hypertension has been reported in the Indian setting by Garg et al(19).

The findings of the present study depict that, the CBAC score, which is widely used by the frontline health worker in India to screen for NCDs, poorly predicted DM (AUC:0.59, 95% CI:0.53–0.65), hypertension (AUC:0.63, 95% CI:0.59–0.67) as well as any NCD (AUC:0.61, 95% CI:0.57–0.65) as compared to IDRS (AUC for any NCD:0.64, 95%CI:0.60–0.67). There is a dearth of scientific evidence exploring the prediction capacity of CBAC, thus making comparison difficult. The CBAC checklist includes additional questions on tobacco and alcohol use as compared to IDRS. The greater predictive accuracy of IDRS could be attributed to relatively higher importance given to age, family history, physical activity and central obesity as

compared to the role of tobacco and alcohol use in the causation of NCDs. Further, both the amount and frequency of alcohol and tobacco use would be important, which is not captured in CBAC. Nevertheless, tobacco use has an important role when predicting the risk of cardiovascular events and mortality.

Near about one-fourth of the participants were at moderate to a higher risk of developing CVDs as per WHO's risk prediction charts. The application of WHO's CVD risk prediction charts for the Indian population has been studied by many authors in different parts of the country. The finding of the present study is in accordance with the findings reported by Deori T.J. et.al. in a rural population of Central India (23.1%) and Raghu A et. Al. in the rural part of South India (25.2%). (20, 21) Contrary to this, Ghorpade AG et.al. have shown only 17% of the participants at moderate to high risk for the occurrence of cardiovascular events by using WHO/ISH risk prediction charts in a rural population of South India (22).

This study further supports the role of anthropometric indicators in predicting NCDs. WC and WHR were significantly predicting DM, while hypertension was predicted by WC, WHR and BMI. A strong association of BMI with hypertension has been demonstrated in the scientific world.(23, 24) A meta-analysis of Indian studies evidenced a statistically significant association of obesity with type 2 DM (pooled OR = 1.14; 95%CI: 1.043 to 1.237) and hypertension (pooled OR = 3.820; 95%CI: 3.392 to 4.248).(25)

Conclusion

The current study provides scientific evidence by recalibrating IDRS and CBAC as instruments for screening for NCDs in a rural area of Western India. Instead of CBAC, the present study emphasizes the usefulness of IDRS as an excellent tool for screening for both Diabetes and Systemic Hypertension. We recommend that IDRS should be widely used to identify those at high risk of diabetes and hypertension in primary care settings. Rather than avoiding false positives, this is the time to expose the hidden section of the iceberg of NCDs by having high sensitivity of non-invasive instruments (like IDRS). As a result of the findings of this study, we propose a cut-off value of 50 for the IDRS to screen for diabetes in the rural population.

Abbreviations

- AUC
- Area Under the Curve
- BMI
- Body Mass Index
- BP
- Blood Pressure
- CBAC
- Community Based Assessment Checklist
- CHC
- Community Health Centre
- CI
- Confidence Interval
- CVDs
- Cardio-Vascular Diseases
- DM
- Diabetes Mellitus
- FPG
- Fasting Plasma Glucose
- HT
- Hypertension
- IDRS
- Indian Diabetic Risk Score
- ISH
- International Society of Hypertension
- JNC
- Joint National Committee
- MDRF
- Madras Diabetes Research Foundation
- NCDs
- Non-Communicable Diseases
- NPV
- Negative Predictive Value

PHC
Primary Health Centre
PPV
Positive Predictive Value
RCBG
Random Capillary Blood Glucose
ROC
Receiver Operating Characteristic Curve
SN
Sensitivity
SP
Specificity
WC
Waist Circumference
WHO
World Health Organization
WHR
Waist Hip Ratio

Declarations

Ethics approval and consent to participate: The study was approved by the Institutional Ethics Committee of All India Institute of Medical Sciences (AIIMS) Jodhpur (certificate reference number: AIIMS/IEC/2018/1085, dated 19th March 2018. Informed consent was taken from all the respondents. All the methods in the study were carried out in accordance with the relevant guidelines and regulations.

Consent for publication: Not Applicable

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request

Competing interests: The authors declare that they have no competing interests

Funding: None

Authors' contributions: The concept of the study was developed by MKG and PR. All the authors contributed equally in designing the study, data collection, formal statistical analysis, interpretations and manuscript development and review. All authors read and approved the final manuscript.

Acknowledgments: None

References

1. Singh N. Indian Diabetes Risk Score: Use beyond population screening for diabetes. Med J Armed Forces India. 2018 Jan;74(1):93–4.
2. Joshi SR, Das AK, Vijay VJ, Mohan V. Challenges in diabetes care in India: sheer numbers, lack of awareness and inadequate control. J Assoc Physicians India. 2008 Jun;56:443–50.
3. 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 Apr;80(1):159–68.
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 Physicians India. 2005 Sep;53:759–63.
5. Nagarathna R, Tyagi R, Battu P, Singh A, Anand A, Nagendra HR. Assessment of risk of diabetes by using Indian Diabetic risk score (IDRS) in Indian population. Diabetes Res Clin Pract. 2020 Apr;162:108088.
6. Adhikari P, Pathak R, Kotian S. Validation of the MDRF-Indian Diabetes Risk Score (IDRS) in another south Indian population through the Bolloor Diabetes Study (BDS). J Assoc Physicians India. 2010 Jul;58:434–6.
7. Government of India. Community Based Assessment Checklist (CBAC) Form for Early Detection of NCDs and Tuberculosis (TB) [Internet]. 2018 [cited 2019 Jan 20]. Available from: <http://nhsrcindia.org/sites/default/files/Revised%20Community%20Based%20Assessment%20Checklist%2027%20June%202018.pdf>
8. Gaziano TA. Reducing the growing burden of cardiovascular disease in the developing world. Health Aff Proj Hope. 2007 Feb;26(1):13–24.

9. Unal B, Critchley JA, Capewell S. Explaining the decline in coronary heart disease mortality in England and Wales between 1981 and 2000. *Circulation*. 2004 Mar 9;109(9):1101–7.
10. Palmieri L, Bennett K, Giampaoli S, Capewell S. Explaining the Decrease in Coronary Heart Disease Mortality in Italy Between 1980 and 2000. *Am J Public Health*. 2010 Apr;100(4):684–92.
11. Ford ES, Ajani UA, Croft JB, Critchley JA, Labarthe DR, Kottke TE, et al. Explaining the decrease in U.S. deaths from coronary disease, 1980–2000. *N Engl J Med*. 2007 Jun 7;356(23):2388–98.
12. World Health Organization: Prevention of cardiovascular... Google Scholar [Internet]. [cited 2021 Mar 26]. Available from: https://scholar.google.com/scholar_lookup?title=Prevention+of+cardiovascular+disease:+Guidelines+for+assessment+and+management+of+cardiovascular+risk&publication_year=2007&
13. Ministry of Health and Family Welfare G. National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke. 2017.
14. James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). *JAMA*. 2014;311(5):507–20.
15. World Health Organization. Redefining Obesity and its treatment: The Asia-Pacific perspective: [Internet]. 2000 [cited 2019 Sep 18]. Available from: https://apps.who.int/iris/bitstream/handle/10665/206936/0957708211_eng.pdf
16. 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;759–63.
17. 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 Apr;73(2):123–8.
18. 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*. 2015 Aug;38(4):359–60.
19. Garg M, Bansa R, Gupta M, Gupta CK. Prevalence of hypertension and its association with stress, indian diabetes risk score and obesity in rural population of meerut. *Indian J Community Health*. 2020 Mar 31;32(1):62–6.
20. Deori TJ, Agarwal M, Masood J, Sharma S, Ansari A. Estimation of cardiovascular risk in a rural population of Lucknow district using WHO/ISH risk prediction charts. *J Fam Med Prim Care*. 2020 Sep 30;9(9):4853–60.
21. Raghu A, Praveen D, Peiris D, Tarassenko L, Clifford G. Implications of Cardiovascular Disease Risk Assessment Using the WHO/ISH Risk Prediction Charts in Rural India. *PLoS ONE* [Internet]. 2015 Aug 19 [cited 2021 Mar 17];10(8). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4545825/>
22. Ghorpade AG, Shrivastava SR, Kar SS, Sarkar S, Majgi SM, Roy G. Estimation of the cardiovascular risk using World Health Organization/International Society of Hypertension (WHO/ISH) risk prediction charts in a rural population of South India. *Int J Health Policy Manag*. 2015 Apr 21;4(8):531–6.
23. Linderman GC, Lu J, Lu Y, Sun X, Xu W, Nasir K, et al. Association of Body Mass Index With Blood Pressure Among 1.7 Million Chinese Adults. *JAMA Netw Open* [Internet]. 2018 Aug 17 [cited 2021 Jun 10];1(4). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6324286/>
24. Landi F, Calvani R, Picca A, Tosato M, Martone AM, Ortolani E, et al. Body Mass Index is Strongly Associated with Hypertension: Results from the Longevity Check-Up 7 + Study. *Nutrients* [Internet]. 2018 Dec 13 [cited 2021 Jun 10];10(12). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6316192/>
25. Babu GR, Murthy GVS, Ana Y, Patel P, Deepa R, Neelon SEB, et al. Association of obesity with hypertension and type 2 diabetes mellitus in India: A meta-analysis of observational studies. *World J Diabetes*. 2018 Jan 15;9(1):40–52.

Figures

Figure 1

ROC curves; (1a). Diabetes with IDRS and CBAC score, (1b). Diabetes with anthropometric variables, (1c). Hypertension with IDRS and CBAC score, (1d). Hypertension with anthropometric variables, (1e). Any NCD (HT or DM) with IDRS and CBAC score, (1f). Any NCD (HT or DM) with anthropometric variables

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryTable1.xlsx](#)